United States Department of the Interior

Fish and Wildlife Service
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In Reply Refer to:
AESO/SE
22410-2009-F-0389

Date to be determined, 2013

Mr. Jim Upchurch, Forest Supervisor
Coronado National Forest
300 West Congress Street
Tucson, Arizona 85701

RE: Draft Biological Opinion for the Rosemont Copper Mine, Pima County, Arizona

Dear Mr. Upchurch:

Thank you for your request for formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). Your initial request was dated June 6, 2012, and was received by us on June 8, 2012. A subsequent request for conference was dated October 19, 2012 and received by us on October 22, 2012. At issue are the effects that may result from your proposed approval of the Mine Plan of Operations for the Rosemont Copper Company Project in Pima County, Arizona.

Your June 6, 2012, letter concluded that proposed mining activities associated with the Barrel Alternative (as modified; hereafter referred to as the the proposed action for the purposes of this consultation) may affect, and will likely adversely affect, the endangered Gila chub (*Gila intermedia*) and its critical habitat, the endangered Gila topminnow (*Poeciliopsis occidentalis occidentalis*), the endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*), the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and its critical habitat, the threatened Chiricahua leopard frog (*Lithobates chiricahuensis*), the endangered lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), the endangered jaguar (*Panthera onca*) and its proposed critical habitat, the endangered ocelot (*Felis pardalis*), and the endangered Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). Your letter also requested our concurrence with your determination that the proposed action may affect, but is not likely to adversely affect the threatened Mexican spotted owl (*Strix occidentalis lucida*). We concur with your determination and have provided our rationale in Appendix A.

This draft biological and conference opinion is based on information provided in: (1) your September 2011 *Draft Environmental Impact Statement for the Rosemont Copper Project, a Proposed Mining Operation, Coronado National Forest, Pima County, Arizona* (Draft EIS); (2) your June 2012 *Biological Assessment, Rosemont Copper Company Project, Santa Rita Mountains, Nogales Ranger District* (BA); (3) your October 2012 *Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest* (Supplemental BA); (4) your February 2013 *Supplement to the Biological Assessment – Proposed Rosemont Copper Mine - Santa Rita Mountains, Pima County, Arizona - Nogales Ranger District* (Second Supplemental BA); and (5) other published and unpublished sources of information. Literature cited in this biological opinion is not a complete bibliography of all literature available on the species of concern, and its effects, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at this office.

Please note that this biological and conference opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service* (No. 03-35279) to complete our analysis with respect to critical habitat. Critical habitat is defined in section 3 of the ESA "as the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical and biological features essential to the conservation of the species and that may require special management considerations or protection; and specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species." We have also relied upon the Consultation Handbook which provides guidance on determining adverse modification of critical habitat and jeopardy pursuant to the following: "Adverse effects on individuals of a species or constituent elements or segments of critical habitat generally do not result in jeopardy or adverse modification determinations unless that loss, when added to the environmental baseline, is likely to result in significant adverse effects throughout the species' range, or appreciably diminish the capability of the critical habitat to satisfy essential requirements of the species" (FWS and NMFS 1998).

Also note that, in reaching our findings that there is a reasonable certainty that lesser long-nosed bat, Chiricahua leopard frog, Gila chub, Gila topminnow, and jaguar will be incidentally taken, we considered the following:

- Section 9 of the Act and our implementing regulations in the Code of Federal Regulations (CFR) at 50 CFR part 17 prohibit the ``take" of fish or wildlife species listed as endangered or threatened.

- Take of listed fish or wildlife is defined under the Act as ``to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct".

- The term ``harass" is defined in the regulations as ``an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

- The term ``harm'' is defined in the regulations as ``an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, and sheltering'' (50 CFR 17.3).
- "Incidental take" refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant"(50 CFR 402.02).

Consultation History

July 3, 2013: We transmitted a Draft Biological Opinion to you, and note that it did not include analyses based on revisions to proposed jaguar critical habitat (78 FR 39237) (see event of July 1, 2013, below).

July 1, 2013: We announced: (1) revisions to our proposed designation of critical habitat for the jaguar; (2) the availability of a draft economic analysis; (3) the availability of a draft environmental assessment; (4) an amended required determinations section for the proposal; and (5) a reopening of the comment period.

June 26, 2013: We received your comments on our June 21, 2013, preliminary, administrative draft analysis of the proposed action's effects to the jaguar and its critical habitat via electronic mail. You also forwarded the comments made by the Rosemont Copper Company.

June 25, 2013: We received comments on our June 21, 2013, preliminary, administrative draft analysis of the proposed action's effects to the jaguar and its critical habitat from Rosemont Copper Company's counsel via electronic mail.

June 21, 2013: We transmitted, via electronic mail, a preliminary, administrative draft analysis of the proposed action's effects to the jaguar and its critical habitat. This section was not included in our April 19, 2013, or May 20, 2013, transmittals.

May 30, 2013: Our respective staffs as well as representatives of AGFD concluded negotiations regarding potential updates to the Proposed Conservation Measures for the Chiricahua leopard frog, finally determining that the measures would appear in the Draft BO as Terms and Conditions.

May 30, 2013: Your staff transmitted to us, via electronic mail, four documents responding to our DATE preliminary, administrative draft effects analyses for aquatic and riparian ecosystem and the southwestern willow flycatcher. The review documents included: (1) a package entitled Comments from Rosemont Copper on Preliminary Draft Biological Opinion Language Regarding Aquatic and Riparian Habitat, and Southwestern Willow Flycatcher authored by WestLand and incorporating additional SWCA reviews comments; (2) FS and SWCA reviews of the Effects to Aquatic Ecosystems, Effects to Riparian Ecosystems, and Effects to the Southwestern Willow Flycatcher.

May 20, 2013: We transmitted, via electronic mail, preliminary, administrative draft analyses of the proposed action's effects to aquatic ecosystems, riparian ecosystems, and the southwestern willow flycatcher. These sections were not included in our April 19, 2013, transmittal.

May 17, 2013: We received, via electronic mail, reviews of the Description of the Preferred Alternative and the Description of the Proposed Action conducted by SWCA Environmental Consultants (SWCA) on behalf of the Forest Service. The reviews were also accompanied by a brief description of the heretofore unknown Sycamore Connector Road component of the proposed action.

May 7, 2013: Your staff transmitted, via electronic mail, additional comments on the preliminary, administrative draft BO.

May 6, 2013: We received the Rosemont Copper Company's collected comments on the April 19, 2013, preliminary, administrative draft BO from WestLand Resources, Inc. (WestLand) via electronic mail.

April 19, 2013: We transmitted a preliminary, administrative draft of this BO to you via electronic mail. The preliminary draft did not contain analyses of effects to aquatic ecosystems, riparian ecosystems, the southwestern willow flycatcher, and the jaguar.

April 12, 2013: We received Rosemont Copper Company's comments on the April 1, 2013, draft narrative of the Description of the Proposed Action and Description of the Proposed Conservation Measures.

April 9, 2013: We transmitted a letter to you stating that we would transmit the core findings of our eventual Draft BO to you during the week of April 15, 2013. The core findings would include, at a minimum, the respective affected species' Environmental Baseline and Conclusion section and, when applicable, an Incidental Take Statement including Reasonable and Prudent Measures (or a Reasonable and Prudent Alternative), and Terms and Conditions section.

April 8, 2013: We received electronic mail messages from SWCA containing a review of the April 1, 2013, draft narrative of the Description of the Proposed Action and Description of the Proposed Conservation Measures and an updated mitigation and monitoring table.

April 1, 2013: We transmitted a draft narrative of the Description of the Proposed Action and Description of the Proposed Conservation Measures to you. We received your response on April 8, 2013. We also participated in a conference call with your staff as well as representatives of Rosemont Copper Company, including their biological consultant, WestLand and counsel, Norm James.

March 29, 2013: We participated in a conference call with your staff as well as representatives of Rosemont Copper Company, WestLand and Norm James.

March 14, 2013: We received a copy of correspondence entitled *Clarification and Supplemental Information in Support of Supplemental Biological Assessment Prepared for the Coronado National Forest and SWCA, Inc., for the Rosemont Copper Project* sent from WestLand.

February 12, 2013: We met with the Arizona Game and Fish Department (AGFD) to discuss the consultation.

February 8, 2013: We received your February 2013 *Supplement to the Biological Assessment – Proposed Rosemont Copper Mine - Santa Rita Mountains, Pima County, Arizona - Nogales Ranger District* (Second Supplemental BA).

January 31, 2013: We met with your staff, the AGFD, and Westland Resources, Inc. to discuss further revisions to the proposed conservation measures.

January 23, 2013: We met with your staff, biologists from SWCA, and representatives of the Rosemont Copper Company to assist in finalizing a second supplemental Biological Assessment.

January 9, 2013: We transmitted a letter to you discussing the outcome of the January 3, 2012, meeting and addressing the concerns found in Norman D. James' December 19, 2012, letter.

January 3, 2013: We met with your staff, biologists from SWCA, and representatives of the Rosemont Copper Company to discuss conservation measures and the content of an anticipated second supplemental Biological Assessment.

December 21, 2012: We received a December 19, 2012, letter from Norman D. James of Fennemore Craig P.C., counsel for the Rosemont Copper Company, regarding our December 13, 2012, letter to you.

December 21, 2012: We received documents entitled *Rosemont Copper Project Biological Assessment Supplement - Cienega Creek Watershed Habitat Restoration And Enhancement Program*, *Rosemont Copper Project: Biological Assessment Supplement - Lesser Long-Nosed Bat Forage And Roost Conservation Measures*, and *Rosemont Copper Project: Section 7 Consultation Grazing Management Conservation Measures* from Westland Resources, Inc.

December 13, 2012: We transmitted a letter to you documenting outstanding information needs requesting additional time to complete formal consultation on the proposed action.

December 7, 2012: We received a revised version of the *Rosemont Copper Project: Potential Effects of Lighting Associated with the Rosemont Project on Endangered Species* from Westland Resources, Inc.

December 5, 2012: We received a document entitled *Rosemont Copper Project: Potential Effects of Lighting Associated with the Rosemont Project on Endangered Species* from Westland Resources, Inc.

November 18, 2012: We met with your staff and staff from SWCA to receive information regarding the biological effects resulting from the groundwater impacts discussed at the aforementioned October 18, 2012, meeting.

November 14, 2012: We received a documents entitled *Rosemont Copper Project: Conservation Measures – Water Features and Rosemont Copper Project: Potential Effects Of The Rosemont Project on Lower Cienega Creek* from Westland Resources, Inc.

November 13, 2012: We met with your staff, biologists from SWCA, Inc., and representatives of the Rosemont Copper Company to discuss conservation measures and progress in the consultation. We received a document entitled *Rosemont Copper Project: Conservation Measures – Water Resources* from Westland Resources, Inc.

November 9, 2012: We received documents entitled *Rosemont Copper Project: Conservation Measures Provided by Clean Water Act Section 404 Mitigation* and *Rosemont Copper Project: Potential Effects of the Rosemont Project to Jaguar and Proposed Jaguar Critical Habitat* from Westland Resources, Inc. via electronic mail.

November 8, 2012: We received the draft *Rosemont Copper Company Habitat Mitigation and Monitoring Plan Permit No. SPL-2008-00816-MB* (HMMP) prepared by Westland Resources, Inc.

October 22, 2012: We received, via electronic mail, your October 19, 2012, letter requesting formal conference on the proposed critical habitat for the jaguar and southwestern willow flycatcher. Your October 19, 2012, letter also transmitted your October 2012 *Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest* (Supplemental BA).

October 18, 2012: We attended a forum attended by your staff and well representatives of the U.S. Geological Survey (USGS), Bureau of Land Management (BLM), SWCA, Inc., the Rosemont Copper Company, Tetra Tech, Engineering Analysis, Inc., and SRK Consulting to discuss the validity and results of groundwater modeling efforts associated with proposed action. These analyses form part of the basis of the BA and Supplemental BA's analyses of effects to aquatic and riparian species.

September 13, 2012: We received, via electronic mail, your September 12, 2012, granting of the 60-day extension we requested on August 29, 2012.

September 6, 2012: We met with your staff, biologists from SWCA, and representatives of the Rosemont Copper Company to discuss conference consultation on proposed critical habitat for the jaguar (77 FR 50214).

August 29, 2012: We transmitted a request for a 60-day extension to the consultation timeline, stating we would deliver a Draft BO by November 5, 2012 and, following timely receipt of your comments, a Final BO by December 20, 2012.

August 2, 2012: My staff met with your staff and other Cooperating Agencies (as defined under the National Environmental Policy Act; NEPA) to discuss the biological outcomes of the proposed action's effects to surface and groundwater hydrology and to help develop conservation measures and monitoring programs for them. It should be noted that the FWS is not a formal Cooperating Agency.

July 24, 2012: My staff participated in a meeting with your staff and the Cooperating Agencies to assist in the development of mitigation measures for the impacts of the propose action.

July 9, 2012: My staff participated in a meeting with your staff and the Cooperating Agencies to assist in the development of mitigation measures for the impacts of the proposed action.

June 28, 2012: My staff participated in a meeting with your staff and the Cooperating Agencies to assist in the development of protocols to verify impacts to riparian resources and monitor those effects for the life of the proposed action.

June 11, 2012: My staff participated in a meeting with your staff and the Cooperating Agencies to assist in the development of mitigation measures for the impacts of the proposed action.

July 20, 2012: We transmitted a letter to you indicating that we had received all of the information required of you to initiate formal consultation required by the regulations governing section 7(a)(2) interagency consultation at 50 CFR §402.14.

May 24, 2012: My staff met with staff from the U.S. Geological Survey water resource and geology disciplines to discuss the hydrologic effects of the proposed action as well as the monitoring needed to measure them.

May 16, 2012: We transmitted you a letter containing our review of the January 2012 deliberative *Draft Biological Assessment, Rosemont Copper Project, Santa Rita Mountains, Nogales Ranger District* (Draft BA), including recommended conservation measures.

April 9, 2012: We met with AGFD staff to jointly develop conservation measures for our respective trust species.

March 8, 2012: We met with your staff as well as representatives of the AGFD, Bureau of Land Management (BLM), SWCA, Inc., Rosemont Copper Company, and Westland Resources, Inc. to be presented with a groundwater model overview and to engage in continued discussions on the Draft BA.

March 5, 2012: My staff transmitted comments regarding the Draft BA's effects analysis for the lesser long-nosed bat to your staff via electronic mail.

February 29, 2012: My staff transmitted comments regarding the Draft BA's effects analysis for the Mexican spotted owl to your staff via electronic mail.

February 14, 2012: We met with your staff as well as representatives of the AGFD,BLM, SWCA, Inc., Rosemont Copper Company, and Westland Resources, Inc. to engage in initial discussions on the content of the Draft BA.

January 25, 2012: We received the electronic version of your Draft BA

January 19, 2012: We transmitted a letter (File No. 02EAAZ00-2012-CPA-0015) to the U.S. Army Corps of Engineers (Corps), commenting on Public Notice 02EAAZ00-2012-CPA-0015. Our letter, a copy of which was provided to you, preliminarily identified our concerns with the proposed action's effects to threatened and endangered species.

October 11, 2011: My staff met with representatives of the Rosemont Copper Company near the mine site to discuss the project and engage in early discussions on potential conservation measures.

August 24, 2011: Our respective staffs met with representative of the Rosemont Copper Company and Westland Resources to discuss the potentially affected species and conceptual conservation measures.

January 11, 2011: Our staff met with representative of the Rosemont Copper Company and Westland Resources to receive a project overview and visit the proposed mine site.

October 18, 2010: We met with your staff to discuss the threatened and endangered species potentially affected by the proposed action.

December 10, 2009: My staff participated in a field trip to examine issues related to the biological outcomes of the proposed action's hydrologic effects.

November 23, 2009: My staff participated in a Karst formation and groundwater hydrology discussion with staff from Arizona State Parks and other agencies.

November 19, 2009: My staff participated in a meeting with your staff and the Cooperating Agencies to discuss the potential for acquisition of off-site lands to mitigate the impacts of the proposed action.

October 13, 2009: Staff from our agencies, AGFD, and representatives of the Rosemont Copper Company attended a site visit to examine habitat for bats, including lesser long-nosed bats.

September 18, 2009: Staff from our agencies, AGFD, and representatives of the Rosemont Copper Company attended a site visit to examine habitat for talussnails (*Sonorella* spp.).

September 15, 2009: My staff participated in a site visit to examine Chiricahua leopard frog habitat within the proposed mine site and on adjacent ranchlands.

September 1, 2009: – Staff from our agencies, the AGFD, and representatives of the Rosemont Copper Company attended a site visit to examine habitat for Chiricahua leopard frogs.

August 5, 2009: We met with your staff as well as representatives of, SWCA, Inc., Rosemont Copper Company, and Westland Resources, Inc. to begin discussions regarding the proposed action's effects to threatened and endangered species and the preparation of a BA to address those effects. This meeting also served as an initiation of early consultation pursuant to section 7(a)(3) of the Act and its implementing regulations at 50 CFR § 402.11.

BIOLOGICAL AND CONFERENCE OPINION

Description of the Proposed Action

Rosemont Copper Company (Rosemont) submitted a proposed mine plan of operations (MPO) to the Coronado National Forest, an administrative unit of the U.S. Department of Agriculture Forest Service (Forest Service), for development of the Rosemont ore deposit. The proposed mine site is located on the east side of the Santa Rita Mountains, approximately 30 miles south of Tucson, Arizona. Activity is proposed on approximately 995 acres of private land owned by Rosemont Copper, 3,670 acres of Cornado National Forest land, and 75 acres of land administered by the Arizona State Land Department. This area includes a utility corridor that is needed to provide power and water to the project area. The mine life, including construction, operation, reclamation, and closure, is approximately 25 years.

Two Federal agencies have authority regarding MPO approval: the Forest Service and U.S. Army Corps of Engineers. The Forest Service is responsible for administering Cornado National Forest land, including the approval of MPOs under that agency's surface management regulations. The Corps of Engineers is responsible for administering Section 404 of the Clean Water Act. Rosemont has applied for a permit from the Corps of Engineers to discharge tailings and waste rock into ephemeral drainages that are considered to be waters of the United States. The agency actions thus consist of approval of an MPO and a permit under Section 404 of the CWA.

The Forest Service, as the lead agency and land manager for the Coronado National Forest, prepared the *Draft Environmental Impact Statement for the Rosemont Copper Project, a Proposed Mining Operation, Coronado National Forest Pima County, Arizona* (Sept. 2011) (DEIS). In the DEIS, the Forest Service identified the Barrel Alternative as the preferred alternative (see Figure I-1).

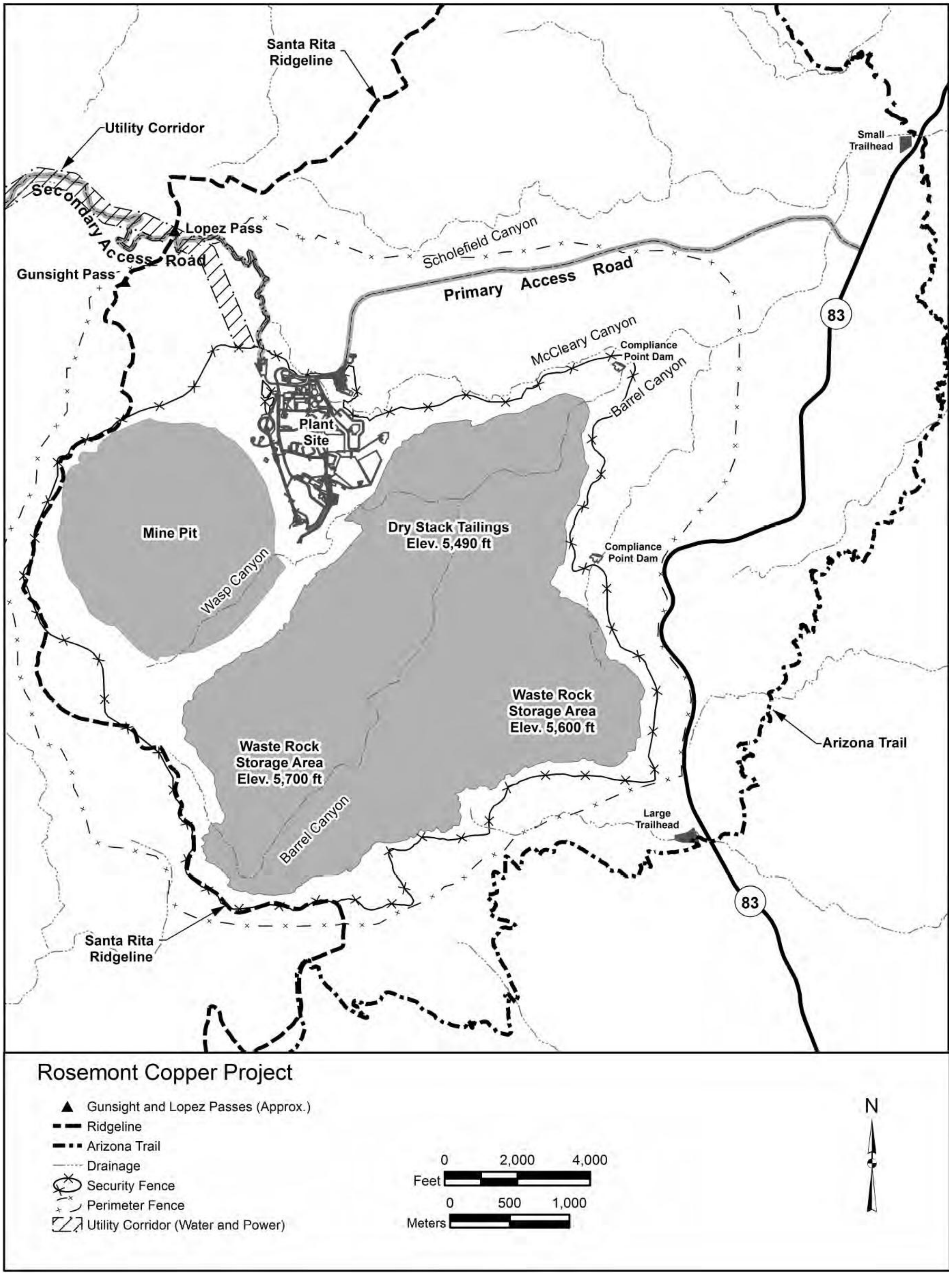

Figure I-1. The Barrel Alternative Footprint (Proposed Action) (Note: This figure does not illustrate the proposed Sycamore Connector Road)

The Barrel Alternative, which places all of the tailings and waste rock in upper Barrel Canyon and the lower portion of Wasp Canyon, was developed during the NEPA process to respond to the significant issues regarding potential impacts on biological resources, cultural resources, and the surface water component of water resources. The Forest Service interdisciplinary team biologist determined this alternative to have the least impact on plant and animal resources because it avoids the McCleary Canyon drainage; it is the most physically and biologically diverse of the nearby canyons, and harbors the rare plant Coleman's coral-root (*Hexalectris colemanii*) (SWCA 2011). Prohibiting mine tailings or waste in McCleary Canyon permanently maintains its contribution of surface water flow to the Barrel Canyon drainage system. Stormwater flow through McCleary Canyon would be somewhat decreased during mine operations because runoff from the plant site would be retained. However, there are also increases to the drainage area that will be diverted through the McCleary Canyon channel, due to diversions from upstream of the pit and the plant site.

The Barrel Alternative incorporates a waste rock perimeter buttress that completely surrounds the dry-stack tailings. Heap leaching facilities are not included in the current iterations of alternative. In order to maintain concurrent reclamation of final outer slopes, waste rock will initially be placed in berms along the outside edge of the waste rock area, followed by waste rock and tailings placement behind the berms. The tailings conveyor system will be modified to accommodate the relocated tailings facility. Surface water management facilities include diversions around the facility to convey storm events upgradient of the pit, operating facilities, and waste rock and tailings storage areas and to place the water back into drains or other control structures. Diversion and stormwater control facilities will include the following:

- Stormwater redesign, including removing the underdrains, eliminating storage on the top and benches of the tailings and waste rock facilities, and incorporating more stormwater routing downstream. The redesign reduced post-closure flow loss from 34 percent to 17 percent (compared to baseline conditions).
- The Barrel Alternative permits no storage of stormwater on the top or benches of the waste rock/tailings landform post-closure. Instead, waste rock and tailings facilities will shed runoff after closure. The tops of the facilities will be graded to discharge stormwater to the lower benches, which in turn are designed to move stormwater laterally along the benches until it reaches several concrete drop structures. The runoff from these drop structures will either be discharged into the natural washes (Barrel Canyon or a tributary) or discharged into a diversion channel that will carry runoff along the toe of the waste rock and tailings facilities and then discharge that runoff into the natural washes. In this manner, as much water as possible will be allowed to flow downstream after reclamation is complete.
- The flow-through drains beneath the tailings and waste rock facilities are not part of the Barrel Alternative because of concerns about intermingling of stormwater and tailings seepage and long-term maintenance. Post-closure, stormwater from the former plant site will instead be diverted to flow into McCleary Canyon via a surface channel.
- Modifying the process water temporary storage pond and adding a double liner with a leak collection and removal system to the process water containment to improve the containment of process water and separate stormwater from process water.

- Realigning the primary access road to avoid Scholefield Canyon, reduce its visibility, decrease stormwater runoff into the Barrel Canyon drainage system, and reduce impacts to riparian vegetation.

Extraction of ore will be from an open-pit mine located primarily on private land (approximately 590 acres of the 955 acre site). Processing, waste management, and other support facilities are proposed to be located on the Coronado National Forest; project infrastructure, such as utilities, will be located on Cornado National Forest and ASLD lands. Access to the mine site will originate on SR 83 east of the pit and facilities. The complete mine life, as described in the Supplemental BA, is as follows:

- Premining phase: 18 to 24 months. (Includes initial clearing vegetation, soil stockpiling, construction of facilities and roads, construction of electric and water lines, fence construction, decommissioning of forest roads, initial construction of pit, initial construction of the perimeter waste rock buttress, and construction of compliance wells).
- Active mining phase: 20 to 25 years. (Includes additional vegetation removal, continued pit development, continued construction of the perimeter waste rock buttress, placement of tailings, concurrent reclamation activities).
- Final reclamation and closure phase: 3 years. (Includes removal of plant site facilities, completion of reclamation, staining of pit walls, removal of perimeter fence, and removal of water and electrical lines on Coronado National Forest lands).
- Post-closure phase. Indeterminate amount of time. (Includes monitoring and maintenance).

Project-related activities that will be conducted over the aforementioned timeframe include the following:

- Construction and operation of an open-pit copper, molybdenum, and silver mine primarily on private land;
- Construction, operation, and reclamation of an ore processing plant, tailings, and waste rock facilities on National Forest System land adjacent to the pit;
- Construction and operation of infrastructure, such as utilities and their corridors, on State, private and National Forest System lands;
- Construction of a new access road, retention structures, wells, ore transportation systems, and reclamation test plots;
- Use of existing roads, new road construction, and maintenance of both;
- Labor requirements for construction, operation, processing, reclamation, and closure;
- Implementation of conservation measures for minimization and mitigation to avoid or minimize impacts;
- Reclamation, closure, and maintenance of the mine and related facilities; and
- Resource monitoring during construction, operation, reclamation, closure, and post-closure.

Calculation of Acres of Disturbance

The proposed mine will be surrounded by a perimeter fence within which public access will not be allowed. The October 2011 DEIS and June 2012 BA both assumed that any lands within the perimeter fence would be disturbed; however, upon further review, not all of those lands will undergo surface disturbance. Within the perimeter fence, a separate security fence/road that will be erected roughly 750 feet from the toe of the waste rock/tailings facilities. Except where specific features such as the primary access road, utility corridor, groundwater monitoring wells and compliance point dam are located, the land between the perimeter fence and the security fence will not be disturbed. This more focused and refined calculation has resulted in a reduced acreage of disturbance as compared to earlier estimates. The June 2012 BA indicated that 7,016 acres of land would be directly disturbed. Owing to the changes described above, this acreage has been refined to 5,393 acres, which includes areas within the security fence (4,228 acres), the primary access road (226 acres), the utility line corridor (867 acres), decommissioned or new forest roads (54 acres), and the rerouted Arizona National Scenic Trail and trailheads (19 acres).

The facilities and activities described in this section are typical of open-pit mine sites. The descriptions below, however, are specific to the components for the proposed action . The mine pit is where blasting and drilling activities would occur. The waste rock and tailings will be transported and processed within the corresponding facilities. Lighting and waste disposal will take place at the plant site and support facilities. A perimeter fence will be constructed, encompassing the main mining and processing operations and excluding portions of the access roads, and some Coronado National Forest lands will be unavailable for public use during the 24.5 to 30-year mine life. A legal closure order will be issued by the Coronado National Forest, and notices will be posted along the fencing. Perimeter fencing will consist of a standard 4-strand barbed wire fence (with a smooth bottom wire, in accordance with BLM and AGFD fencing standards). Sections of the perimeter fence are expected to be removed following closure after considering grazing and safety needs. Portions of the site, including the mine pit, will likely remain fenced off and closed to the public indefinitely for safety reasons.

Pit

Preproduction stripping of overlying rock is expected to require 18 to 24 months to prepare for full-scale mining operations, train work crews, construct access and haul roads, and clear and grub the pit and waste rock storage areas that will be disturbed during the initial years of operation. Open-pit mining will be used to excavate ore to recover copper, molybdenum, and silver. The roughly circular open-pit mine will measure between 6,000 and 6,500 feet in diameter at the end of mine life, with a final depth of up to 3,000 feet (3,050 feet above mean sea level). Pit slope angles between roads will be controlled by rock strength and will range between 33 and 50 degrees. The pit will disturb approximately 955 acres: 590 acres on private land and 365 acres on Coronado National Forest lands.

Blasting and Drilling

Blasting will be required prior to excavation of the ore and waste rock, and will generally conducted daily. Explosives storage, transport, and use will adhere to all rules, regulations, and safety standards. Once a day on average, an ammonium nitrate and fuel oil explosive will be detonated in the mine pit. This will occur during daylight hours only, generally between 9 a.m.

and 4 p.m. Dry bulk ammonium nitrate will be transported for use from storage silos at the adjacent plant site. Blasting detonators, such as caps, delays, cord, and boosters, will be stored in special magazines and transported to the pit in separate vehicles. If wet-hole blasting is necessary, an emulsion and/or slurry will be transported to the pit from onsite storage tanks. Mixed ammonium nitrate and fuel oil will be loaded and transported using trucks specifically designed for that purpose.

Ore Processing

Originally, Rosemont proposed two different types of ore processing methods: a conventional flotation method and a heap leach-solution extraction method. Based on the proposed action selected by the Forest Service, which imposed engineering constraints that affect the operation of a heap leach pad, and comments on the DEIS, Rosemont Copper removed the heap leach-solution extraction circuit, and will process ore only by means of a conventional flotation method.

Ore will be sent through a circuit of crushers, grinding mills, and ball mills to reduce the rock size to a fine sand consistency. A flotation circuit will concentrate the copper and molybdenum minerals from the rest of the ore material. The concentrates will then be dewatered, thickened, filtered, and loaded for shipment. Water from the filtering and thickening process wi returned to the process and recycled.

Waste Rock and Tailings Placement

Waste rock, which consists largely of chemically basic limestone and other largely non-acid-generating rocks, will be placed in areas located outside the open pit. The tailing is the material remaining after the floatation process to recover the copper and molybdenum minerals are removed. These tailings are thickened and then further dewatered through filtering. The water from the dewatering process is returned to the mill for reuse. The tailings are transported via conveyor belt to the unlined dry-stack tailings disposal area, where the tailings will be deposited, stacked, and compacted as needed. Ultimately, the tailings will be placed behind a waste rock buttress and, ultimately, encapsulated, or covered completely by a thick layer of waste rock.

Transportation of ore, waste rock, and tailings will occur only in the mine area, which will be closed to the public for safety reasons. Ore and waste rock will be moved in large, off-highway haul trucks. Roads for the haul trucks will be constructed both within the open pit and between the pit and the plant, tailings facility, and waste rock storage area. In accordance with Mine Safety and Health Administration (MSHA) regulations, haul roads will be approximately 125 feet wide, including safety berms and drainage ditches, and no steeper than 10% to 12%. Maximum truck speed will be 35 miles per hour. Haul roads are temporary and regularly move based on the locations of material placement.

Plant Site and Support Facilities

Facilities necessary to support Rosemont's mining and ore processing operations will be constructed during the premining phase, and removed during final reclamation and closure. These facilities include buildings and structures, such as administration buildings, change house, warehouse with laydown yards, analytical laboratory, light vehicle and process maintenance building, mine truck shop, mine truck wash and lube facility, powder magazines and ammonium nitrate storage, main guard shack with truck scale, and fuel and lubricant storage and dispensing facilities. The facilities are located generally in one centralized area near the open pit.

Lighting

The proposed action lies within an area of concern relative to the effects of light pollution (Monrad *et al.* 2012). Neither the existing 2006 Pima County Outdoor Lighting Code (PCOLC) nor the draft 2011 PCOLC have jurisdiction over the proposed action area; however, Rosemont will employ an advanced light pollution mitigation plan. The plan includes the use of state of the art lighting equipment and controls to minimize environmental impact to levels below the intent of the PCOLC, including other comparable modern light pollution control standards, while simultaneously complying with the proposed action 's operation safety requirements prescribed by the Mine Safety and Health Administration (MSHA).

The proposed action is expected to generate approximately 10% to 15% of the amount of environmental light that, under the PCOLC, would normally be allowed by a similar commercial development of the same scale in the same location using conventional lighting systems on a similarly sized parcel (Monrad *et al.* 2012). The proposed action is expected to produce approximately 6.15 million lumens, which takes into account all lighting sources, including equipment-mounted lighting systems.

Solid, Hazardous, and Sanitary Waste

Solid waste will be recycled as appropriate and feasible. Non-recyclable inert waste will be disposed of at a state licensed on-site landfill located on Rosemont's private property. The landfill will cover approximately about 2 acres on Rosemont's private property and will be permitted and regulated by the Arizona Department of Environmental Quality (ADEQ). The excavated depth of the landfill will range from 5 to 43 feet, with a minimum excavation elevation of approximately 5,190 feet above mean sea level; maximum height of the landfill at closure will be no more than 5,280 feet above mean sea level. All putrescent materials or other items that cannot be appropriately disposed of in the solid waste facility will be transported of off-site by a commercial vendor. Large (greater than 3 feet in diameter) equipment tires, such as those on the haul trucks, will be recycled if practicable, or otherwise disposed of on-site in specific tire burial cells located within the waste rock facility. Hazardous waste will be handled and disposed of in accordance with applicable regulations, and no hazardous waste will be disposed of on-site. All hazardous waste will be transported by licensed haulers and disposed of at regulated facilities. Sanitary waste at the project site will be handled by septic systems, with leach fields located in the vicinity of each building. During the construction phase and where necessary during operations, portable toilets will be used in various locations throughout the plant and mine sites.

Electrical Power Supply

The total power requirement for the proposed action is 108 to 112 megawatts and will require a minimum transmission voltage of 138 kilovolts. Tucson Electric Power (TEP) has entered into an agreement with Rosemont to construct a transmission line to the mine site. All costs of the line will be borne by Rosemont. In addition to traditional electrical service from TEP, the proposed action will also generate energy on-site using solar technologies, such as solar technologies to partially power the administration buildings and potentially other areas.

On June 12, 2012, the Arizona Corporation Commission approved the Certificate of Environmental Compatibility authorizing the construction of an aboveground 138-kilovolt electrical transmission line and associated facilities from the proposed Toro Switchyard to the Rosemont Substation (Figure 2 in the October 2012 Supplemental BA and figure I-1 in tis document). Following a hearing, the Certificate of Environmental Compatibility was issued by the Arizona Power Plant and Line Siting Committee, approving the preferred route. Thereafter the Arizona Corporation Commission approved the Certificate of Environmental Compatibility with certain modifications that included the issuance of the Record of Decision. The water supply (see Water Supply section) and secondary access road (see Utility Maintenance Road section) are co-located with the lines. The route generally parallels the existing South Santa Rita Road before entering private property held by Rosemont and crosses the ridgeline at Lopez Pass. The alignment then enters Coronado National Forest lands before entering the mine facility area.

Water Supply

The project is permitted by the Arizona Department of Water Resources (ADWR) to draw up to 6,000 acre-feet per year. However, it is currently estimated that the project will use between 4,700 and 5,400 acre-feet per year of fresh water, for a total use over the mine life of approximately 100,000 acre-feet. The water will be pumped from four to six wells located on land owned or leased by Rosemont near the community of Sahuarita in the Santa Cruz Valley at a maximum rate of 5,000 gallons per minute (total pumpage). The pipeline requires 4 booster pump stations to maintain water flow in the line. The majority of the water used by the mine operation will be allocated to ore processing, with less water used for activities such as dust control, fire protection, drinking water, and sanitary uses. The majority of the water supply will come from groundwater wells in the Santa Cruz Valley, with a much smaller amount obtained from stormwater and pit dewatering on the mine site. Where feasible, water will be reclaimed from a variety of uses on the mine and returned for use in processing. Water acquired through pit dewatering will either be used in processing or for dust control purposes. The water pipeline alignment will largely follow the TEP Preferred Alternative Transmission Line (see Figure PPC-1 in the Pima pineapple cactus effects analysis).

A 20- to 24-inch ductile iron water pipeline will be constructed from the mine supply wells to the mine site. It will be buried where feasible. Where rock prohibits burial, the pipeline will be placed above the rock and covered with soil, with a minimum soil cover of 36 inches on ASLD easements and up to 24 inches on Rosemont Copper private land, depending on slope, topography, and the availability of cover material. The pipe bedding requirements will follow the manufacturer's recommendations. Isolation valves will be installed in the pipeline at intervals of approximately 3,000 feet and at elevation changes of 250 feet. At wash crossings, the pipeline will be constructed below the calculated scour depth of the wash, and grade control structures will be provided at the largest washes to provide additional protection. Construction of the pipeline will include an unpaved permanent maintenance road and up to four enclosed storage reservoirs and pump stations. The reservoirs and pump stations will be built outside potential jurisdictional Waters of the U.S.

Water Control

The primary water control objective is to reduce the risk of discharging potentially contaminated water into the environment. Three major areas of water contamination control are as follows: process water, groundwater, and stormwater that comes into contact with process facilities or tailings. Control of process water consists of containing the process water in engineered structures, such as tanks, pipes, sumps, lined ponds, and lined ditches, and maintaining the water content of the dry-stack tailings at a level that reduces seepage from the dry-stack tailings facility. The engineering design and performance of the various process water control facilities, including seepage and leakage monitoring and recovery, will meet or exceed the best available demonstrated control technology criteria used by the ADEQ and will be regulated under their permits issued pursuant to the State Aquifer Protection Permit that was issued on April 3, 2012.

Groundwater control includes those activities and facilities intended to protect and monitor the quality of the groundwater in the area, as well as the investigation and modeling used to predict the response of the groundwater systems to both the withdrawal of groundwater and the influence of seepage and leakage from project facilities. Implementation of groundwater control requirements will be monitored as part of the aquifer protection permit that has been issued by the ADEQ. This includes monitoring of the seepage and leakage detection systems required to be designed into processing facilities by the aquifer protection permit.

Of particular importance to the long-term groundwater protection is the acid rock drainage protection and monitoring program. Monitoring to ensure that off-site groundwater quality is not impacted beyond the level allowed by the aquifer protection permit is accomplished through the installation and scheduled sampling and testing of specific groundwater monitoring wells as required by the aquifer protection permit and by applying best available demonstrated control technology (i.e., engineering controls and practices). Protection of groundwater quality following mine closure is achieved by the following: the closure and reclamation of the process facilities: elimination or reduction of acid rock drainage generation in the tailings and waste rock from the design and operation of the facilities; monitoring and testing required by the aquifer protection permit following mine closure; and capture of possible impacted mine site groundwater by localized groundwater flowing into the pit.

The general design concept for managing stormwater from the dry-stack tailings facility is to minimize infiltration of water in the tailings. The top surface of the dry-stack tailings will be exposed to precipitation only during operations. All tailings will be covered with waste rock at closure. The general design concept for managing stormwater from the dry-stack tailings facility is to minimize infiltration of water in the tailings and prevent discharge of stormwater that comes in contact with the tailings. This will be accomplished by constructing uniform lifts of dry tailings that are buttressed by waste rock. The buttresses will be built around the tailings surface for containment and erosion control. The top of the tailings facility will be relatively impervious. That is, during operations, all precipitation will remain on top of the tailings facility to evaporate. If water ponds on top of the tailings facility, it will be pumped to the process water temporary storage pond to limit infiltration into the tailings facility. Diversion channels will be constructed to direct surface runoff that has not contacted tailings from the outer waste rock shell slopes into either sediment ponds or adjacent drainages to a sediment control structure. .

Stormwater from above the mine pit will be diverted around the pit and plant site. During operations, stormwater that falls within the mine pit and associated disturbed areas, and all stormwater that comes into contact with ore, will be contained onsite and used for mining and mineral processing purposes. Post-closure, any stormwater that enters the pit will contribute to the pit lake. The small ridge just east of the plant site will be eliminated post-closure in order to enable stormwater from the reclaimed plant site area to flow downstream into McCleary Canyon. Precipitation that comes into contact with waste rock does not need to be retained, but can be released downstream. Regardless of this, much of the runoff from the waste rock facilities will be retained during operations, with the exception of the perimeter waste rock buttresses. For perimeter buttresses, concurrent reclamation and appropriate best management practices will progress up the outer slopes as the buttresses are constructed. This will limit erosion potential and allow noncontact runoff to discharge to down-gradient sediment ponds and eventually to the watershed.

Stormwater management at the waste rock facilities is similar to that for the dry-stack tailings facility. For the construction of the initial perimeter buttresses, concurrent reclamation and appropriate best management practices will progress up the outer slopes as the buttresses are constructed. This will limit erosion potential, while minor diversion channels will be used to direct non-contact runoff to downgradient sediment ponds. The sediment ponds at the toe of the outer slopes will be designed to store and release up to the 10-year, 24-hour storm event so that suspended sediment concentrations of discharged water are no greater than background conditions.

Stormwater diversion channels will be constructed to route noncontact surface water runoff around the proposed project site and from undisturbed areas within the proposed site area to natural drainages downgradient of the mine site. Stormwater (contact water) from the mine pit, ore processing facilities, and mine maintenance plant areas will be prohibited from surface discharge by the stormwater permit during operations. Stormwater from the waste rock and tailings facilities, including the waste rock buttresses that are not reclaimed or stabilized, will be routed to sediment control structures, where any overflow discharging off-site will be monitored for constituent and sediment content in accordance with ADEQ's Arizona Polluntant Discharge Elimination Systyem Multi-Sector General Industrial Stormwater Permit.

General stormwater management structures are designed using a precipitation-runoff simulation computer program developed by the USACE. Two calculations have been evaluated (the peak flow and the runoff volumes) for Rosemont's selection of the most practical and protective methodology and criteria for use (Tetra Tech 2010a, 2010b).

Active stormwater management will continue after the mine closes, as required by the mining stormwater general permit and the erosion control provisions of the mine land reclamation plan, administered by the Arizona State Mine Inspector. The Arizona State Mine Inspector has jurisdiction for reclamation under Title 27 Arizona Revised Statutes (ARS) Chapter 5; this is the Reclamation Act statute for reclamation of hardrock mining, which pertains to private lands with more than 5 acres of mining disturbance. In general, reclamation and closure is designed to shed all stormwater from the waste rock facility, the tailings facility (which will have been capped with waste rock), stormwater that is diverted around the northeast side of the pit, and the plant site. Post-closure precipitation falling in the pit itself and stormwater diverted around the northwest side of the pit will not discharge downstream.

Compliance Point Dam

A compliance point dam will serve as the final compliance point where stormwater can be monitored. Each of the two dams included in the Barrel alternative will be approximately 6 feet tall and approximately 100 to 200 feet wide, with a storage capacity of approximately 2 acre-feet. They will be constructed in year 0, prior to the commencement of mining, using inert waste rock, and be classified as an Arizona Department of Water Resources nonjurisdictional, unlined embankment. Normally, the area upstream of and behind the embankment will be empty. During storm events, water will be temporarily impounded and slowly released through the porous rock-fill dam. Large storm events will overtop the dam and proceed downstream. The compliance point dam will be removed after closure of the proposed action facilities or if the facilities reach final stabilization through concurrent reclamation and sediment runoff is within acceptable limits.

Primary Access Road

A new 2-lane paved road, referred to as the “primary access road,” will be constructed to provide access between SR 83 and the mine (see Figure 1 in the BA and Figure I-1 in this document). The primary access road will leave SR 83 along a straight section of the highway. At the intersection, SR 83 will be widened and provided with additional lanes. Public use will be restricted on portions of the primary access road during construction and operation of the mine because of safety considerations, but will be reopened to the public after closure. Segments of the primary access road will be added to the national forest system road inventory.

Utility Maintenance Road

Referred to as the “secondary access road” in the DEIS, a better understanding of this road and its function resulted in its being renamed the “utility maintenance road.” This road will be located within the utility corridor to serve as access to the power supply line, water supply line, and water booster pump stations. The road will consist of two discrete segments: one from the plant site, over Lopez Pass, to a major wash on private land; and another from the supply wells near Sahuarita to the other side of the major wash, generally following the electrical transmission and water line location. Refer to Figure I-1 and Figure PPC-1 for a map of the utility maintenance road.

A gravel road will be reconstructed from the plant site to Lopez Pass (NFSR 505) to serve as a maintenance road for the utility supply lines. The existing road over Lopez Pass is on NFS land and private land. While NFSR 505 is recognized within the Forest Service’s road inventory, it has no public easement across private land. The rocky, hilly portion of the road will be reconstructed, and a new road will be created that will run west across private land. The road will intercept a major wash at its western terminus. There are no plans to construct a crossing of this wash, which would require an engineered structure. The second segment of the utility maintenance road will begin at the mine water supply wells near Sahuarita and follow the location of the electrical transmission and water lines. This road segment will cross land administered by the ASLD and private lands and generally parallel Santa Rita Road.

A right-of-way (ROW) permit from ASLD is required for the sections of the utility maintenance road and utility corridor on State land. A ROW application has been filed; the ROW permit itself will not be issued until approval of the project by the Forest Service. The sections of the road within the ASLD ROW will be newly constructed.

Where the water pipeline to the mine travels under Santa Rita Road, the utility maintenance road intersects the public roadway. It will be gated here to prevent unauthorized access. Because there are three different mine water supply well locations, the utility maintenance road will include spurs that extend to each of the three locations.

The utility maintenance road will be required to meet MSHA standards by including truck axle-high berms (anticipated to be about 3 feet high) on the sides of the section of roadway located on Rosemont Copper private lands. Some road reconstruction will be on Cornado National Forest lands before the road intersects private lands, and the Coronado National Forest will negotiate with MSHA to accommodate safety while minimizing impacts to Cornado National Forest surface resources. Otherwise, the segments on ASLD and will be a standard 14-foot-wide native surface road without any additional MSHA requirements.

The utility maintenance road will be closed to the public during construction and operation of the mine, and portions may be reopened to the public after closure, depending on safety concerns.

Sycamore Connector Road

The Sycamore Connector Road is a new road that was identified by the Coronado National Forest. The perimeter fence will cut off legal public access to National Forest System Roads (NFSR) in the Sycamore Canyon area, north of the project area. The Sycamore Connector road would be a new road that would be constructed from a point on the primary access road outside the perimeter fence, to connect with NFSR 4050-0.36R-1 (which intersects NFSR 4050 about 0.3 mile farther west). For the Barrel alternative, the Sycamore Connector road is about 12,184 feet long (2.3 miles) and impacts about 26 acres.

The NFSRs in Sycamore Canyon currently connect to public roads out the bottom (north) end of the canyon. However, the roads cross numerous private ownerships, and a public easement for the road does not exist. Public access from this direction into Sycamore Canyon is thereby controlled by these private landowners. While public assess is sometimes granted, it cannot be guaranteed. Constructing the Sycamore Connector Road as a NFSR will continue to provide legal public access to the roads that currently exist on Coronado National Forest lands in this area.

Refer to Figures I-1, I-2, J-2, and J-7 for depictions of the Sycamore Canyon Connector road, as well as other roads being constructed and decommissioned as part of the Barrel alternative.

Other Area Roads – Including Decommissioned and New Forest Road Segments

Those National Forest System Roads (NFSR) that are open to the public or have restricted public access and that enter the perimeter fence will either be decommissioned, rerouted to connect to another area road, or have a built-in turnaround area near the fenceline. The June 2012 BA did not explicitly recognize that changes will occur to the NFSRs that intersect the perimeter fence. The location of the roads to be decommissioned and segments to be constructed is shown in

Figure I-2 below and Appendix 1, Figure 18 of the Supplemental BA. This and other new road segments designed to connect remnant NFSRs are shown in Figure I-2 below and Figure 18 in what will become chapter 2 of the FEIS (USFS 2013b). This includes the construction of a new road from the primary access road to NFSR 4050-0.36R-1 (which intersects NFSR 4050 about 0.3 mile farther west), in order to continue to provide public legal access to the Sycamore Canyon area. Because Open-Authorized-Restricted roads are typically used in the project area for access to adjoining grazing allotments, these will mostly remain intact to allow administrative and permitted use postclosure. During operations, Rosemont Copper will be responsible for providing access, in some form, to the grazing lease holders for management of their allotments and to the Forest Service for permit administration.

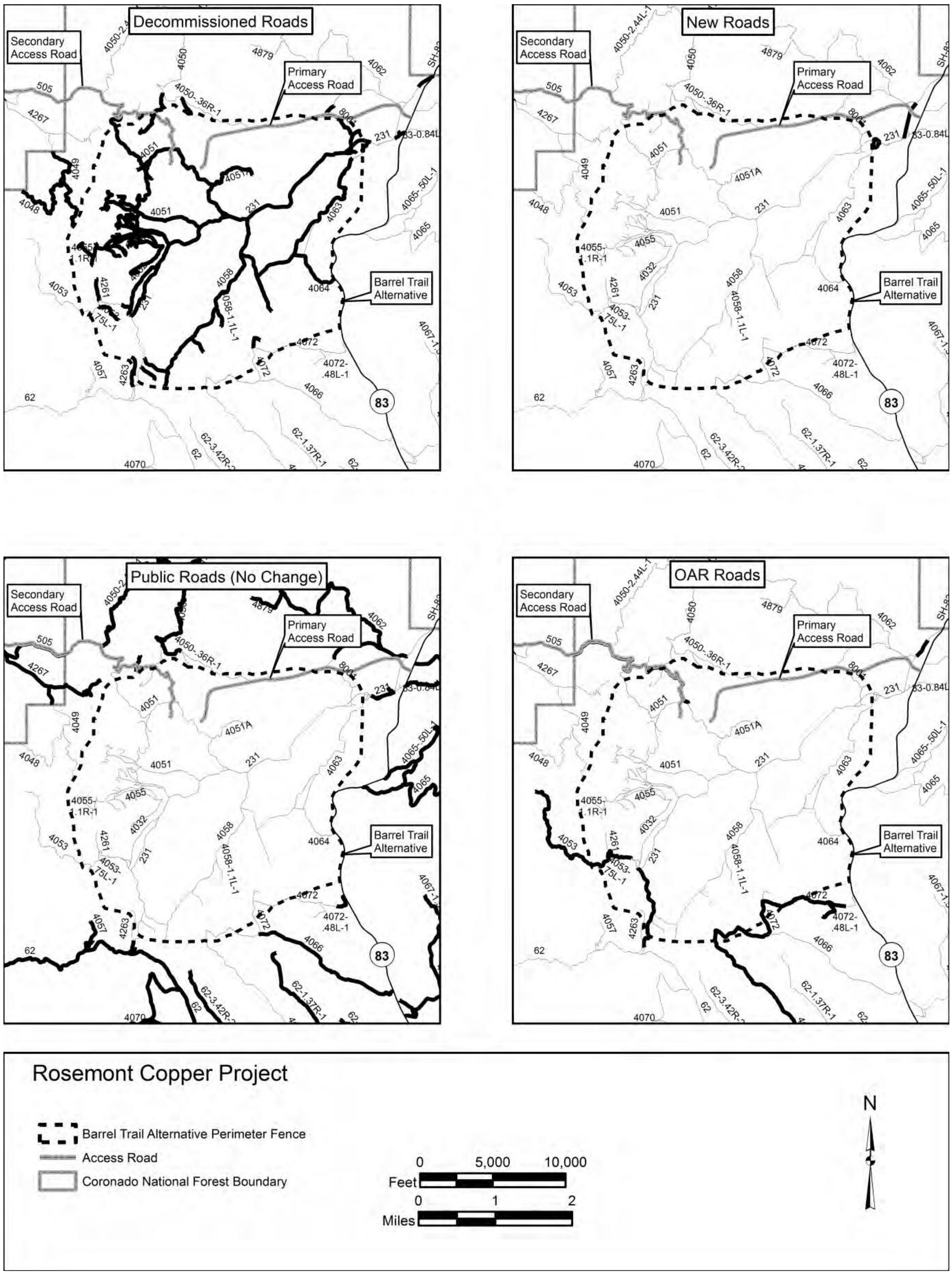

Figure I-2: Location of the roads to be decommissioned and segments to be constructed.

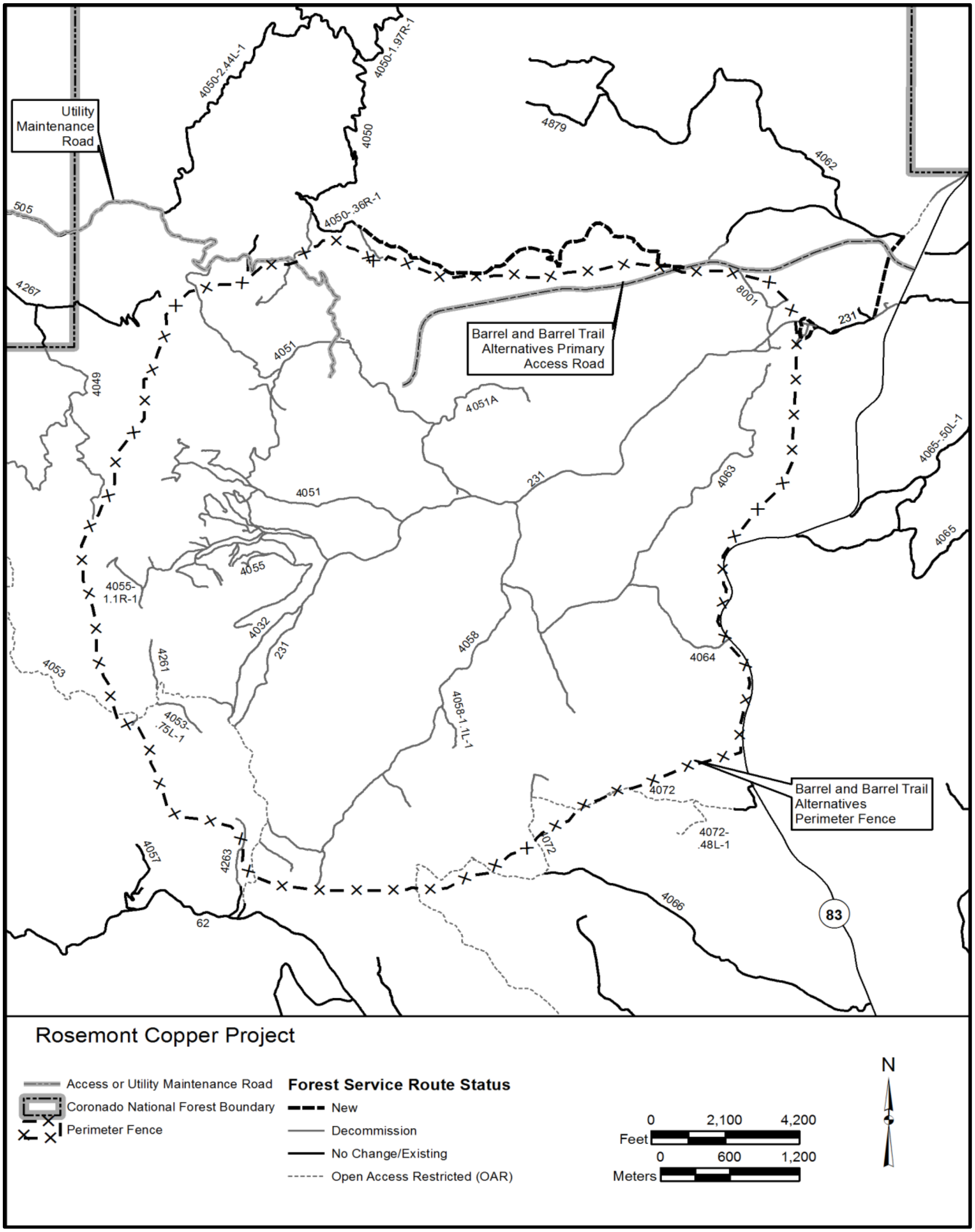

Figure I-2: National Forest Service Road System in relation to the Rosemont Mine project with new Sycamore Canyon Connector Road.

Transportation on State Route 83

Mine-related traffic on SR 83 during operations will primarily consist of trucks carrying supplies to the proposed action , trucks carrying concentrate from the proposed action , and employee traffic. Mine-related traffic on SR 83 during operations would primarily consist of trucks carrying supplies to the project area, trucks carrying concentrate from the project area, and employee traffic. Copper and molybdenum concentrate shipments would form the largest number of routine truck shipments, with approximately 50 round trips per day and 356 trips per week. The largest concentrated volume of mine traffic during a 24-hour period will occur during workforce shift change which will vary between 6 a.m. to 8 a.m. and 4 p.m. to 6 p.m. In addition, there will be equipment, construction material, and mining material deliveries to the project area. Major equipment arriving by rail will likely be received at the Port of Tucson, which is located near Vail, Arizona. Traffic during the pre-mining phase will use SR 83 and existing Forest Road 231 to access the project area until the new primary access road is constructed. This may require an upgrade to Forest Road 231 within the existing easement, in addition to an upgrade of the entrance to SR 83. Table 1 in the October 2012 Supplemental BA identifies mine-related truck traffic and states that there will be 470 trips per week and 69 per day; however these figures have been revised and the updated number of trips is 455 trips per week and 69 per day. This does not include other forms of vehicular access, such as by mine staff entering and leaving the site.

Although there have been no studies or indication of increased traffic on Box Canyon Road (Forest Road 62), it is possible that the road might receive increased traffic as an alternate around SR 83 to avoid slow mining traffic (i.e., a bypass from Tucson to Sonoita). This could be important because the road crosses the north-south spine of the Santa Rita Mountains, an area that might be important for resident or migrating animals (e.g., golden eagle, jaguar, Chiricahua leopard frog).

Arizona National Scenic Trail Location

The June 2012 BA did not explicitly recognize that approximately 10 miles of the Arizona National Scenic Trail would need to be rerouted, resulting in some additional surface disturbance, including several trailheads. The additional acreage of disturbance from the rerouting of the Arizona National Scenic Trail is included in the revised calculation of disturbance. The location of the rerouted trail is shown in Appendix 1, Figure 15 of the October 2012 Supplemental BA.

Reclamation and Closure/Concurrent Reclamation

Reclamation of the proposed action will be administered and regulated by the Coronado National Forest [36 Code of Federal Regulations (CFR) 228] on Cornado National Forest lands; and administered and regulated for the State of Arizona by the Arizona State Mine Inspector (Arizona Revised Statutes 27-901 through 27-1026; and Arizona Administrative Code 11-2-101 through 11-2-822), and the ADEQ (Arizona Revised Statutes 49-241 through 49-252; and Arizona Administrative Code 18-9-101 through 403).

The June 2012 BA did not include details of reclamation and closure activities specific to the Barrel alternative. A July 2012 *Preliminary Reclamation and Closure Plan for the Preferred Alternative* (CDM Smith 2012) was incorporated into the Supplemental BA. Appendix 2 of the Supplemental BA includes detailed descriptions of the reclamation activities, including locations and handling of stockpiled salvaged soils, detailed phasing of concurrent reclamation, and revegetation/reclamation procedures and techniques. Table I-1, below, shows a summary of concurrent reclamation phasing.

Table I-1: (Table 2 from Supplemental BA): Phasing of Concurrent Reclamation

Project Phase	**Total Acres Undergoing Reclamation**	**Total Acres Reclaimed**
End of year 1 of active mining	114	0
End of year 2 of active mining	169	114
End of year 3 of active mining	259	283
End of year 4 of active mining	75	542
End of year 5 of active mining	93	617
End of year 10 of active mining	390	710
End of year 15 of active mining	383	1,100
End of year 22 of active mining	1,764	1,483
Postclosure	0	3,589

Almost half of the reclamation to be done at Rosemont will have been completed by the end of year 15 of active mining (1,500 of 3,600 acres).

Soil Salvage Plans

Detailed plans for soil salvage have been identified for the proposed action (CDM Smith 2012 Soil Salvage Management Plan).

- Soil salvaging in specific areas will not take place until it is necessary to disturb those areas for mine activities.
- At soil salvage locations, pits will be dug to verify removal depth of salvage soils.
- Erosion and sediment controls will be installed, both upslope and downslope of soil removal areas. These controls are required under the stormwater pollution prevention plan that will be mandatory under the mine's Arizona Pollutant Discharge Elimination System Multi-sector General Permit for stormwater. Dust controls will also be implemented.
- Soil will be transported using haul trucks or other equipment to a stockpile location or directly to the waste rock/tailings facilities. If possible, transportation will be direct rather than incorporating long-term stockpiles. Stockpiles will be located in four different areas over the life of the mine.
- Stockpile 1 is located immediately east of the phase 2 dry-stack tailings facility, with a footprint of approximately 18 acres and a capacity of 501,000 cubic yards. This stockpile will be used generally through the first 8 years of operation.

- Stockpile 2 is located south of stockpile 1 and will be used for years 8 through 14 of operations. Stockpile 2 has a footprint of approximately 39 acres and a capacity of 502,000 cubic yards.
- Stockpile 3 is located on the top of the waste rock storage area and will be used for years 14 through 22 of operations. Stockpile 3 has a footprint of 22 acres and a capacity of 335,000 cubic yards.
- Stockpile 4 is also located on the top of the waste rock storage area and will be used for years 14 through 22 of operations and during closure. Stockpile 4 has a footprint of 18 acres and a capacity of 283,000 cubic yards.
- Soil stockpiles will be managed to reduce potential erosion, designed to reduce potential for compaction to maintain air circulation and drainage, and if anticipated to be in existence for at least 1 year, will have vegetative cover using a broadcast seed mix and possibly stabilizers like straw mulch with tackifier

Revegetation and Expected Revegetation Success

Concurrent reclamation will take place over the life of the project, with initial reclamation beginning on the lowest levels of the waste rock buttresses by the end of concentrate production when tailings are placed behind the buttress. The proposed acreage of reclamation activities over time is shown above, and in Appendix 2 of the October 2012 Supplemental BA and Table I-2, below.

Revegetation would only be considered complete when certain reclamation criteria have been met. It is the responsibility of the Coronado National Forest to determine these success criteria and the responsibility of Rosemont Copper to develop methodologies and techniques, including adaptive management that can meet the revegetation criteria. The final reclamation and closure plan would provide further detail on the techniques to be employed, as well as monitoring and success criteria required for approval by the Coronado National Forest. The long-term purpose of undertaking revegetation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function.

Revegetation procedures will differ, depending on whether upland or riparian areas are being revegetated. Most of the landform, which consists of the waste rock and tailings facilities, will be covered with growth medium and revegetated with upland vegetation, as will the upper pit benches and the plant site. However, there may be limited areas along drainages where riparian revegetation would be appropriate. Upland revegetation will generally follow these steps: regrading, placement of salvage soils, ripping, transplantation of trees and shrubs, seed application, mulch and tackifier and maintenance/monitoring activities.

Areas will be regraded to obtain stable, permanent slope condition as designated in the final reclamation plans. Where possible, such as at the plant site, grading is intended to restore more natural slopes and minimize erosion. The potential for restoring natural slopes is limited with respect to the waste rock and tailings facility, but such shaping will be incorporated to the extent practicable, primarily on top of the facilities.

Soils will be salvaged onsite, as previously described ,and will be used as surface cover for revegetation. Almost all slopes will receive either a cover of soil or a mixture of soil and rock cover. In the most recent reclamation closure plan developed for the Barrel Alternative, several steep slopes on the side of the landform adjacent to the pit will remain solely rock with no soil cover. Specific surface treatment locations for the waste rock and tailings facilities will be shown in in the Soils and Revegetation section in Chapter 3 of the FEIS, which is in preparation (USFS 2013a). For shorter slope runs between benches (less than 300 feet), the surface treatment is likely to be primarily soil cover. For longer slope runs between benches (over 300 feet), the soil cover could be limited to the upper 300 feet of the slope to prevent erosion. The lower 300 feet may consist of rock or a combination of soil/rock. Other configurations may also be considered, such as the use of soil islands; these are small areas (probably less than 10 acres) in which soil of greater depth is placed to improve species' diversity and benefit planted trees and shrubs. Where present, the total depth of soil cover will vary, but is estimated to be approximately 12 inches. Mulched vegetation material available from site clearance could be used as a soil additive if appropriate.

After placement of salvage soil, the soil surface will be ripped or otherwise mechanically manipulated in order to create an optimal seedbed. Ripping and furrowing generally will follow contours to minimize erosion. The seed mix and application techniques could vary, depending on slope, aspect, elevation, and underlying growth media. The seed mix may also incorporate native plant species that are culturally important to tribes.

The native seed mix will be agreed upon and approved by the Coronado National Forest and will be informed by the greenhouse studies, test-plot data, reference sites and results from previously revegetated areas.

Appropriate site preparation may include lightly dragging the area after seed application, soil amendments, and/or application of certified weed-free straw mulch with a tackifier. Slow release fertilizer may be incorporated to promote plant growth.

Desired Condition

The Coronado National Forest has determined the general desired vegetation condition for the reclaimed waste rock and tailings facilities over time. The desired vegetation condition represents what can reasonably be expected on disturbed, reclaimed growth medium that would exhibit more xeric soil moisture conditions than those found on natural areas. Desired conditions are included in the FEIS as a somewhat general, qualitative description of what the reclaimed sites will support following revegetation, at different time periods. The desired conditions have been developed through a review of the Natural Resources Conservation Service Ecological Site Descriptions, test plot data, and expertise of Coronado National Forest staff and others.

It should be noted that the desired condition is not the same as reclamation success criteria, which are more site specific and quantitative, and will be fully described in the revegetation plan currently being developed and to be approved with the final MPO. This plan will use the process described in the Adaptive Management Technical Guide developed by the U.S. Department of the Interior (Williams *et al*. 2009), and further detail is shown in the "Revegetation Success Criteria" part of this resource section. Desired vegetation condition varies across the site, influenced primarily by aspect and soil texture and chemistry. There are six revegetation site types that are considered for the reclaimed waste rock and tailings facilities, as summarized in T X below. The spatial distribution over time of these areas across the site is summarized in the Soils and Revegetation section of the EIS.

Table I-2: Desired vegetation condition over time

Revegetation Site Type	**Vegetation Type**	**Number of Species**	**Percent Canopy Cover – 5 Years after Planting**	**Percent Canopy Cover – 10 Years after Planting**	**Percent Canopy Cover – 15 Years after Planting**	**Percent Canopy Cover – 20 Years after Planting**
East-facing slopes	Grasses	5 to 10	10 to 30	10 to 30	10 to 30	10 to 30
	Shrubs	3 to 5	1 to 5	1 to 5	1 to 15	1 to 15
West-facing slopes	Grasses	5 to 10	10 to 20	10 to 30	10 to 30	10 to 30
	Shrubs	3 to 5	1 to 5	1 to 5	1 to 15	1 to 15
Slopes with increased rock cover	Grasses	3 to 7	5 to 20	10 to 20	10 to 20	10 to 20
	Shrubs	1 to 3	0 to 5	1 to 5	3 to 5	3 to 5
South-facing slopes	Grasses	5 to 10	5 to 15	10 to 20	10 to 20	10 to 30
	Shrubs	1 to 3	1 to 5	1 to 5	1 to 5	1 to 5
	Succulents	1 to 3	1 to 3	1 to 5	1 to 5	1 to 5
North-facing slopes	Grasses	5 to 10	10 to 30	10 to 30	15 to 45	15 to 45
	Shrubs	3 to 7 (<10 years after planting) 3 to 10 (>10 years after planting)	3 to 10	3 to 10	5 to 10	5 to 15
	Trees	1 to 2	0 to 3	1 to 5	1 to 5	2 to 5
Level areas	Grasses	5 to 10	10 to 30	10 to 30	15 to 40	15 to 40
	Shrubs	3 to 5	1 to 5	1 to 10	1 to 10	1 to 10
	Trees	1 to 2	0 to 3	0 to 3	1 to 3	1 to 3

As shown in T X, while grasses and shrubs would occur across all revegetation site types, trees are likely only to consistently occur on north-facing slopes and level areas, and succulents are most likely to consistently occur on southern exposures. Note that succulents do not offer significant cover, so although the cover would not change over time, the density of these plants still would increase. Each revegetation site type is described below. Slope aspect influences soil moisture, with the greatest amount of soil moisture being retained on the north slopes and the least on south-facing slopes. More soil moisture is also retained on flat areas, compared with angled slopes such as on the sides of the waste rock and tailings facilities. Elevation also influences plant communities. The waste rock and tailings facilities fall roughly from 4,600 to 5,500 feet above mean sea level, with some areas extending as high as 5,700 feet above mean sea level.

East-facing slopes — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present but would be very widely distributed and would make up a small amount of the plant community. Long slope runs may require additional rock cover for soil stabilization.

West-facing slopes — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present, but would be very widely distributed and would make up a small amount of the plant community. West-facing aspects would look similar to east-facing aspects but may be composed of different species within the same functional groups.

Slopes with increased rock cover — Vegetation would be composed primarily of warm season perennial grasses, mixed forbs, and a minor component of small shrubs, compared with east- and west-facing slopes. Because of the steepness of these slopes, increased rock cover would be placed over the soil cap for erosion protection and increased stability. Species that favor rocky soils would be used. These areas are expected to be stable, even with relatively low amounts of vegetation cover; they would primarily be on the western side of the facilities and would not be visible from SR 83.

South-facing slopes — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present but would be very widely distributed and would make up a small amount of the plant community. Palmer agaves would be transplanted in clumps to mimic how they appear on undisturbed sites. Other culturally significant plans, such as sotol (*Dasylrion wheeleri*) and beargrass (*Nolina microcarpa*), may also be planted in clumped distribution on these portions of the facility. The greater amount of surface rock and less grass cover in these areas would be clearly visible.

North-facing slopes — Vegetation would be composed of warm season perennial grasses and forbs, mixed with shrubs and dispersed trees. A higher density of shrubs and trees would establish on these slopes, compared with savannas or level-ground grasslands. It would take a number of years for shrubs and trees to grow large enough to be visible from a distance. Some species of trees may be deciduous, losing their leaves during the winter.

Level areas — Vegetation would be composed primarily of warm season perennial grasses, mixed forbs, an increased amount of small shrubs, compared with east- and west-facing slopes, and widely dispersed trees. Shrubs and trees would give a savanna-like appearance and would be visible from a distance once the plant community matures, which would take a number of years.

Plant species — A variety of plant species would be incorporated into the seed mixes used for revegetation, informed in part by greenhouse and test plot studies conducted by Rosemont Copper, reference area vegetation, and the success of previously revegetated areas on the mine site. This seed mix would be expected to adaptively change over time based on the success of different species. In addition, other species not specifically seeded would be expected to opportunistically grow, including those that might be in the natural seed bed in the salvaged soil. It is important to note that the seed/planting mix and desired conditions do not account for mesquite, acacia, mimosa, or one-seed juniper. It is expected that these species would readily colonize the reclaimed sites and therefore would not be seeded. They are not included in desired condition estimates of species richness or canopy cover. Their presence would contribute additional species richness and cover beyond what is described here.

The species currently proposed for the seed mix are summarized in Table I-3, below, along with a list of additional species that are being considered for seeding/planting.

Table I-3: Species expected to be present

Grasses	Shrubs	Trees
Planned Seed Mix		
Arizona cottontop	Beargrass	White oak
Blue grama	Desert spoon	Mexican blue oak
Curly mesquite	Skunkbush sumac	Emory oak
Green sprangletop	Evergreen sumac	Alligator juniper
Plains lovegrass	Mountain mahogany	
Sideouts grama	Four-wing saltbush	
Bottlebrush squirreltail	Ocotillo	
Mexican gold poppy	Wright’s silktassel	
Desert marigold	Palmer agave	
Fairy duster	Soaptree yucca	
	Schott’s yucca	
	Desert hackberry	
Potential additions		
Canebeard grass	Range ratney	
Hairy grama	Buckwheat	
Wolftail	Dalia	
Tanglehead	Menodora (on calcareous soils)	
Sprucetop	Mariola (on calcareous soils)	
Slender grama	Zinnia (on calcareous soils)	
Sanddrop seed	Winterfat (on calcareous soils)	
	Lippia (on calcareous soils)	

Mine Closure

At closure, fence construction for the mine pit will be a minimum of three-strand barbed wire with warning signs. Arizona Administrative Code R11-2-401 specifies measures that include fencing and signage. Additionally, Rosemontwill construct structures to provide additional safety protections if needed, such as berms around the pit, possible “tank traps” as necessary to restrict unauthorized road access, and upgraded fencing (i.e., chain link) if necessary on steeper slope areas above the pit or other areas. Operating facilities at the proposed action site will be demolished and removed, and building foundations will be demolished, covered with soil, and graded or removed. All areas will be investigated for contaminants, and any contaminated soils, reagents, or fuels will be disposed of off-site at licensed facilities. Post-mine land use on Coronado National Forest lands will follow the direction in the forest plan that is in place at that time. Post-mining/closure reclamation objectives for Rosemont’s private property could include dispersed recreation, wildlife habitat, and ranching.

Mitigation and Monitoring

Council on Environmental Quality (CEQ) regulations (40 CFR 1508.20) define mitigation measures as follows:

- Avoiding an impact by not taking a certain action or parts of an action;
- Minimizing an impact by limiting the degree or magnitude of the action and its implementation;
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment;

- Reducing or eliminating an impact over time, through preservation and maintenance operations during the life of the action; and
- Compensating for an impact by replacing or providing substitute resources or environments.

Mitigation measures can be an integral component in the design of a project [Council on Environmental Quality (CEQ) 2011]. The Rosemont project contains numerous measures designed to avoid, minimize, rectify, reduce or eliminate, or compensate for environmental impacts. Measures designed to mitigate impacts have been identified from a variety of sources, including the ID team, cooperating agencies, Rosemont Copper, and public comments.

In its regulations, the Forest Service is directed to minimize adverse environmental impacts to Cornado National Forest surface resources, where feasible (36 CFR 228.8). The Coronado National Forest has developed a mitigation and monitoring plan that meets the guidance and direction specified by the CEQ and applicable laws and regulations (see appendix B of this document; and Appendix B of the FEIS). It is important to note that the NEPA analysis and documentation is being prepared prior to final design of the project and before a final MPO is prepared. The full suite of mitigation and monitoring requirements will be finalized once all required permits have been issued, as they contain measures required by resource agencies to avoid, reduce, and monitor environmental effects.

Guidance provided to Federal agencies by the CEQ states that agencies should not commit to mitigation measures absent the authority or expectation of resources to ensure the mitigation is performed (CEQ 2011). All suggested mitigation measures were screened by the ID team and recommended measures reviewed by the responsible official. Part of that review involved determining whether the Forest Service has the authority to require certain mitigation; whether the proposed mitigation would effectively avoid, reduce, eliminate, or compensate for predicted effects; and whether the Forest Service or another regulatory permitting agency can ensure that the mitigation will be implemented.

While most of mitigation measures specified in this FEIS will be required as a condition of the ROD, Rosemont Copper has proposed to implement a number of mitigation measures that are beyond the scope of authority of the Forest Service or other regulatory permitting agencies. The listing and description of mitigation measures and monitoring in this BO indicate which measures are mandated by either the Forest Service or other regulatory agencies and which are being proposed by Rosemont Copper. It is important to note that mitigation measures that are proposed by Rosemont Copper are addressed separately from mitigation that is within the authority of the Forest Service or other regulatory and permitting agencies, with the understanding that measures proposed by Rosemont Copper may or may not be implemented.

A description of mitigation and monitoring contained in the Barrel alternative is contained in Appendix B of this document. The discussion that follows provides information pertaining to specific resource topics that provide a context for the specific mitigation and monitoring items described in Appendix B of this document.

Air Resources

An air quality permit is a requirement under the Clean Air Act, whose regulatory authority has been delegated from the EPA to the Arizona Department of Environmental Quality to implement and enforce applicable federal air quality standards. The Arizona Department of Environmental Quality issued an Air Quality Permit to Rosemont Copper on January 31, 2013. It is the responsibility of the mine owner/operator to maintain compliance with their air permit, which contains conditions to limit fugitive dust and other potential emissions.

The Barrel alternative contains a number of mitigation and monitoring measures designed to reduce potential impacts to air quality and to meet federal National Ambient Air Quality Standards (NAAQS). These are described in the Mitigation and Monitoring – Other Regulatory and Permitting Agencies in Appendix B of this document. Air quality modeling indicates that the Barrel alternative will meet NAAQS for air quality at the location of the perimeter fence. Further details can be found within the January 31, 2013 Air Quality Permit (ADEQ, Air Quality Permit Number 55223).

Hazardous Materials

In order to reduce potential human health and environmental risks, hazardous materials and substances would be managed and contained within facilities that are designed, constructed, and maintained to meet applicable laws and regulations. These facilities will include leak containment and recovery systems as required and adequate stormwater management and drainage systems to prevent contamination outside containment areas.

Specific mitigation and monitoring related to hazardous materials are described in the Mitigation and Monitoring – Forest Service section of Appendix B of this document.

Land Impact

The design of the project includes efforts to restrict mine activities within a mine footprint that is substantially smaller than conventional mines with similar production capacity. This is achieved through the use of dry-stack tailings technology, which will have an overall crest-to-toe slope of 3.5:1 (horizontal: vertical) on the outer surface of the dry-stack tailings facility and waste rock facilities; and concurrent revegetation requirements. Slopes will be 3:1 between benches. The use of dry-stack tailings facilities will avoid impacts to cultural sites; wildlife habitat; soils; waters of the United States; and surface water due to its smaller footprint. It will also reduce impacts related to water use; reduced seepage resulting from lower moisture content of the tailings would avoid or reduce impacts to potential groundwater contamination; and reduced evaporation would reduce water use. Reclamation can begin earlier, improving vegetative recovery. Filtered tailings will be transported, spread, and compacted to form an unsaturated, dense, stable tailings stack that will include a surrounding rock and soil buttress that will be seeded for revegetation during operations. These design features are a combination of requirements by the Forest Service and permit requirements under the Aquifer Protection Permit, issued by the Arizona Department of Environmental Quality on April 3, 2012.

Specific mitigation and monitoring related to design features that will reduce land impact are described in both the Mitigation and Monitoring – Forest Service, and Mitigation and Monitoring – Other Regulatory and Permitting Agencies sections of Appendix B of this document.

Noise

Rosemontwill use noise management techniques and operational tools to minimize noise generated during mine operations. Blasting only during daylight hours and sequenced blasting using time-delay technology have been incorporated into the proposed action design. Another tool to be used is attenuated back-up alarms on trucks and similar equipment that are electronically modulated to meet federal requirements.

Specific mitigation and monitoring related to noise are described in the Mitigation and Monitoring – Forest Service section of Appendix B of this document.

Light Pollution

To the extent allowed under MSHA regulations, all exterior and access route lighting will be designed and operated with the intent to reduce nighttime light pollution. Rosemont has developed a revised lighting plan that identified steps that will be taken to achieve the goals of the 2006 City of Tucson and Pima County Outdoor Lighting Code while also protecting the safety of the workers and visitors to the proposed action facilities (Monrad *et al.* 2012). The revised lighting plan reduces the amount of light proposed for the site by at least 75% and incorporates additional mitigation measures. Where safety requirements allow, outdoor lighting design incorporated the following: appropriate shields; dimmers and/or full cutoff lighting fixtures; timers; motion detectors; directional lighting; limited spectrum technologies; and production of the minimum lumens practicable. In addition, structures are to be designed and painted to be non-reflective to reduce glare and are to incorporate strategic placement of lighting fixtures.

The light pollution mitigation recommendation report identifies the six principal mitigation strategies that were used to develop a lighting design plan (Monrad *et al.* 2012):

1. Employ twenty-first century light sources (e.g., light emitting diodes [LED], induction, organic LED, or plasma) and use strategies such as adaptive lighting and on-demand lighting
2. Employ very well shielded and aimed light sources
3. Employ spectral control with the ability to manage the emission of certain wavelengths
4. Use the smallest necessary light source (i.e., “lumen package”)
5. Address the environmental concerns of native flora and fauna
6. Use solid-state lighting for vehicular-mounted task lighting to impart less stray light and direct more useful light to critical task and operation areas

The primary mitigation strategy that specifically addresses the environmental concerns relative to native flora and fauna includes the use of specific LED lighting solutions (Monrad *et al.* 2012). This strategy includes limitations on the use of sub-500 nanometer lighting spectra (generally blue light) that will be applied to minimize the impact to the night environment. The control of sub-500 nanometer wavelengths is a known factor in minimizing artificial lighting effects on nighttime insects and their predators.

Specific mitigation and monitoring related to artificial night lighting are described in the

Mitigation and Monitoring – Forest Service section of Appendix B of this document under both the Dark Skies and Biological Resources headings.

Plants and Animals

Rosemontwill revegetate disturbed areas with native vegetation, excluding the pit area. A preliminary site seed mix has been developed from tests with native plant species that can be used to reclaim the proposed project site (Fehmi 2007; Fehmi *et al.* 2008). Seed mixes and methodology for revegetation will be determined in a Final Reclamation and Closure Plan currently under development to include the most recent changes to stormwater design, and ongoing investigation into revegetation potential. The selected seed mix would be informed by the greenhouse studies, test-plot data, reference sites, and results from previously revegetated areas. The Final Reclamation and Closure Plan will be completed after approval of the Record of Decision, but prior to approval of the final MPO. Linear features such as utilities and pipelines would be reclaimed to avoid fragmentation of native biological communities. Specifications are anticipated to be the same as those for other disturbed sites. Specific mitigation and monitoring related to revegetation are described in the Mitigation and Monitoring – Forest Service section of Appendix B, under the Soils and Revegetation heading.

Process water ponds or chemical or fuel storage areas will be enclosed, covered, or otherwise managed to protect wildlife, livestock, and public safety. Location and construction criteria for the proposed action facilities will prevent deleterious exposure of livestock, wildlife, and birds to toxic chemicals or hazardous conditions created by, used in, or resulting from processing operations. Mitigation and monitoring related to enclosing or covering these facilities are described in the Mitigation and Monitoring – Forest Service section of Appendix B, under the Biological Resources heading. Additional requirements are contained in measures listed in the Mitigation and Monitoring – Other Regulatory and Permitting Agencies, under Air Quality.

In order to reduce or avoid impacts to habitat specific to rocky slopes on the east side of the Santa Rita Mountains, construction of the electrical power line that provides electricity to the pit will be located on the west-side of pit operations and within the disturbance perimeter of the pit and diversion structures. This will reduce disturbance to talus slopes and talussnail habitat, as well as reducing impacts to visual resources by avoiding construction on the ridgeline. This measure is described in the Mitigation and Monitoring – Forest Service section of Appendix B of this document, under the Biological Resources heading.

Invasive Species Control Plan

Invasive species must be addressed as directed by Executive Order 13112, "Invasive Species." Rosemont has prepared a preliminary invasive species control plan which will be updated prior to approval of the final MPO. Mitigation and monitoring requirements are contained in measures described in the Mitigation and Monitoring – Forest Service section of Appendix B of this document, under the Soils and Revegetation and Biological Resources headings.

Transportation Plan

Rosemont has agreed to develop a comprehensive Transportation Plan for all project related roads on Coronado National Forest lands. The transportation plan will address maintenance standards; levels of appropriate use; methods to maintain the roadways sufficiently to prevent washboard, rutting, and drainage problems; commitment to replace surfacing lost to drainage; commitment to repair roads damaged by use; commitment to restore temporary roads to pre-operation conditions during reclamation/closure; and installation and maintenance of wildlife crossing structures (e.g., corrugated metal pipes) under the primary access road at locations of known wildlife concentration. The transportation plan would be developed after approval of the Record of Decision and prior to approval of the final MPO.

These measures are described in the Mitigation and Monitoring – Forest Service section of Appendix B of this document, under the Transportation and Access heading.

Water Resources

In order to conserve water, Rosemont has committed to filter the tailings and maximize water conservation, as detailed in the preliminary MPO (WestLand 2007). The filtered tailings will reduce Rosemont Copper Company's consumption of water by 50% to 60% over traditional industry designs. This is a primary component of dry stack tailings previously described.

In addition to filtering the tailings, Rosemont has also included in their facility designs a number of ways in which they will maximize the reuse of process water and stormwater. These measures are primarily required by the Aquifer Protection Permit, and are described in the Mitigation and Monitoring – Other Regulatory and Permitting Agencies section of Appendix B, under the Groundwater Quantity and Quality heading. Further detail can be found in the Aquifer Protection Permit.

Rosemont has voluntarily committed to implement regional groundwater mitigation measures within the Tucson Active Management Area that will use available Central Arizona Project water as a source to conduct recharge within the Tucson Active Management Area. To date, Rosemont has recharged 45,000 acre-feet of water within the Tucson Active Management Area. Note that this compensatory mitigation is dependent on Central Arizona Water Project water's being available to Rosemont. Further details are contained in a measures described in the Mitigation and Monitoring – Rosemont Copper Company section of Appendix B, under the Groundwater Quantity and Quality heading.

Rosemont has stated they will annually fund the U.S. Geological Survey (USGS) to operate and maintain the existing surface water flow measurement gage at Barrel Canyon. After 5 years post-mining, the USGS may fund the gage or remove it at their discretion. Further details are contained in measures described in the Mitigation and Monitoring – Rosemont Copper Company section of Appendix B, under the Groundwater Quantity and Quality heading.

Rosemontwill manage water on the tailings storage and waste rock facilities to avoid or reduce erosion as previously described. Where mine facilities remain over the long term, specific dam safety permit limits require Rosemont to install permanent water control structures that may exist beyond the life of the mine. Specific permit conditions provide for periodic monitoring and maintenance of spillways, diversions, and other permanent facilities. Specific information is contained in a variety of measures, including those described as follows: Mitigation and

Monitoring – Forest Service section of Appendix B, under the Surface Water Quantity and Quality heading; Mitigation and Monitoring – Other Regulatory and Permitting Agencies section of Appendix B of this document, under the Groundwater Quantity and Quality and Surface Water Quantity and Quality headings. Further details are contained in the Aquifer Protection Permit, and will be contained in the Stormwater Pollution Prevention Plan (developed after approval of the Record of Decision but prior to approval of the final MPO).

Water Source Enhancement and Mitigation

Rosemontwill construct, manage and maintain water features to reduce potential impacts to wildlife and livestock from reduced flow in seeps, springs, surface water and groundwater. Existing water features, including stock ponds, will be enhanced, and additional water features added as needed. Seven water features will be managed for sustainability of surface water. Up to 30 water features will be managed or constructed if needed for threatened and endangered species. This is further described in a measure in Mitigation and Monitoring – Forest Service section of Appendix B of this document, under the Biological Resources heading.

Aquifer Protection Permit

On April 3, 2012, ADEQ issued its decision granting Aquifer Protection Permit No. P-106100 to Rosemont. Among other things, the aquifer protection plan requires Rosemont to manage discharges from its facilities so that they do not cause or contribute to a violation of aquifer water quality standards at the point of compliance; or, if the ambient groundwater quality already exceeds aquifer water quality standards at the time of permit issuance, then the discharges must be managed so that they do not cause further degradation of the water quality.

Under the aquifer protection permit, Rosemont will implement a Waste Rock Segregation Plan, to identify and manage materials using geochemical analysis and acid-base accounting methods. This plan requires that a geologist or trained technician will inspect each pile of blasted and broken rock before removal from the active mining face and any rock that is identified as potentially acid-generating will be isolated from other waste rock.

The aquifer protection permit also requires Rosemont to install 8 monitoring wells (called “point of compliance” or “POC” wells) at locations around the project area approved by ADEQ. Rosemont is required to sample and test the groundwater in these wells on a quarterly basis and to report the results to ADEQ. A baseline monitoring program has been implemented as part of the monitoring plan in the aquifer protection permit in order to establish ambient groundwater conditions prior to operations. This program is in place to determine the amount of chemical constituents, such as sulfate and chloride, already in the aquifer. Ambient groundwater quality will be established before aquifer protection permit regulated facilities begin operation. A contingency plan is addressed in the APP.

Stormwater Pollution Prevention Plan

This plan is required by the ADEQ as part of the process for obtaining coverage under the multisector general permit, which is also required under Section 402 of the CWA. This permit requires the preparation of a stormwater pollution prevention plan and implementation of control measures, as outlined by the ADEQ's Arizona Pollutant Discharge Elimination System Multi-sector General Permit program. Coverage under this program was obtained from ADEQ by Rosemont Copper on February 7, 2013. The use of best management practices is an integral part of these plans and permits. The stormwater pollution prevention plan was prepared and and the permit issued by ADEQ on February 7, 2013.

Mitigation and Monitoring – Evaluation and Reporting

Rosemont Copper will fund the monitoring to which the Forest Service commits in the ROD and that will be defined in the final MPO. Other monitoring activities may be associated with the regulatory authority of Federal and State agencies and would be funded by permit fees or the agencies themselves as part of their normal activities. Title 36 CFR 219.11(d) states:

<u>Use of monitoring information.</u> Where monitoring and evaluation is required by the plan monitoring strategy, the responsible official must ensure that monitoring information is used to determine one or more of the following:

1. If site-specific actions are completed as specified in applicable decision documents;
2. If the aggregated outcomes and effects of completed and ongoing actions are achieving or contributing to the desired conditions;
3. If key assumptions identified for monitoring in plan decisions remain valid; and/or
4. If plan or site-specific decisions need to be modified.

Monitoring and evaluation activities will be prescribed, conducted, and/or reviewed by Rosemont, the Coronado National Forest, the Army Corps of Engineers, and other agencies and groups participating in a multiagency monitoring and evaluation task force. The Coronado Forest Supervisor will invite County, State, and Federal agencies with permitting or other regulatory authority, Rosemont Copper, and additional agencies and groups who would bring expertise to monitoring efforts (e.g., AGFD, Arizona State Mine Inspector) to participate on this task force. The task force will meet at least annually to review and evaluate monitoring results and make recommendations to the forest supervisor. Evaluation will indicate: (1) whether monitoring requirements have been completed according to the final monitoring plan; (2) whether monitoring results indicate that the effects and results of mining and related activities are within the range of those predicted in the eventual FEIS and ROD (USFS 2013b); (3) whether monitoring activities and methods remain valid and whether continued monitoring is warranted going forward; and (4) whether changed conditions, if any, dictate modification of the final MPO and/or ROD.

Rosemont Copper will be required to compile monitoring results into a monitoring report that will be provided to the Forest Service on a quarterly basis. Any monitoring result that is not in compliance with the effectiveness criteria will be reported to the Forest Service within 72 hours. After reviewing the results of these reporting requirements, the Forest Service will notify members of the multiagency monitoring group should conditions warrant interim or emergency meetings.

In addition to quarterly monitoring reports, Rosemont Copper will submit an annual report to the Coronado National Forest and the multiagency monitoring group that contains a description of all activities conducted during the previous year and a summary of applicable information as approved by the Forest Service, along with annual results of all monitoring plans in a format approved by the Forest Service, including a complete data summary and any data trends, a mining status plan, and plans for the coming year. Significant changes will be incorporated into the final MPO and reflected in financial assurance. Past, ongoing, or projected impacts on the environment may also require amendment of the final MPO, ROD, and/or financial assurance held for the project.

Rosemont Copper will fund work performed by Coronado National Forest employees, consultants, and/or cooperators assigned to administer and monitor the project. This includes a minerals administrator and a biological monitor, whose role in overseeing monitoring activities is described in this Biological Opinion within the Description of the Proposed Conservation Measures. Details regarding other Coronado National Forest positions that will be necessary for administering the project and overseeing monitoring are still being developed.

Postclosure Monitoring

While the Rosemont Copper Project has been designed with the intent of minimizing long-term maintenance and monitoring, it is recognized that the potential exists for continued monitoring of postmine conditions. To that end, all reclaimed sites will be monitored a minimum of twice a year for a period to be determined, in order to evaluate the success of reclamation work. Any areas not meeting reclamation goals will be analyzed to determine the underlying problems, which would be addressed with a modified plan.
In addition, groundwater will be monitored for a specific period of time to be decided by ADEQ closure requirements. Surface water will be monitored as required in the Arizona Pollutant Discharge Elimination System program following cessation of mining operations. Final monitoring details and locations will be decided when the ADEQ provides the Arizona Pollutant Discharge Elimination System permit. Results of this monitoring will be used to evaluate the success of the measures taken to protect the water resources. Any changes in water quality will be evaluated to determine whether the changes are related to the reclaimed mining features, and appropriate steps will be taken to address the problem. Financial assurance will be adjusted to the extent allowed by law and regulation related to these ongoing activities.

Conservation Measures

These conservation measures appear in the February 2013 Supplemental BA and are additive to, or help clarify those in, the initial and the October 2012 Supplemental BA.

On behalf of the Coronado National Forest, the Rosemont agrees to implement the following conservation measures for the Rosemont Copper project.

A. General Monitoring and Reporting Requirements

1.1. The Coronado National Forest shall identify a Coronado National Forest journey-level biologist (GS-9 or higher grade), the Biological Monitor, to provide oversight and assess compliance with these conservation measures and any Reasonable and Prudent Measures and Terms and Conditions. Rosemont shall reimburse the Coronado National Forest for work performed by the Biological Monitor, along with necessary overhead and supervisory support to the extent necessary to perform the duties as outlined below.

1.2. The Biological Monitor shall support biological monitoring for listed and non-listed species and biological resources, as well as other mitigation and monitoring measures that may be required by the Coronado National Forest.

1.3. The Biological Monitor will coordinate directly with Rosemont and Rosemont's consultants on behalf of the Forest Service, as well as the Coronado National Forest Project Implementation Monitor, and shall be responsible for reviewing and approving submitted reports and analyses.

1.4. Initially, the level of effort anticipated to perform the role outlined above (specifically for ESA commitments) is estimated at approximately 20 percent of a full-time employee position. Additional cost recovery for the Biological Monitor may also be needed for oversight on reclamation, invasive species management, and mitigation measures for migratory birds and sensitive species. The funding requirements will be reviewed and updated annually, and shall continue through the life of the project and for five years following mine closure. Monitoring activities, unless specifically stated otherwise in the conservation measures described below, are anticipated to occur throughout the life of the project and for 5 years following mine closure. Rosemont and the Biological Monitor, with the FWS, shall review the monitoring results annually. If appropriate, monitoring requirements and methods may be reduced or eliminated.

1.5. The Biological Monitor shall be Rosemont's primary point of contact with the Coronado National Forest for all activities related to biological resources. The Biological Monitor will be the principal liaison with all other stakeholder agencies. Rosemont shall report significant findings, its reports, etc., to the Biological Monitor first, rather than providing such information directly to FWS, AGFD, BLM, or Pima County. This requirement shall not prohibit or limit the reporting obligations established in Rosemont's consultant's or biological contractor's scientific collecting permits. The Biological Monitor will coordinate biological monitoring activities with the Rosemont Environmental Manager or other designated representative as identified by Rosemont.

2. Rosemont shall be responsible for all monitoring and reporting. The Biological Monitor will assess compliance with conservation measures through field visits and inspection and by review of an Annual Report.

3. Rosemont shall prepare an Annual Conservation Measure Implementation and Monitoring Report ("Annual Report") at the end of each calendar year. The Annual Report shall be due to Coronado National Forest by January 31 of the next calendar year throughout the life of the project and for five years post- closure. This report will include, but is not limited to, the following:

3.1. A brief narrative or tabular description of the specific actions accomplished with regard to each specific conservation measure (and Reasonable and Prudent Measures' Terms and Conditions, also a condition of reporting).

3.2. A brief narrative or tabular description/summary of the objective of each of the conservation measures and whether the objective of that conservation measure was or was not met.

3.3. A brief narrative or tabular description/summary of the status of concurrent reclamation efforts.
3.4. A brief narrative or tabular description on the status of invasive species management.
3.5. For each conservation measure description and summary a change in baseline (e.g., number of water features with breeding Chiricahua Leopard Frogs CLF) from previous years' surveys) condition will be provided.
3.6. Amount of take of threatened and endangered species
3.7. A brief narrative or tabular summary of any problems, issues, or opportunities encountered in the prior calendar year with regard to the implementation of the conservation measures, Reasonable and Prudent Measures and Terms and Conditions that may be authorized by the FWS, or other biological mitigation and monitoring measures.
3.8. A brief narrative or summary of any adaptive management actions taken, and recommendations for future adaptive management actions to be considered by Rosemont, Coronado National Forest, and the FWS.
3.9. Along with hard-copy reports, Rosemont will provide editable electronic files, including GIS files, in a format that can be used by Coronado National Forest. The Coronado National Forest will convert editable files to uneditable files before sharing outside the agency.
4. Rosemont will ensure that anyone dealing directly with threatened and endangered species (e.g., surveys, salvage, translocation, etc.) for the Project has valid state and federal scientific collecting permits, or are agents on Coronado National Forest's or other suitable permits. Surveyors must send copies of permits with the year-end reports to the Biological Monitor as proof of compliance.
5. The Coronado National Forest will reinitiate Section 7 ESA consultation if Coronado National Forest and FWS determine that Conservation Measures and/or Reasonable and Prudent Measures' Terms and Conditions have not been met.

B. Sonoita Creek Ranch:

1. Rosemont has acquired the right to purchase approximately 1,200 acres of land along Sonoita Creek with +590 acre-feet of certificated surface water rights from Monkey Spring along Sonoita Creek. These lands will be made available to the AGFD or other suitable land trust or conservation organization. The land area and water rights will afford the AGFD or other conservation organization an opportunity to develop an in-lieu fee mitigation program for impacts to waters of the U.S. in conformance with the Corps' 2008 mitigation rule and other Corps regulations.
2. Rosemont will record a restrictive covenant or conservation easement on the Sonoita Creek Ranch property that precludes real estate development and similar land use activities and livestock grazing and other agricultural uses subject to the limitations outlined below. This restrictive covenant shall not restrict access for recreational or traditional cultural purposes to these lands provided that these uses are not incompatible with the conservation uses of the property as determined by the Land Manager and the FWS.

3. Rosemont anticipates transferring ownership of Sonoita Creek Ranch, including the appurtenant water rights, to the AGFD or other suitable owner for conservation purposes consistent with the conservation and public benefits contemplated by these conservation measures.

4. Funding for long-term management will be provided by Rosemont via a payment of $150,000 per year to a management account for a period of 10 years commencing with the production of copper concentrates at the project. Prohibitions on livestock grazing and other agricultural uses incompatible with the conservation goals outlined here for Sonoita Creek Ranch shall not be placed in full force and effect until such time as the water rights appurtenant to the property have been secured for conservation purposes by transfer to a qualified organization that can hold such rights for conservation purposes.

5. Surface water rights will be used to support the existing ponds that will be managed for threatened and endangered species. Water available after the needs of the existing ponds have been met will be discharged onto the floodplain terrace of Sonoita Creek that is currently an agricultural field to facilitate the passive restoration of riparian habitat.

6. The two perennial ponds, adjacent wetland habitat, and earthen-lined channel between the ponds on Sonoita Creek Ranch will be renovated to provide habitat for the threatened and endangered species.

6.1. To remove aquatic invasive species, the ponds will be drained and the undesirable species removed via chemical or mechanical means.

6.2. We anticipate that the AGFD or other approved conservation partner will implement the proposed renovation efforts. In addition to the payments described in #4 above, Rosemont will provide a total of $100,000 in support of these renovation efforts. Funding for this effort will be provided by Rosemont via a payment of $20,000 per year to a management account for a period of 5 years commencing with the production of copper concentrates at the Project.

7. Sonoita Creek Ranch will be managed for conservation purposes to provide habitat and connectivity for the Jaguar and Ocelot between the Canelo Hills/Patagonia Mountains and the Santa Rita Mountains, slightly over a mile away to the west of the ranch, in perpetuity. The southern portion of the ranch has been identified by the Arizona Wildlife Linkages Workgroup and the Arizona Missing Linkages Corridor design as a likely corridor between these two Coronado National Forest land blocks.

8. Management actions in Sonoita Creek Ranch will not compromise the ability to manage for threatened and endangered species. This includes species that are not currently present, but could recolonize the area if habitat were improved.

9. Wildlife-friendly fencing will be installed to discourage use by cattle and encourage use by threatened and endangered species.

9.1 Rosemont will construct wildlife fence along the west boundary of the property to enhance the utilization of the SR 82 crossing of Big Casa Blanca Canyon and Smith Canyon.

9.2 The balance of fence repaired and or replaced at Sonoita Creek Ranch will be wildlife-friendly four-strand wire fence built in accordance with AGFD standards.

C. Davidson Canyon Parcels

1. Rosemont will record a restrictive covenant or conservation easement on the Davidson Canyon Watershed Parcels that precludes real estate development and similar land use activities and restricts grazing.
2. The Davidson Canyon Watershed Parcels will be included as available land for the establishment of water features beneficial to listed species such as CLF, Jaguar, and Ocelot and to provide general wildlife benefits.
3. Portions of the Davidson Canyon Watershed Parcels have been identified as culturally important by Native Americans. None of the conservation actions outlined for the Davidson Canyon Watershed Parcels will preclude reasonable access to these parcels by interested Native American groups.

D. Helvetia Ranch North

1. Rosemont will record a restrictive covenant or conservation easement on the Helvetia Ranch Annex North Parcels that precludes real estate development and similar land use activities.
2. The Helvetia Ranch Annex North Parcels will be included as available land for the establishment of water features beneficial to listed species such as CLF, Jaguar, and Ocelot and to provide general wildlife benefits. See elements of Conservation Measures G, H, and I.

E. Cienega Creek Watershed

Rosemont has acquired the right to purchase approximately 1,122 ac-ft of surface water rights held by the Del Lago Golf Course. These surface water rights will be used to enhance aquatic habitat values in the Cienega Creek Watershed. The acquired rights are:

- 1908 Right (ADWR Certificate 610.0002) of 597.755 ac-ft per annum,
- 1933 Right (ADWR Certificate 665.0003) of 477.545 ac-ft per annum, and
- 1935 Right (ADWR Certificate 617.0002) of 46.455 ac-ft per annum.

1. Rosemont will provide funding for stream renovation and restoration projects to increase water flows and enhance wetlands in the Cienega Creek watershed. The location and design of these projects will be determined by the Bureau of Land Management (BLM) and the AGFD, with input from other key stakeholders in the watershed, including the Coronado National Forest and the U.S. Fish and Wildlife Service (FWS).

1.1. Rosemont will provide funding for these projects by establishing a $2,000,000 fund (the Conservation Fund). The Conservation Fund will be established through the annual payment of $200,000 for 10 years to an escrow or other suitable account managed and controlled by the AGFD or other designated conservation partner (the Conservation Partner). Payments to the fund will commence beginning on April 1 of the year following the year in which copper concentrates are initially produced at the Rosemont Copper Project and will be made on that same day in each succeeding calendar year until a total of $2,000,000 has been contributed to the Conservation Fund. Not more than 15 percent of this fund may be used by the Conservation Partner for fund administration, with the balance used for direct project execution.

1.2. The Conservation Partner shall work cooperatively and in consultation with FWS, Coronado National Forest, the BLM, AGFD (if they are not identified as the Conservation Partner), and other landowners in the watershed to fund the development and implementation of conservation measures designed to preserve and enhance aquatic and riparian ecosystems and protect and maintain habitat for federally listed aquatic and riparian species in the watershed. These projects may include surveys for and removal of bullfrogs, crayfish and other nonnative species in the watershed. The funds can be used to support approved management efforts by Pima County to control invasive aquatic species in the Cienega Creek Nature Preserve below and above the Pantano Dam. Project funds are not to be used for remediation of unanticipated issues associated with the Rosemont Project, such as waste rock slope failure. Funds can be used for initial restoration activities and adaptive management. It is recommended that some funds be reserved in anticipation of unforeseen issues (e.g., new invasive species) and adaptive management.

2. Rosemont will transfer 150 acre-feet of the 1933 water right to AGFD or to another entity authorized under Arizona law to hold a surface water right for recreation and wildlife purposes, subject to the conditions described in C-5 below. This water right must be used to preserve and enhance the aquatic and riparian ecosystem in the upper Cienega Creek watershed for the benefit of federally listed species and other native species of fish, wildlife and plants.

3. Rosemont will transfer 100 acre-feet of the 1933 water right to Pima County (or to another entity authorized under Arizona law to hold a surface water right for recreation and wildlife purposes), subject to the conditions described in C-5 below. Following transfer, these water rights must be used to preserve and enhance the aquatic and riparian ecosystem the County's Cienega Creek Natural Preserve, for the benefit of federally listed species and other native species of fish, wildlife and plants.

4. Rosemont will transfer all of the 1935 water right to Pima County (or to another entity authorized under Arizona law to hold a surface water right for recreation and wildlife purposes), subject to the conditions described in C-5 below to the lower reach of Davidson Wash within the Cienega Creek Nature Preserve that has also been designated an Outstanding Arizona Water. Following transfer, these water rights must be used to enhance and maintain the aquatic and riparian ecosystem in the lower reach of Davidson Canyon within the County's Cienega Creek Natural Preserve, for the benefit of federally listed species and other native species of fish, wildlife and plants.

5. To facilitate the transfer, Rosemont will file an application to sever 250 acre-feet of the 1933 water right and all of the 1935 water right and transfer the place of diversion and beneficial use to the Cienega Creek watershed, at such location(s) as may be determined in coordination and consultation with AGFD and Pima County. Such application will be

filed with the Arizona Department of Water Resources (ADWR) on or before July 1, 2013. The severance and transfer of the water right is subject to approval by ADWR. It is anticipated that it will take approximately two years for ADWR to review and approve the application. It is also possible that irrigation districts and other water rights holders will object to the severance and transfer application, which may delay the approval process and could cause ADWR to deny the application in whole or in part. In addition, due to the nature of Rosemont's agreement with the current owner of the water right, the transfer of the water right may be delayed until January 1, 2016. Rosemont will work diligently and in good faith to prepare and prosecute the severance and transfer application and will bear all costs associated with the application.

6. The balance of the surface water rights, approximately 825 ac-ft per annum, will be used for aquifer recharge below Pantano Dam. To accomplish this, a "managed underground storage facility" (MUSF) will be permitted through the Arizona Department of Water Resources (ADWR). This will allow surface water flows currently diverted for golf course irrigation to be captured and discharged back to the stream bed below the Pantano Dam within the Cienega Creek Nature Preserve.

6.1. The anticipated environmental benefits of this discharge to the Cienega Creek Nature Preserve have been described by Pima County in a joint technical report prepared by Pima County and the City of Tucson. Approximately 3,000 linear feet of surface flow and associated riparian habitat are expected to develop as a result of the MUSF. In addition to establishment of some surface flow, a large proportion of the water discharged to the MUSF will recharge the alluvial aquifer. The net change in shallow groundwater elevation and the rate of change are unknown, but we anticipate that changes in the aquifer in the upper reaches of the MUSF will be much greater than in the lower reach of the MUSF.

6.2. Additional benefits may be realized beyond the benefits associated with CWA Section 404 mitigation for the Rosemont project. Pima County, the Pima County Regional Flood Control District, and/or its conservation partners may, at their discretion develop an in-lieu fee mitigation program in reliance on the waters discharged to the MUSF in excess of the benefits expected to support in part, Rosemont's CWA Section 404 mitigation requirements. These potential future in-lieu fee mitigation credits that may or may not be developed here are not considered part of Rosemont's proposed conservation measures.

7. A groundwater well is located on lands associated with the Pantano Dam. Rosemont will acquire and retire this well to so that any potential effects of that well on the surface water of Cienega Creek and the Pantano Wash from its use and operation do not occur.

F. Water Features and Grazing Management

1. Rosemont's Allotments (Thurber, Debaud, Greaterville, and Rosemont) are subject to the requirements of the Federal Land Management and Policy Act, 43 U.S.C. § 1752, and the Forest Service's regulations governing grazing management, codified at 36 C.F.R.

Part 222. In accordance with those requirements, Rosemont will prepare and submit to the Coronado National Forest a request to modify the Allotment Management Plans (AMP) for the allotments within one year after the issuance of the ROD. The modifications will be developed in consultation, cooperation and coordination with the Coronado National Forest range staff and the Biological Monitor, with input from AGFD.

2. Rosemont will request modification of the AMPs specifying that to compensate for the permanent loss of flowering agaves for LLNB due the proposed mine, 4,221 acres, grazing by cattle will be restricted during the April 1 to June 15 period through rotation to alternative pastures on approximately 8,000 acres of portions of the Debaud, Greaterville and Rosemont allotments that currently are permitted to be grazed during the agave bolting period.
3. Portions of the pastures within Coronado National Forest grazing allotments leased to Rosemont will be put on a winter rotation to limit grazing during the growing season within riparian areas.
4. Key pastures will be rested for extended periods of time and made available for grazing when forage production on active pastures is reduced because of drought or other factors. This "grass bank" element within the modified AMP is similarly expected to enhance overall forage production within the Allotments without a reduction in current cattle stocking rates.
5. Rosemont will enhance existing water features, including stockponds, and add additional water features throughout the allotments to mitigate for potential project impacts to seeps and springs on their grazing allotments. Up to 30 potential water features will be managed or constructed, if needed, for metapopulation management (persistence) of CLF, and to meet the minimum requirements of Jaguar proposed/designated critical habitat PCE's.

5.1 Water feature enhancements and construction proposed to support a CLF metapopulation will be implemented at the start of mining activities. A summary of the water features and proposed mitigation measures is provided in section for CLF Conservation Measures.

5.2. Additional water features proposed for construction within the Rosemont-controlled grazing allotments will be implemented as needed and based on the findings of ongoing groundwater and seep and spring monitoring activities. [See CLF and Aquatic Species conservation measures for description of monitoring activities.] Rosemont will work cooperatively with the Biological Monitor to identify specific springs and seeps impacted by the proposed action and will construct water features to mitigate for those losses.

5.3. Rosemont will establish a long-term management and maintenance fund to maintain the water features constructed in furtherance of this conservation measure.

G. Chiricahua Leopard Frog

1. Conservation measures included for Sonoita Creek Ranch, Cienega Creek Watershed, and the section on Water Features and Grazing that benefit CLF are incorporated here by reference.
2. Rosemont will conduct pre-disturbance surveys, following AGFD/FWS survey protocols, of suitable habitat within the footprint of the proposed construction area and a ¼ mile buffer of the security fence prior to construction.
2.1. Survey will be conducted in the survey season prior to the initiation of construction activities.
2.2. Surveyors shall use the latest version of standard disinfection techniques to guard against spread of disease between surveyed tanks and other water features.
2.3. If CLF are found in the survey area, Rosemont will contact the Biological Monitor to facilitate capture and relocation of CLF or otherwise determine their fate. Prior to relocation, captured frogs will be tested for chytridiomycosis.
2.4. Surveyors will swab dead and dying frogs to test for chytridiomycosis. Periodic swabbing of live frogs will also be required. The Biological Monitor will determine where samples will be sent for testing. Rosemont will pay for testing on up to ten frogs. Alternatively, environmental DNA testing may be useful for advanced testing, when methods are refined, and cost effective, and may be substituted for testing of individual frogs.
2.5. The Biological Monitor shall approve the list of vendors where samples will be sent for chytridiomycosis testing.

3. Rosemont will conduct annual monitoring for CLF.
3.1. Surveys will be conducted annually commencing from the first spring survey period after construction activities begins through closure.
3.2 Surveys will be conducted using established survey protocols.
3.2.1. Surveys will be conducted in suitable habitat within the perimeter fence area and within suitable habitat within one mile of the perimeter fence area.
4.2.2. Any dead or dying frog encountered during annual monitoring surveys will be swabbed to test for chytridiomycosis.
4.3. During annual monitoring surveys, periodic swabbing of live, healthy appearing frogs will be required to test for the presence of chytridiomycosis. Up to 10 samples will be collected during each annual survey effort. Alternatively, environmental DNA testing may be useful for advanced testing, when methods are refined, and cost effect, and may be substituted for testing of individual frogs.
3.3.1 The Biological Monitor shall approve the list of vendors where samples will be sent for chytridiomycosis testing.
3.3.2 Surveyors will note any American Bullfrogs and other non-native, invasive aquatic species encountered during survey.

E. Tank/water feature construction will be implemented, if needed, to support maintenance of the metapopulation in the Greaterville area. [See Water Feature and Grazing Conservation Measure for additional discussion.]

4.1 The following tanks will be renovated to increase the reliability of water features available to support the CLF Greaterville metapopulation.

Table I-4: Excerpt from February 2013 Supplemental BA Table entitled Tanks within the Greaterville Chiricahua Leopard Frog metapopulation that will be renovated to enhance the reliability of the tanks to support the species

Tank Name	**Proposed Improvements**
Bowman Tank	Renovations and improvements to earthen stock tanks to increase water holding capacity and duration. Renovations to stock tanks would involve removal of sediments to increase their volume, compaction of substrates (i.e., fines, if available) in the tank basin and berm to decrease infiltration, and/or installation of impervious liners to impede infiltration in all or part of the basin. Design consideration will be given to installation of structures (e.g., gabions, silt traps) for erosion and sediment control. Supplement surface waters with structure for breeding, thermoregulation, and hiding. Examples of structure include submergent and emergent vegetation, bank vegetation, shrub branches above and below the surface.
California Gulch Tank East	
California Gulch Tank West	
Enzenberg Canyon Tank	
Granite Mountain Tank	
Granite Tank	
North Greaterville Tank	

5.2. Renovation activities will commence within one year of initiation of construction activities to develop the Project.

5.3. Rosemont will monitor the integrity of the seven renovated tanks listed above annually during the life of the mine and for five years post closure.

5.4. Rosemont will participate in CLF recovery team meetings for the Southeastern Arizona Working Group and Recovery Unit 2 to find opportunities and solutions toward species recovery in Recovery Unit 2.

F. To the extent determined necessary by the Biological Monitor, Rosemont will create up to 23 new water features to support CLF in the northern Santa Rita Mountains, in the area within the 5-ft, 150-year drawdown area, mapped by WestLand (2012a).

5.1 The water features will be constructed within Rosemont-controlled grazing allotments, the Helvetia Ranch Parcels, and the Davidson Watershed Parcels.

5.2 They will generally follow the conceptual designs and locations provided in WestLand (2012a). The selection of the appropriate design and location shall be made in consultation with the Biological Monitor.

5.3 The new structures are intended to enhance metapopulation dynamics, but not at the expense of encouraging rapid colonization between recovery unit populations, dispersal of invasive aquatic species, or spread of chytridiomycosis.

G. As part of the Invasive Species Management Plan, Rosemont will implement control measures to remove invasive aquatic species that have the potential to negatively affect CLF such as American Bullfrog, crayfish, and warm water fish species.

6.1. Methods for implementation of this program will be outlined in the Invasive Species Management Plan.

6.2 The program will be implemented beginning in the first year copper is produced.

6.3 The program will include the seven tanks renovated as part of the CLF conservation measures near Greaterville, new tanks constructed as part of these conservation measures during the life of the Project, and at other suitable CLF habitats within the perimeter fence.

7. Up to four of the stormwater ponds located along the perimeter of the reclamation footprint and included in the reclamation plan will be designed in a fashion that will facilitate their use by CLF following the general principals outlined in WestLand (2012a). The timing of construction of these features will be dictated by the timing of concurrent reclamation programs, in coordination with the Biological Monitor.

8. If it is determined that CLF are or may be exposed to process water harmful to CLF, Rosemont will construct barriers to exclude CLF from these areas. This work will be conducted in coordination with the Biological Monitor.

H. Aquatic Species: Gila Chub, Gila Topminnow, Huachuca Water Umbel

1. Conservation measures included for Sonoita Creek Ranch and Cienega Creek Watershed that benefit these species are incorporated here by reference.
2. Rosemont will implement the conceptual monitoring plan prepared by Water and Earth Technologies (2012) to evaluate impacts of groundwater drawdown to surface water features to the extent that authorization to install and access proposed monitoring sites are obtained. Two of the sites identified in this report have been installed and monitoring is being conducted at these sites. Application for the other monitoring locations has been made to the Arizona State Land Department. As authorizations for these sites are obtained, monitoring will commence at these sites.
3. Groundwater monitoring wells constructed and being constructed for the Aquifer Protection Permit (APP) will be monitored on quarterly basis for depth to ground water and water quality as prescribed by the APP. These data will be provided to the FS for comparison to the model predicted impacts to groundwater elevation changes. In addition, a suite of 27 existing wells and one new well within and beyond the footprint of the proposed mine will be monitored for depth and ground water over the long term. Certain of these existing wells are placed and will allow monitoring of water levels between the project area and:
   - Lower Cienega Creek
   - Upper Cienega Creek
   - Empire Gulch
   - Lower Davidson Canyon
   - Box Canyon
4. Should groundwater quality data reach alert or compliance standards Rosemont will comply with the requirements of the APP.

5. The stormwater permit for the project imposes specific requirements for surface water sampling and it will be implemented in accordance with the requirements of ADEQ as specified by EPA. Should impacts over and above the levels predicted in the EIS be anticipated by monitoring efforts, the funding provided by the Cienega Creek Watershed Conservation Fund will be used to implement adaptive management strategies to offset unanticipated effects.
6. Monitor geomorphic changes to Davidson Canyon.
6.1 Initial monitoring will begin at the start of construction and then conducted at the same monitoring sites every five years until five years after closure.
6.2 Four sample sites will be established by Rosemont. The Biological Monitor will approve site location.
6.3 Geomorphic monitoring will be conducted using the Forest Service Protocol or an agreed upon alternative approved by the Biological Monitor.
7. If monitoring shows the Cienega Creek Watershed is being affected, the Cienega Creek Watershed Conservation Fund should be used as a resource to fund mitigation projects.
8. The Cienega Creek Watershed Conservation Fund cannot be used outside of the Cienega Creek Watershed or to implement other conservation measures proposed by Rosemont (WestLand 2013a).

I. Southwestern Willow Flycatcher

1. Conservation measures included in sections for Cienega Creek Watershed, CLF, and Aquatic Species that benefit Southwestern Willow Flycatcher are incorporated here by reference.

J. Jaguar and Ocelot

1. Conservation measures included in sections for Sonoita Creek Ranch, Cienega Creek Watershed, Helvetia Ranch, Davidson Watershed Parcels, Water Features and Grazing, and Aquatic Species (particularly monitoring aspects within the current configuration of proposed Jaguar critical habitat) that benefit Jaguar and Ocelot are incorporated here by reference.
2. Rosemont will ensure that restored or replaced springs (see Water Features Conservation Measures, above) within Jaguar critical habitat (most current delineation) are constructed in accordance with Jaguar PCEs for surface water.
3. As part of the concurrent reclamation program Rosemont will establish a percentage of woody vegetation cover consistent with the elements of jaguar critical habitat (note that the relevant PCE is from >1 to 50 percent) as averaged over reclamation area, excluding the pit. This shall be established as a prescriptive obligation of the concurrent reclamation program in appropriate areas as determined in conjunction with the biological monitor during project development.
4. Monitor road-kill weekly on SR 83, adjacent to mine site, from the northern extent of currently proposed critical habitat to Gardner Canyon Road, to assess loss of Jaguar,

Ocelot, or Jaguar prey base (white-tailed and mule deer, collared peccary, white-nosed coati, in particular). Monitoring will begin at the commencement of mine construction and continue through the second year of mine operation, a total of four years. After the initial four years of monitoring, the Biological Monitor, working with Rosemont, AGFD and FWS, will determine if additional field data collection is necessary to inform determination of crossing need and location. Report road-kill in the annual report. Smaller Ocelot prey (lagomorphs, rodents) do not need to be reported. Mortality of any FS and BLM sensitive species should also be reported. This work may be conducted by the Biological Monitor as part of their regular site visits funded by Rosemont, with funding from the proponent. In addition to increasing knowledge regarding the movement of wildlife in the area, information collected during this investigation may identify a suitable wildlife crossing structure location that could be constructed using Regional Transportation Authority funds dedicated for that purpose.

5. Report all Jaguar and Ocelot sightings immediately to the Biological Monitor.
6. Rosemont will provide $50,000 to AGFD or other suitable entity approved by the Coronado National Forest to support camera studies for large predators including Jaguar and Ocelot. The money will be provided for additional monitoring efforts between the Santa Rita and the Whetstone Mountains and along the Santa Rita Mountains. In addition to increasing knowledge regarding the movement of wildlife in the area, information collected during this investigation may identify a suitable wildlife crossing structure location that could be constructed using Regional Transportation Authority funds dedicated for that purpose.

K. Lesser Long-nosed Bat:

The June 2012 BA includes some Conservation Measures which have been updated in subsequent versions of the BA and through discussions with Rosemont and the Coronado National Forest. For example: Bullet 1: there is not a final MPO yet, so we cannot confirm content, hence, what conservation measures may be included; Bullet 2: there is no detailed Palmer Agave management strategy;and Bullet 3: these are multi-species minimization measures (multiple-species design criteria).

Conservation measures included in sections for Sonoita Creek Ranch, Davidson Watershed Parcels, Helvetia Ranch, and Water Features and Grazing that benefit LLNB are incorporated here by reference. Additional measures include:

1. Prior to submittal of proposed modification of the Allotment Management Plan (Conservation Measure D.2), Rosemont shall refine existing estimates of Palmer Agave that will be impacted within the security fence area and conduct studies sufficient to identify and establish baseline conditions of pastures that will be proposed in the AMP modification for seasonal grazing restrictions to increase flowering success of agave.
2. Rosemont shall include Palmer's Agave in its concurrent reclamation plan.

3.1 Rosemont shall plant (transplanted or nursery grown stock) at least 35,850 Palmer Agaves as outlined in Table 1 of WestLand (2012b). The average density of plantings as proposed is 10.3 per acre. A record of the agave transplanted and planted from nursery-grown stock during concurrent reclamation efforts and the general location and density of transplants shall be maintained and reported to the Biological Monitor and in the Annual Report.

3.2 Rosemont shall include Palmer's Agave seed in its seed mix provided such seed are commercially available.

3. Rosemont shall conduct a scientifically designed study to document the efficacy of seasonal grazing restrictions to enhance agave flowering success. The study shall be implemented annually for five years following approval of the AMP and implementation of grazing management practices.

4. During the sixth year of implementation of conservation measures L.3 and L.4, Rosemont, FWS, and the Biological Monitor will evaluate the success of these conservation measures. If warranted, appropriate adaptive management actions will be developed by the Biological Monitor, FWS and Rosemont.

5. Rosemont will monitor the Helena Mine complex and Adit R2 plus any newly discovered large LLNB roost sites (>100 bats) within 1 mile of the Perimeter Fence annually for LLNB. (Note if the mine feature is not controlled by Rosemont or if for any other reason access cannot be obtained by the Biological Monitor this monitoring obligation shall not apply.)

6.1 Monitoring of each site shall be conducted three times during the late summer LLNB survey period – July, August and September. One of the surveys during the survey season at the Helena Mine will be scheduled to coincide with the region wide count.

6.2 Monitoring of Helena Mine complex, Adit R2, and other Large LLNB Roost Sites shall be conducted annually until five years after mine closure. Monitoring surveys area anticipated to commence beginning in 2013.

6.3 Surveys shall be conducted by evening emergence counts. Infrared tape recordings of the exit shall be recorded during each survey. The number of cameras used to capture emergence on tape will be sufficient to fully document monitored emergence events. Digital copies of the recordings will be provided to the Biological Monitor. The exit counts will be reported in the Annual Report.

6.4 Monitored roost sites shall not be entered, except as authorized by the Biological Monitor in coordination with FWS.

6.5 Rosemont shall provide a brief tabular summary of monitoring results to the Biological Monitor within two working days of each monitoring effort.

7. Rosemont will conduct reconnaissance-level surveys of other known cave and mine features capable of supporting bats within in the perimeter fence and within 1 mile of the perimeter fence for LLNB and other bat species.

7.1 Reconnaissance-level surveys shall be conducted on other known cave and mine features capable of support LLNB or other bats that have only minor numbers of LLNB (<100).

7.2 Reconnaissance-level surveys shall consist of one visit to each monitored feature during the late summer (July through September).

7.3 Reconnaissance-level surveys of these other known caves and mine features shall be conducted annually for the life of the Project and for five years following closure.

7.4 Features known or suspected to have minor numbers of LLNB (<100) will be monitored by external exit count or other remote sensing method approved by the Biological Monitor.

7.5 Caves or mine features suspected to be occupied by LLNB shall not be entered. Caves or mine features that are not suspected to have LLNB may be entered, if determined safe, or may be monitored by external exit count, placement of IR cameras, or other suitable means.

7.6 Rosemont shall provide a brief tabular summary of reconnaissance-level survey results to the Biological Monitor within 10 working days of completion of the reconnaissance surveys.

8. Rosemont will close 20 mine features, including the Chicago Mine prior to Project construction (WestLand 2012b). If other sites are identified by Rosemont in proximity to the Project that may require closure for safety purposes, Rosemont will coordinate with the Biological Monitor. The mine and cave closure process is described in WestLand (2012b). Basically, the site is surveyed for bats or other species, and then closed with chicken wire (to allow bats to escape and not re-enter). Prior to exclusion, Rosemont will notify the Biological Monitor.

9. Following construction of the mine and during the initial year of operation, Rosemont shall work with the Biological Monitor to review the efficacy of light mitigation measures at key resource areas around the mine, such as the Helena Mine, as identified by the Biological Monitor. If additional shielding can be placed to further reduce lighting effects without adverse consequences to safety and unreasonable operational expectations, Rosemont shall implement the additional requested shielding in a manner consistent with safe mining practices.

10. Fence the R2 Mine and Helena Mine complex to exclude unauthorized human access. Fence construction shall be as described in Rosemont's summary of the conservation measures. If during the life of the Project any new major roost sites (greater than 100 LLNB at peak count) are detected within one mile of the perimeter fence it will be fenced or otherwise protected from unauthorized human access in a manner approved by the Biological Monitor.

11. During the life of the Project Rosemont shall work with the Biological Monitor to identify potential restoration areas outside of the security fence and within 2 miles of the perimeter fence that are suitable for Palmer's Agave. Using the seed mix being used for concurrent reclamation programs where appropriate, Rosemont will assist the Coronado National Forest with the revegetation of these areas. In addition to seeding, revegetation efforts will include planting Palmer's Agave transplants or nursery-grown Palmer's

Agave. This effort will include portions of the old Arizona Trail being abandoned as part of these conservation measures.

12. Rosemont shall work with the Coronado National Forest to relocate the Arizona Trail away from the Helena Mine complex.

L. Pima Pineapple Cactus

1. Conservation measures included in sections for Helvetia Ranch Parcels are incorporated here by reference.
2. Construction practices along the proposed utility corridors will be employed to keep surface disturbance to the minimum practicable and to avoid Pima Pineapple cactus.

2.1. Before ground disturbance, the utility corridor routes will be surveyed. Known Pima Pineapple cactus localities will be flagged and to the extent possible will be avoided.

2.2. Rosemont will protect Pima Pineapple cactus that can be avoided with clear limit fencing, and construction/reclamation activity in the vicinity of these plants will be monitored during construction.

2.3. Educate construction personnel for the power and water line in the offsite utility corridor how to identify Pima Pineapple cactus and marking/avoidance methods.

2.4. Pima Pineapple Cactus that cannot be avoided by utility construction/reclamation will be transplanted within the corridor into suitable habitat. A monitoring and maintenance program will be initiated to facilitate establishment that will follow similar previous efforts for Pima pineapple cactus transplantation and will involve watering for the first few months after transplant, followed by regular monitoring.

M. Western Yellow-billed Cuckoo:

1. Conservation measures included in sections for Sonoita Creek Ranch, Cienega Creek Watershed, Davidson Watershed Parcels, and Water Features and Grazing that benefit CLF are incorporated here by reference.
2. Rosemont will survey for Yellow-billed Cuckoo (YBC) in those drainages in the Project Area that have potential habitat (e.g., Barrel Canyon, McCleary Canyon) before trees (including large mesquites) within the Perimeter Fence boundary are removed.

2.1 Survey shall be accordance with the current approved protocol and shall commence in June 2013.

2.2 Survey shall be conducted within suitable habitat within undisturbed portions of the Perimeter Fence area annually for the first five years of mine operation.

3. Should vegetation clearing be proposed during the YBC nesting season, Rosemont shall coordinate with the Biological Monitor and FWS prior to vegetation clearing in suitable YBC habitat.

3.1 Vegetation clearing within 50 meters of an active YBC nest or the center of an active YBC territory shall not occur during the YBC nesting period. This conservation measure shall not restrict vegetation clearing for implementation of an approved Plan of Operation outside of the YBC nesting period.

Project Area

The BA defines the *project area* as all areas in which any ground disturbance would take place as a result of the proposed action , the Barrel Alternative (i.e., the proposed action as chosen by the Coronado National Forest Supervisor during the NEPA Draft EIS process), including the mine pit, waste rock piles, tailings, access roads, utility corridors (the TEP transmission line and water line), and on-site facilities (i.e., the mine "footprint"). The project area acreage, expected to result in direct impacts owing to project activities, is 5,393 acres (see FEIS).

The project is located in the Helvetia mining district, approximately 30 miles southeast of Tucson in Pima County, Arizona. The project site is just west of State Route (SR) 83, on the northern edge of the Santa Rita Mountains (Figure 2 in the June 2012 BA and Figure I-1 in this document). The area covered by Rosemont's patented claims, unpatented claims, and fee lands totals approximately 14,880 acres and includes all or portions of the Rosemont, Peach-Elgin, Broad Top Butte, and Copper World deposits. The Barrel alternative is in Pima County, Arizona, Gila and Salt River Baseline and Meridian; legal descriptions of the components are as follows:

- The perimeter fence: Sections 19–21 and 28–33, Township 18 South, Range 16 East; Sections 1 and 12, Township 19 South, Range 15 East; Sections 24, 25, and 36, Township 18 South, Range 15 East; and Sections 4–8, Township 19 South, Range 16 East.
- The corridor for the water line and electrical transmission line: Sections 17, 20, 21, 27–29, and 32–35, Township 17 South, Range 14 East; Sections 1, 2, and 12, Township 18 South, Range 14 East; Sections 7, 17, 18, and 20–24, Township 18 South, Range 15; and Sections 19 and 30, Township 18 South, Range 16 East.
- The primary access road corridor: Sections 19–22 and 30, Township 18 South, Range 16 East.
- The secondary access road corridor: Sections 22–24, Township 18 South, Range 15 East and Sections 19 and 30, Township 18 South, Range 16 East.

Action Area

Of greater relevance to section 7 consultation is the *action area*; which includes "…all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02)". The proposed action will adversely affect seven animal and two plant species, each with differing life histories, habitat requirements, and distributions in the areas affected by the proposed action. Given that the proposed action has effects ranging from nearly immediate, direct losses of habitat in the mine's footprint to subtle and longer-term hydrologic changes in distant sites, each species will be affected over a different temporal nd spatial scale.

The BA has defined the action area as the aforementioned project area plus a larger, surrounding area that may experience direct or indirect temporal and spatial impacts from the project.

Temporally, the potential on-site and off-site impacts resulting from the proposed action encompass all the activities associated with construction, operation, reclamation, and post-closure activities. The action area for this analysis is based on: (1) the area of the mine footprint; (2) areas outside the mine footprint that may be affected by noise, dust, light pollution, and other mining activities; (3) all areas for which mining activity may affect groundwater and surface water; and (4) other areas outside the footprint that are related to mining activity, such as road modifications, power lines, and pipelines (i.e., connected or interrelated/ interdependent actions).

Spatially, the action area totals approximately 145,513 acres, including the footprint of the Barrel and TEP Alternatives. The action area is located primarily in Pima County but also encompasses a small portion of Santa Cruz County; 65,215 acres are on Forest Service and Bureau of Land Management (BLM) lands, and the remaining 80,298 acres within the action area are on Arizona State Land Department (ASLD) State Trust land and private land. Included in the BLM acreage within the action area, primarily as a result of expected groundwater drawdown impacts within Cienega Creek and Empire Gulch, is a large portion of Las Cienegas National Conservation Area (NCA). The larger action area was drawn to consider the impacts of noise, dust, light pollution, groundwater drawdown, and surface water reduction.

The action area includes vegetation communities, surface water drainages, and on-site physical and topographic features (e.g., mountains, caves and mine adits/shafts, seeps and springs, stock tanks, rocky outcrops, etc.) that may be directly affected by the proposed action. The action area also includes the indirect downgradient effects on the surface water and groundwater environments that would result from the on-site diversion and impoundment of surface water; the indirect effects on springs and seeps surrounding the proposed action area; and the indirect effects of noise, dust, and light resulting from mining and transportation activities. Therefore, the action area includes the following: (1) drainages that receive surface water discharge from the mine site, including Davidson Canyon Wash past its confluence with Cienega Creek to Pantano Dam; (2) springs and seeps within the area of projected groundwater drawdown associated with the mine pit, including Empire Gulch and Cienega Creek, which contain BLM-administered wetlands; and (3) areas adjacent to the mine site and transportation corridors that may be impacted by noise, dust, and light. The temporal analysis period includes 24 hours of light and noise for at least 20 years and the potential for groundwater drawdown for up to 1,000 years after closure of the mine. Impacts to downstream water quality would occur as a result of runoff from tailings and waste rock piles, and disruption of surface water flow would result from the capture of runoff in the pit. Downstream impacts to water quality and/or disruption of surface water flow resulting from the capture of runoff in the pit are only expected to occur along the Barrel Canyon drainage and through Davidson Canyon to its confluence with Cienega Creek.

Land Ownership and Surrounding Land Uses

The action area is a combination of public (federal and state) and private lands, totaling approximately 145,513 acres. Land ownership immediately surrounding the proposed action includes Forest Service, BLM, ASLD State Trust land, and private land. Land use in the vicinity of the proposed action primarily consists of mining, livestock grazing, and dispersed recreation. Sporadic prospecting reportedly began in the northwestern portion of the proposed action area, the Helvetia mining district, sometime in the mid-1800s. By the 1880s, the production from mines on both sides of the northern Santa Rita Mountains was supporting the construction and operation of the Columbia smelter at Helvetia on the west side of the Santa Rita Mountains and the Rosemont smelter in the Rosemont mining district on the east side of the Santa Rita Mountains. Since copper production ceased in 1951, the area stretching from the Peach-Elgin prospect to Rosemont has seen a progression of exploration campaigns. The majority of the land surrounding the proposed action area is currently under permit for livestock grazing. Current rangeland conditions on the district are largely the result of recent drought conditions and an older history of intense grazing pressure that resulted in severe erosion, including arroyo cutting. Recreation activities on lands within and adjacent to the proposed action area include casual or dispersed uses, as well as organized events. Typical recreation activities in the proposed action area consist of motorized vehicle touring (including off-highway vehicle use), dispersed camping, wildlife observation, nature study, bird watching, recreational prospecting, hunting, rock and mineral collection, picnicking, mountain biking, hiking, and horseback riding.

Local and Regional Climate

The climate in the actions area is semiarid, with precipitation varying by season and with elevation. The 30-year normal (1971 to 2000) annual average precipitation for the Santa Rita Experimental Range station (approximately 5 miles northwest of the project area) is 23.41 inches (Western Regional Climate Center 2009). Over this 30-year period, nearly one-half of the precipitation occurred in July, August, and September. The smallest amount of precipitation occurred in April, May, and June.

Temperatures regionally are moderate to extreme, with maximums and minimums also varying with elevation. The 30-year normal average monthly maximum temperatures at the Santa Rita Experimental Range station ranged from a low of 60.4 degrees Fahrenheit (°F) in January to a high of 93.3°F in June. Average monthly minimum temperatures ranged from a low of 37.5°F in December and January to a high of 66.8°F in July. A climatological summary appears in Table 27 of the Draft EIS.

Biophysical Features

The action area ranges in elevation from approximately 2,740 to 6,610 feet above mean sea level. The topography is dominated by rolling to steep hills, drainages, and canyons. The Santa Rita Mountain range includes numerous drainages that contain riparian vegetation. Barrel Canyon is the principal drainage system within the action area (see Figure A-1). Wasp, McCleary, and Scholefield Canyons discharge to Barrel Canyon, which discharges to Davidson Canyon and then to Cienega Creek in the northeastern portion of the action area (see Figure A-1). Empire Gulch and Gardner Canyon discharge into upper Cienega Creek in the southeastern portion of the action area. The northwest side of the action area is drained by a series of unnamed headwater tributaries of Sycamore Canyon. Box Canyon is the major drainage system within the southwestern portion of the action area, west of the main ridgeline. There are 101 springs and seeps (i.e., areas where there is moist soil or lotic or lentic surface water systems) and 148 stock tanks in the action area (Figure 3 in the June 2012 BA). Two springs in the action area were identified as being associated with wetlands: Scholefield Spring, located on a tributary to Scholefield Canyon; and Fig Tree Spring, a developed spring near the head of a minor unnamed tributary to Sycamore Canyon (WestLand 2010a, as cited in the BA). The aforementioned water sources provide habitat for aquatic plant and animal species within the action area. Previous mining activity has resulted in a number of mine adits and shafts within the action area (Figure 4 in the June 2012 BA); mine adits and shafts provide roosting habitat for bats and other wildlife species (WestLand 2009a).

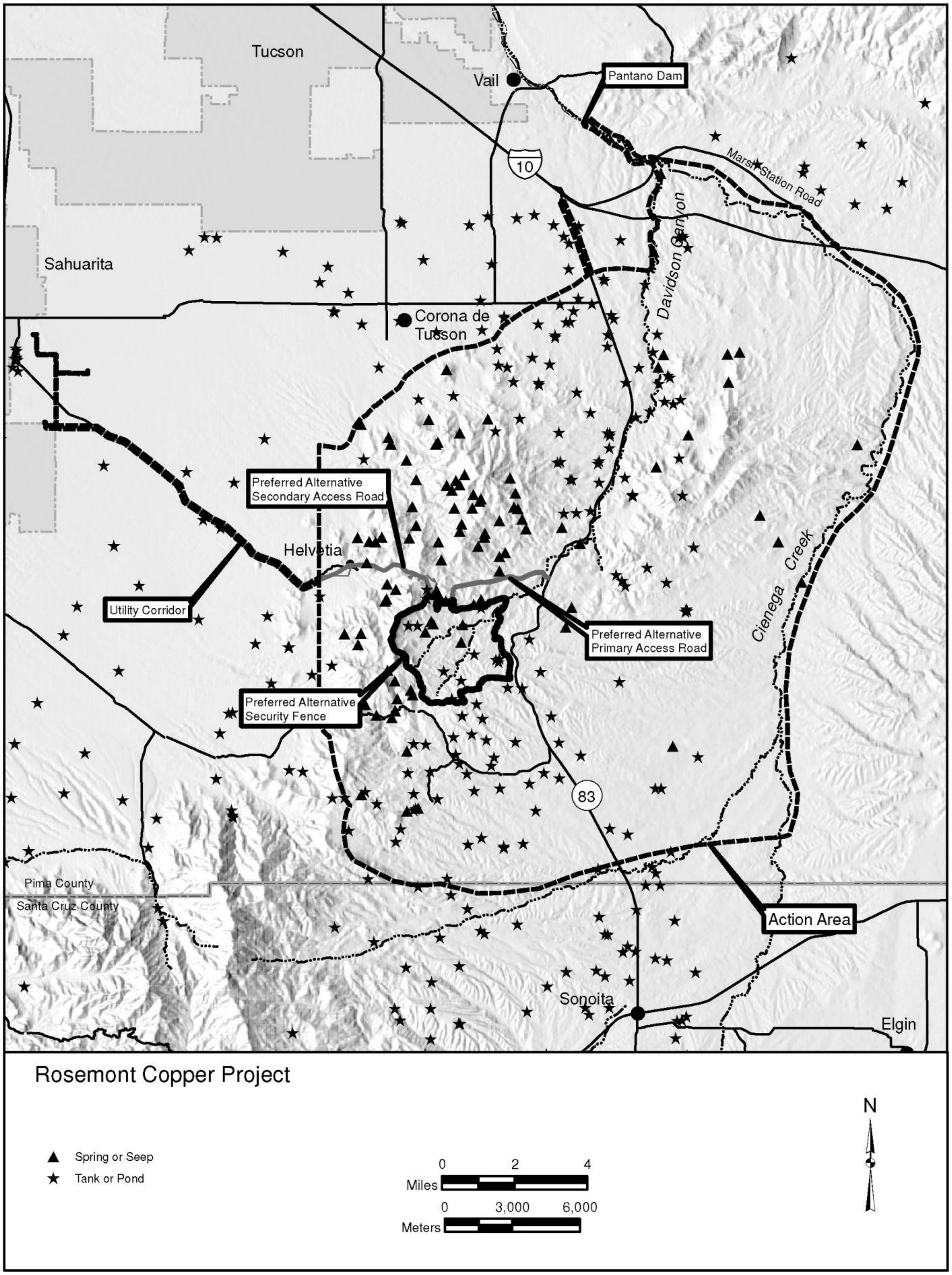

Figure I-3: Water resources within the Action Area of the Rosemont Mine project.

Vegetation Communities

Uplands

The action area is located in three upland vegetation communities: semidesert grassland, Madrean evergreen woodland, and Chihuahuan desertscrub (Brown 1994) (see Figure I-4). Semidesert grassland, characterized by open grasslands with widely scattered shrubs and cacti, generally covers the lower elevations of the action area. Madrean evergreen woodland mostly covers the higher elevations of the action area, generally in the western and southern areas, and is characterized by open woodlands or savanna, primarily consisting of trees interspersed with grasses and forbs. Chihuahuan desertscrub is dominated by the shrub, creosotebush (*Larrea tridentata* var. *tridentata*), on plains, low hills, and valleys on the uplands surrounding middle Cienega Creek.

Semidesert Grassland

There is a total of approximately 107,396 acres of the semidesert grassland vegetation community in the action area. In the semidesert grassland vegetation type, composition, and density varies with geographic location, precipitation, and topography. Some areas within this vegetation community are nearly barren with an abundance of sand, rock, gravel, scree, or talus, while other areas may have sparse to dense vegetation cover that includes succulent species, grasses, shrubs, scattered trees, and some herbaceous cover (Brown 1994; Forest Service 2009b, as cited in the BA). Within the action area, semidesert grassland is characterized by grasses interspersed with a variety of low-growing trees, shrubs, and cacti, including whitethorn acacia (*Acacia constricta*), catlaw acacia (*A. greggii*), prickly-pear cactus (*Opuntia* spp.), cholla (*Cylindropuntia* spp.), soaptree yucca (*Yucca elata*), beargrass (*Nolina microcarpa*), desert spoon (*Dasylirion wheeleri*), and agave (principally *Agave schottii* and *A. palmeri*). Native grass species include black grama (*Bouteloua eriopoda*), blue grama (*B. gracilis*), sideoats grama (*B. curtipendula*), hairy grama (*B. hirsuta*), buffalo grass (*B. dactyloides*), plains lovegrass (*Eragrostis intermedia*), little bluestem (*Schizachyrium cirratum*), plains bristlegrass (*Setaria machrostachya*), fluffgrass (*Dasyochloa pulchella*), burrograss (*Scleropogon brevifolius*), and slim tridens (*Tridens muticus*). The non-native Lehmann lovegrass (*E. lehmanniana*) is one of the more abundant nonnative grass species semidesert grassland portions within the action area.

Madrean Evergreen Woodland

There is a total of approximately 30,417 acres of the Madrean evergreen woodland vegetation community mapped within the action area (Brown 1994; Forest Service 2009b, as cited in the BA). The Madrean evergreen woodland vegetation community occurs on foothills, canyons, bajadas, and plateaus between semidesert grasslands and montane conifer forests; however, in the action area, virtually all of the Madrean evergreen woodland (sensu Brown 1994, as cited in the BA) is the lower end, more appropriately termed Madrean encinal (oak) woodland, as opposed to the upper end, usually termed Madrean pine/oak woodland, and trees indicative of the Madrean pine/oak woodland are absent (McLaughlin and Van Asdall n.d. [1977], as cited in the BA). This community is dominated by evergreen oaks, and in the action area, common oak arizonica). Other tree species present are alligator bark juniper (*Juniperus deppeana*), one-seed juniper (*J. monsperma*) species include Emory oak (Quercus *emoryi*), Mexican blue oak (*Q. oblongifolia*), and Arizona white oak (*Q. monosperma*), velvet mesquite (*Prosopis velutina*), and Mexican pinyon (*Pinus cembroides*). All of the shrub and warm season grass species and other ground cover listed in the semidesert grassland section can also be found in areas dominated by the Madrean evergreen woodland vegetation community.

Chihuahuan Desertscrub

There is a total of approximately 2,622 acres of the Chihuahuan desertscrub vegetation community in the action area. Chihuahuan desertscrub is limited to uplands in the vicinity of Cienega Creek within the action area (Brown 1994). The action area is within the Mexican Highlands Ecoregion, the Chihuahuan Desert influences this ecoregion, and McLaughlin and Van Asdall (1977) noted that Chihuahuan desertscrub vegetation components are present in the mine site area. Shrubs such as creosotebush and whitethorn acacia dominate the Chihuahuan desertscrub vegetation community. Other vegetation in this community includes very large yucca (*Yucca* spp.), which grow among grasses (mostly *Bouteloua* spp.) or scattered shrubs [e.g., desert zinnia (*Zinnia acerosa*) and condalia (*Condalia* sp.)], agave (*Agave* spp.), ocotillo (*Fouquieria splendens*), jatropha (*Jatropha* sp.), and scattered cacti.

Sonoran Desertscrub

Sonoran desertscrub is located outside the action area (Brown 1994); however, the action area falls within the Mexican Highlands Ecoregion, and the Sonoran Desert influences this ecoregion. One portion of the action area that contains elements of the Sonoran desertscrub biotic community is downstream, near the point where Davidson Canyon merges with Cienega Creek. The other portions of the action area that exhibit characteristics of the Sonoran desertscrub biotic community are the areas proposed for utility lines and access roads connecting the mine operations to the town of Sahuarita. The conspicuous vegetation of the Arizona Upland subdivision of the Sonoran Desert includes saguaro (*Carnegiea gigantea*), palo verdes (*Parkinsonia* spp.), creosotebush, and numerous species of cacti, such as chain fruit cholla (*Cylindropuntia fulgida*), and Engelmann prickly pear (*Opuntia phaeocantha* var. *phaeocantha*). Birds are often associated with (e.g., nest in) the saguaro and cholla cacti, as well as palo verdes.

Riparian

The Forest Service recognizes two riparian vegetation communities within the action area: interior riparian deciduous woodland; and ephemeral fluvial systems, which support upland vegetation (Robbie pers. comm. 2009, as cited in the BA). These vegetation communities are present in drainages within the action area and along downstream portions of Cienega Creek, Davidson Canyon, and Barrel Canyon. There is a total of approximately 5,079 acres of riparian vegetation communities in the action area. This acreage is a combination of those mapped for interior riparian deciduous woodland and ephemeral fluvial systems supporting upland vegetation. Additionally, two springs in the action area were identified as being associated with wetlands: Scholefield Spring, located on a tributary to Scholefield Canyon; and Fig Tree Spring, which is a developed spring near the head of a minor unnamed tributary to Sycamore Canyon (WestLand 2010a). These two springs and seeps, along with numerous other springs and seeps, provide habitat for aquatic plant and animal species, as well as water sources for terrestrial species, within the action area.

Interior Riparian Deciduous Woodland

The vegetation in this type is a mix of riparian woodlands and shrublands, with a variety of vegetation associations (Forest Service 2009b). The dominant vegetation varies, depending on a suite of site-specific characteristics, including elevation, substrate, stream gradient, and depth to groundwater. Within the fence line of the Barrel alternative, interior riparian deciduous woodland vegetation is confined to portions of Barrel, McCleary, Wasp, Sycamore, and Scholefield Canyons. Vegetation includes a variety of trees and shrubs, including Arizona black walnut (*Juglans major*), Goodding's willow (*Salix gooddingii*), netleaf hackberry (*Celtis reticulata*), desert willow (*Chilopsis linearis*), desert broom (*Baccharis sarothroides*), and seep willow (*B. glutinosa*). Also present are desert false indigo (*Amorpha fruticosa*), canyon grape (*Vitis arizonica*), American brooklime (*Veronica americana*), and southern cattail (*Typha domingensis*). Within the action area, interior riparian deciduous woodland vegetation extends downstream through Davidson Canyon, Empire Gulch, Gardner Canyon, and Cienega Creek.

Ephemeral Fluvial Systems Supporting Upland Vegetation

These systems are found along major and minor ephemeral washes that do not contain a perennial flow of water (Forest Service 2009b). This vegetation type is often referred to as xeroriparian vegetation and typically contains plant species also found in neighboring uplands, although riparian plants are typically larger, support a variety of plants and animals that are often considered riparian, often occur at higher densities than those in the associated uplands, and may occasionally include plant species found in interior riparian deciduous woodlands, although typically at a lower density and frequency. In the action area, this vegetation community occurs in numerous smaller named and unnamed washes where the dominant plant species include Emory oak, Mexican blue oak, Arizona white oak, one-seed juniper, whitethorn acacia, catclaw acacia, and velvet mesquite McLaughlin and Van Asdall (1977).

Aquatic Habitat

Aquatic vegetation is unique to the springs and seeps within the action area and includes obligate wetland plants (i.e., almost always occurs under natural conditions in wetlands) such as seep monkey flower (*Mimulus guttatus*) and water speedwell (*Veronica anagallis-aquatica*), along with facultative wetland plants (i.e., usually occur in wetlands, but occasionally found in non-wetlands) such as smooth horsetail (*Equisetum laevigatum*) and Arizona giant sedge (*Carex spissa* var. *ultra*) (which is likely a facultative wetland plant). Other riparian plant species documented at springs and seeps in the action area include sycamore (*Plantanus wrightii*), willow (*Salix* spp.), netleaf hackberry, and deergrass (*Muhlenbergia rigens*). Within the action area, moist soil or surface water (both lentic and lotic systems) and associated aquatic vegetation are known to occur at the following springs (WestLand 2011a): Basin, Deering, Empire Gulch, Fig Tree, Mudhole, Oak, Ojo Blanco, Rosemont, Scholefield, Sycamore, and Water Develop. Areas of aquatic habitats are too small to map; therefore, they do not appear on Figure I-3.

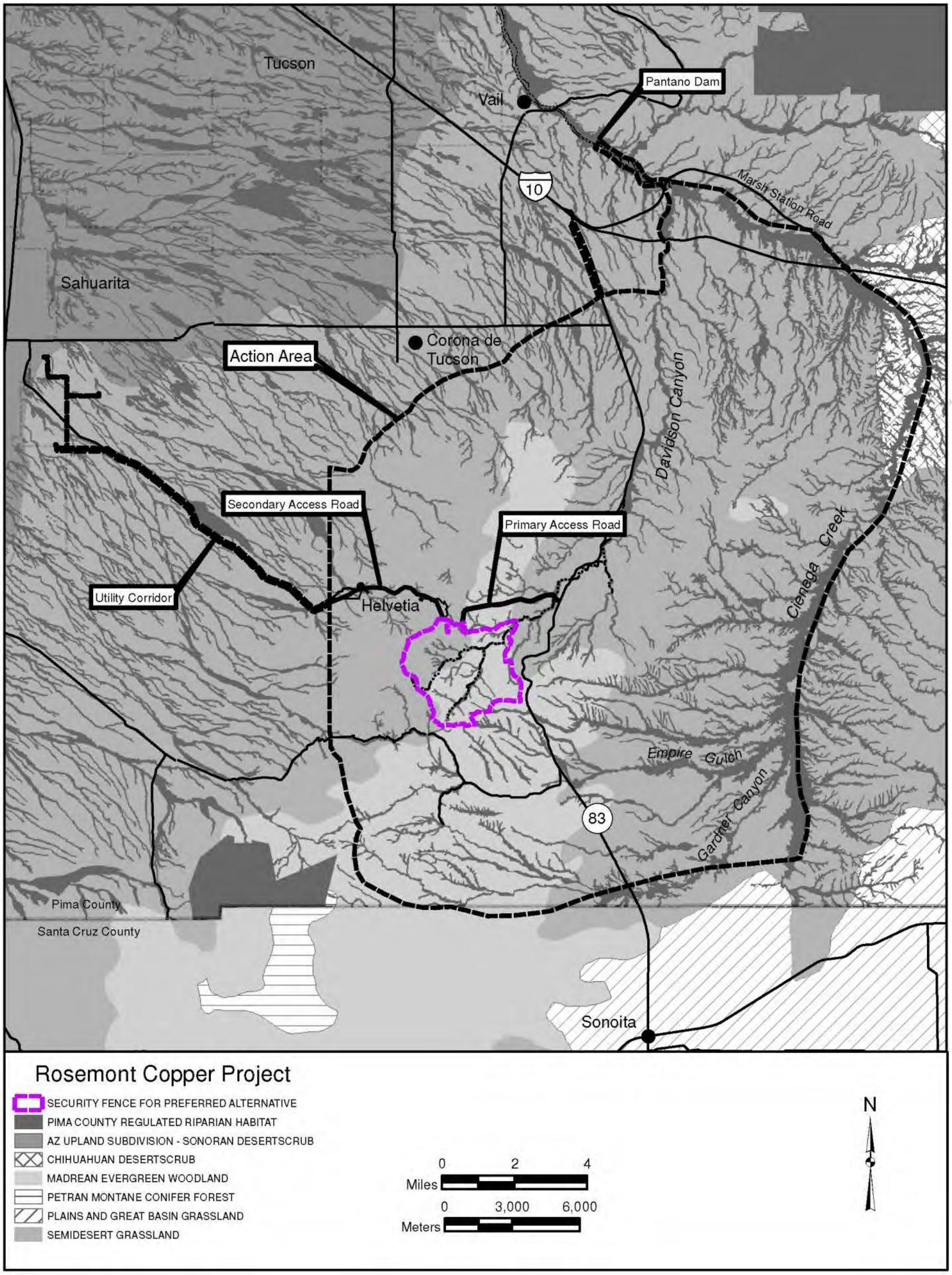

Figure I-4: Vegetation communities within the Action Area for the Rosemont Mine project

Existing Disturbances

Previous mineral exploration and production activities in the proposed action area have resulted in numerous landscape disturbances, such as mine prospects and adits, mine related access roads, and geotechnical drilling sites. These disturbances are scattered throughout the proposed action area. Additional anthropogenic disturbances have resulted from livestock grazing and all-terrain vehicle (ATV) use. Within and adjacent to the action area, there are numerous wells in the Sonoita area that support residential and ranching uses.

Historic Mining Activities

Helvetia was the largest mining camp of the Helvetia district, followed by Old Rosemont, New Rosemont, and smaller mining camps established at the "Tiptop, Blue Jay, Proctor and Deering, Beuhman, Cuprite, Pauline, Metallic, Helena, Scholefield and Ridley mines" (Ayres 1984, as cited in the BA). The major era of mining at Rosemont was 1879 to 1915, although Old Rosemont was most active from 1894 to 1915, and New Rosemont was most active from 1915 to 1921.

Ranching and Grazing

Livestock grazing has been an ongoing disturbance in and around the footprint of the proposed mine for over 100 years—historically at much higher levels than at present. One of the earliest ranches in the proposed action area was the VR Ranch, which was established in the 1880s and later homesteaded. By about 1900, the López and Martínez ranches were in operation, but neither of these was homesteaded. In 1903–1904, when the 1905 Patagonia USGS quadrangle map was surveyed, there were three ranches within the proposed action area: López, Martínez, and VR. With the establishment of the Santa Rita Forest Preserve in 1902 and the Coronado National Forest in 1908 (Ayres 1984), the federal government began to require permits to graze cattle on federal land. Smaller ranchers, such as the Lópezes and the Martínezes, were allowed to graze a few head without permits. The Taylor Grazing Act of 1934 established a system of grazing allotments for public lands. Most of the project area lies within the Rosemont grazing allotment, which was established in 1935 and covers 11,369 acres. From 1938 to 1951, this allotment was leased by Chiricahua Ranches. Rosemont holds term grazing permits on four allotments: Rosemont, Thurber, Greaterville, and DeBaud. Rosemont plans to continue all current grazing activities as permitted throughout the course of the proposed action .

Recent Geotechnical and Hydrologic Drilling

In August 2006, Tetra Tech completed a geotechnical investigation on lands within the proposed action area in support of feasibility-level designs of a heap leach pad and associated ponds, dry-stack tailings facilities, plant site facilities, a waste rock storage area, and various water management facilities (Tetra Tech and Schafer 2007). Initial geotechnical site investigations were conducted between November 2006 and March 2007. A total of 10 boreholes and 33 test pits were completed during this initial phase of the work. The boreholes and test pits were confined to the limits of private land (patented claims and fee lands).

In March 6, 2008, you conditionally approved the preliminary MPO, which proposed short-term geotechnical and hydrologic drilling and related activities on the Coronado National Forest. From May through July 2008, Tetra Tech completed a total of 19 boreholes at 15 drill sites located on Forest Service land (Tetra Tech 2009b, as cited in the BA). Because of the restricted amount of ground disturbance allowed on Forest Service land, 13 of the 15 drill sites were located along existing dirt roads. Two new access roads were constructed in order to reach drill sites located within the plant site area and the footprint of the proposed primary crusher. In accordance with Forest Service instructions, all disturbed areas associated with the geotechnical drilling on Forest Service land will be reclaimed (i.e., recontoured and seeded) within 30 days of the completion of drilling, with the exception of boreholes that will be used for groundwater monitoring. Gating of new access roads and the permanent closure of access roads following the completion of drilling activities were also conditions stipulated by the Forest Service.

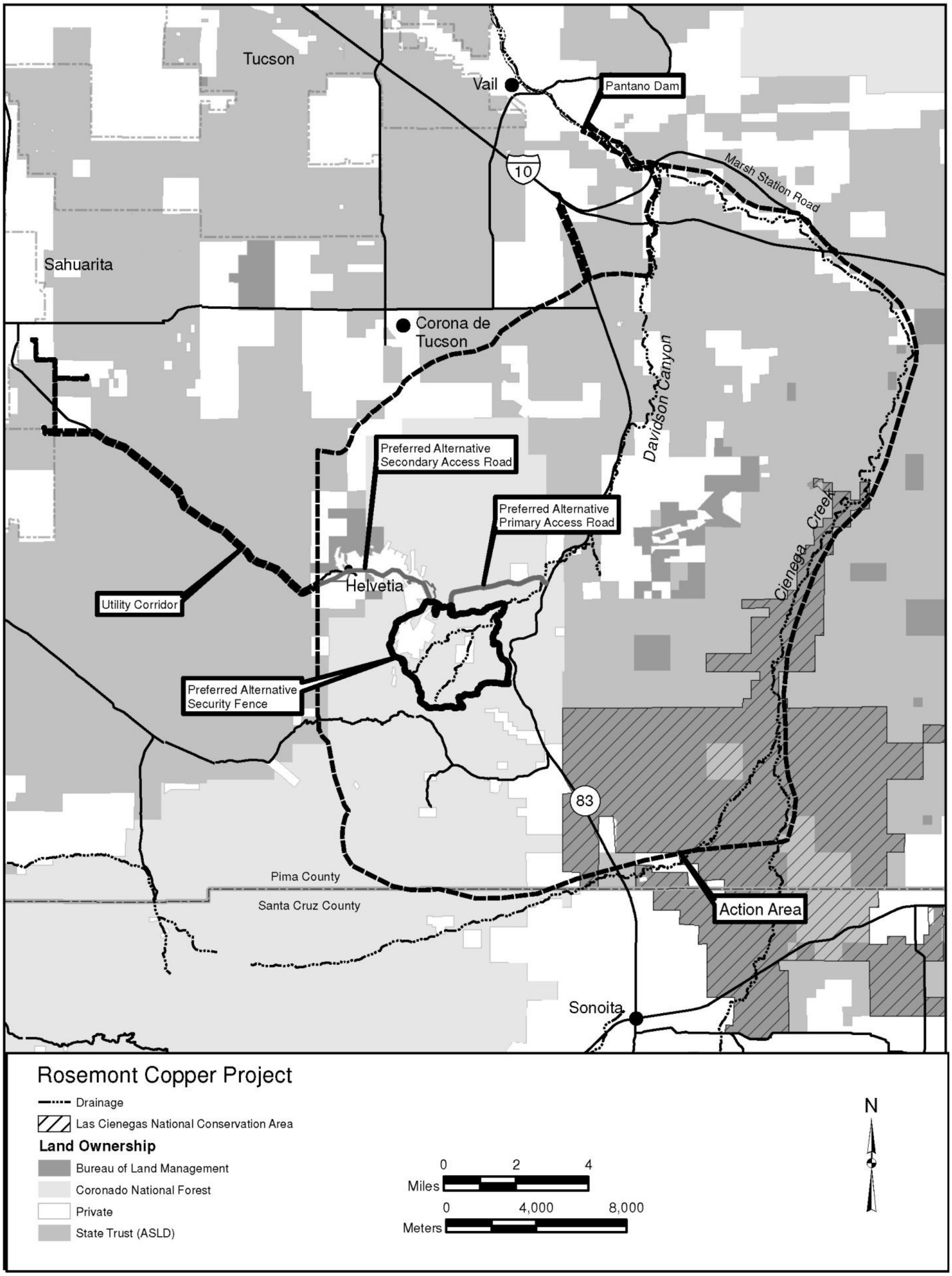

Figure I-5: Action Area for the Rosemont Mine project

Status of the Species - Lesser Long-Nosed Bat

Species Description

The lesser long-nosed bat is a medium-sized, leaf-nosed bat. It has a long muzzle and a long tongue, and is capable of hover flight. These features are adaptations for feeding on nectar from the flowers of columnar cacti (e.g., saguaro [*Carnegiea gigantea*]; cardon [*Pachycereus pringlei*]; and organ pipe cactus [*Stenocereus thurberi*]; and from paniculate agaves (e.g., Palmer's agave [*Agave palmeri*]) (Hoffmeister 1986). The lesser long-nosed bat was listed (originally, as *Leptonycteris sanborni*; Sanborn's long-nosed bat) as endangered in 1988 (U.S. Fish and Wildlife Service 1988). No critical habitat has been designated for this species. A recovery plan was completed in 1997 (U.S. Fish and Wildlife Service 1997). Loss of roost and foraging habitat, as well as direct taking of individual bats during animal control programs, particularly in Mexico, have contributed to the current endangered status of the species. Recovery actions include roost monitoring, protection of roosts and foraging resources, and reducing existing and new threats. The recovery plan states that the species will be considered for delisting when three major maternity roosts and two post-maternity roosts in the U.S., and three maternity roosts in Mexico have remained stable or increased in size for at least five years, following the approval of the recovery plan. A five-year review has been completed and recommends downlisting to threatened (U.S. Fish and Wildlife Service 2007b).

Distribution and Life History

The lesser long-nosed bat is migratory and found throughout its historical range, from southern Arizona and extreme southwestern New Mexico, through western Mexico, and south to El Salvador. It has been recorded in southern Arizona from the Picacho Mountains (Pinal County) southwest to the Agua Dulce Mountains (Pima County) and Copper Mountains (Yuma County), southeast to the Peloncillo Mountains (Cochise County), and south to the international boundary.

Within the U.S., habitat types occupied by the lesser long-nosed bat include Sonoran Desert scrub, semi-desert and plains grasslands, and oak and pine-oak woodlands. Farther south, the lesser long-nosed bat occurs at higher elevations. Maternity roosts, suitable day roosts, and concentrations of food plants are all critical resources for the lesser long-nosed bat. All of the factors that make roost sites suitable have not yet been identified, but maternity roosts tend to be very warm and poorly ventilated (U.S. Fish and Wildlife Service 1997). Such roosts reduce the energetic requirements of adult females while they are raising their young (Arends *et al.* 1995).

Roosts in Arizona are occupied from late April to September (Cockrum and Petryszyn 1991) and on occasion, as late as November (Sidner 2000); the lesser long-nosed bat has only rarely been recorded outside of this time period in Arizona (U. S. Fish and Wildlife Service 1997, Hoffmeister 1986, Sidner and Houser 1990). In spring, adult females, most of which are pregnant, arrive in Arizona and gather into maternity colonies in southwestern Arizona. These roosts are typically at low elevations near concentrations of flowering columnar cacti. After the young are weaned, these colonies mostly disband in July and August; some females and young move to higher elevations, primarily in the southeastern parts of Arizona near concentrations of blooming paniculate agaves. Adult males typically occupy separate roosts forming bachelor colonies. Males are known mostly from the Chiricahua Mountains and, recently, the Galiuro

Mountains (personal communication with Tim Snow, Arizona Game and Fish Department, 1999), but also occur with adult females and young of the year at maternity sites (U. S. Fish and Wildlife Service 1997). Throughout the night between foraging bouts, both sexes will rest in temporary night roosts (Hoffmeister 1986).

Lesser long-nosed bats appear to be opportunistic foragers and extremely efficient fliers. They are known to fly long distances from roost sites to foraging sites. Night flights from maternity colonies to foraging areas have been documented in Arizona at up to 25 miles, and in Mexico, at 25 miles and 36 miles (one way) (Ober *et al.* 2000; Dalton *et al.* 1994, Ober and Steidl 2004, Lowery *et al.* 2009). Lowery *et al.* 2009 and Steidl (personal communication, 2001) found that typical one-way foraging distance for bats in southeastern Arizona is roughly 6 to 18 miles. A substantial portion of the lesser long-nosed bats at the Pinacate Cave in northwestern Sonora (a maternity colony) fly 25-31 miles each night to foraging areas in OPCNM (U.S. Fish and Wildlife Service 1997). Horner *et al.* (1990) found that lesser long-nosed bats commuted 30-36 miles round trip between an island maternity roost and the mainland in Sonora; the authors suggested these bats regularly flew at least 47 miles each night. Lesser long-nosed bats have been observed feeding at hummingbird feeders many miles from the closest known potential roost site (Lowery *et al.* 2009; personal communication with Yar Petryszyn, University of Arizona 1997).

Lesser long-nosed bats, which often forage in flocks, consume nectar and pollen of paniculate agave flowers; and pollen and fruit produced by a variety of columnar cacti. Nectar of these cacti and agaves is high energy food. Concentrations of some food resources appear to be patchily distributed on the landscape, and the nectar of each plant species used is only seasonally available. Cacti flowers and fruit are available during the spring and early summer; blooming agaves are available primarily from July through October. In Arizona, columnar cacti occur in lower elevational areas of the Sonoran Desert region, and paniculate agaves are found primarily in higher elevation desert scrub areas, semi-desert grasslands and shrublands, and into the oak and pine-oak woodlands (Gentry 1982). Lesser long-nosed bats are important pollinators for agave and cacti, and are important seed dispersers for some cacti.

The conservation and recovery of lesser long-nosed bats requires the presence of secure and appropriate roost sites throughout the landscape (including maternity roost sites, as well as transitional and migration roost sites) and adequate forage resources in appropriate juxtaposition to provide for life history needs including breeding, parturition, and migration.

Status and Threats

Recent information indicates that lesser long-nosed bat populations appear to be increasing or stable at most Arizona roost sites identified in the recovery plan (Arizona Game and Fish Department 2005, Tibbitts 2005, Wolf and Dalton 2005, U.S. Fish and Wildlife Service 2007b; electronic mail from Tim Tibbitts 2009). Lesser long-nosed bat populations additionally appear to be increasing or stable at other roost sites in Arizona and Mexico not included for monitoring in the recovery plan (Sidner 2005, Arizona Game and Fish Department 2009). Less is known about lesser long-nosed bat numbers and roosts in New Mexico. Though lesser long-nosed bat populations appear to be doing well, many threats to their stability and recovery still exist, including excess harvesting of agaves in Mexico; collection and destruction of cacti in the U.S.;

conversion of habitat for agricultural and livestock uses, including the introduction of bufflegrass, a non-native, invasive grass species; wood-cutting; alternative energy development (wind and solar power); illegal border activities and required law enforcement activities; drought and climate change; fires; human disturbance at roost sites; and urban development.

Approximately 20 – 25 large lesser long-nosed bat roost sites, including maternity and late-summer roosts, have been documented in Arizona. Of these, 10 – 20 are monitored on an annual basis depending on available resources (U.S. Fish and Wildlife Service 2007b). Monitoring in Arizona in 2004 documented approximately 78,600 lesser long-nosed bats in late-summer roosts and approximately 34,600 in maternity roosts. More recently, in 2008, the numbers were 63,000 at late-summer roosts and 49,700 at maternity roosts (Arizona Game and Fish Department 2009). Ten to 20 lesser long-nosed bat roost sites in Mexico are also monitored annually. Over 100,000 lesser long-nosed bats are found at just one natural cave at the Pinacate Biosphere Reserve, Sonora, Mexico (Cockrum and Petryszyn 1991). The numbers above indicate that although a relatively large number of lesser long-nosed bats exist, the relative number of known large roosts is quite small.

The primary threat to lesser long-nosed bat is roost disturbance or loss. The colonial roosting behavior of this species, where high percentages of the population can congregate at a limited number of roost sites, increases the risk of significant declines or extinction due to impacts at roost sites. Lesser long-nosed bats remain vulnerable because they are so highly aggregated (Nabhan and Fleming 1993). Some of the most significant threats known to lesser long-nosed bat roost sites are impacts resulting from use and occupancy of these roost sites by individuals crossing the border illegally for a number of reasons. Mines and caves, which provide roosts for lesser long-nosed bats, also provide shade, protection, and sometimes water, for border crossers. The types of impacts that result from illegal border activities include disturbance from human occupancy, lighting fires, direct mortality, accumulation of trash and other harmful materials, alteration of temperature and humidity, destruction of the roost itself, and the inability to carry out conservation and research activities related to lesser long-nosed bats. These effects can lead to harm, harassment, or, ultimately, roost abandonment (U.S. Fish and Wildlife Service 2005). For example, the illegal activity, presumably by individuals crossing the border, at the Bluebird maternity roost site, caused bats to abandon the site in 2002, 2003, and 2005. Other reasons for disturbance or loss of bat roosts include the use of caves and mines for recreation; the deliberate destruction, defacing or damage of caves or mines; roost deterioration (including both buildings or mines); short or long-term impacts from fire; and mine closures for safety purposes. The presence of alternate roost sites may be critical when this type of disturbance occurs.

In summary, threats to lesser long-nosed bat forage habitat include excess harvesting of agaves in Mexico; collection and destruction of cacti in the U.S.; conversion of habitat for agricultural and livestock uses; the introduction of bufflegrass and other invasive species that can carry fire in Sonoran Desert scrub; wood-cutting; urban development; fires; and drought and climate change.

Large fires supported by invasive vegetation in 2005 affected some lesser long-nosed bat foraging habitat, though the extent is unknown. For example, the Goldwater, Aux, and Sand Tank Fire Complexes on Barry M. Goldwater Range-East burned through and around isolated patches of saguaros. Rogers (1985) showed that saguaros are not fire-adapted and suffer a high mortality rate as a result of fire. Therefore, fire can significantly affect forage resources for lesser long-nosed bats in the Sonoran desert. Monitoring of saguaro mortality rates should be done to assess the impacts on potential lesser long-nosed bat foraging habitat. More recently, the summer of 2011 saw huge wildfires burning across Arizona. The Wallow Fire (538,049 acres) set a new state record, burning a larger area than the 2002 Rodeo-Chediski Fire (468,638 acres). The Horseshoe 2 Fire (222,954 acres) burned approximately 70% of the Chiricahua Mountains and became the 4th largest fire in Arizona history. In addition to the Horseshoe 2 Fire, two other large wildfires (Murphy Complex and the Monument Fire) and numerous smaller fires burned a total of 366,679 acres in the Coronado National Forest. The Horseshoe 2, Monument, and Murphy fires affected lesser long-nosed bat forage and roost resources throughout those mountain ranges. Fire suppression activities associated with wildfires could also affect foraging habitat. For example, slurry drops can leave residue on saguaro flowers, which could impact lesser long-nosed bat feeding efficiency or result in minor contamination.

Drought may affect lesser long-nosed bat foraging habitat, though the effects of drought on bats are not well understood. The drought in 2004 resulted in near complete flower failure in saguaros throughout the range of lesser long-nosed bats. During that time however, in lieu of saguaro flowers, lesser long-nosed bats foraged heavily on desert agave (*Agave deserti*) flowers, an agave species used less consistently by lesser long-nosed bats (Tibbitts 2006). Similarly, there was a failure of the agave bloom in southeastern Arizona in 2006, probably related to the ongoing drought. As a result, lesser long-nosed bats left some roosts earlier than normal and increased use of hummingbird feeders by lesser long-nosed bats was observed in the Tucson area (personal communication with Scott Richardson, FWS, January 11, 2008). Climate change impacts to the lesser long-nosed bats in this portion of its range likely include loss of forage resources. Of particular concern is the prediction that saguaros, the primary lesser long-nosed bat forage resource in the Sonoran Desert, will decrease or even disappear within the current extent of the Sonoran Desert as climate change progresses (Weiss and Overpeck 2005, p. 2074). Monitoring bats and their forage during drought years is needed to better understand the effects of drought on this species.

The lesser long-nosed bat recovery plan (U.S. Fish and Wildlife Service 1997) identifies the need to protect roost habitats and foraging areas and food plants, such as columnar cacti and agaves. The lesser long-nosed bat recovery plan provides specific discussion and guidance for management and information needs regarding bat roosts and forage resources (U.S. Fish and Wildlife Service 1997). More information regarding the average size of foraging areas around roosts would be helpful to identify the minimum area around roosts that should be protected to maintain adequate forage resources.

We have produced numerous BOs on the lesser long-nosed bat since it was listed as endangered in 1988, some of which anticipated incidental take. Incidental take has been in the form of direct mortality and injury, harm, and harassment and has typically been only for a small number of individuals. Because incidental take of individual bats is difficult to detect, incidental take has often been quantified in terms of loss of forage resources, decreases in numbers of bats at roost sites, or increases in proposed action activities.

Examples of more recent BOs that anticipated incidental take for lesser long-nosed bats are summarized below. The 2010 BO related to the National Park Service's abandoned mine closure program, anticipated the direct take of up to 115 lesser long-nosed bats as a result of collisions with mine closure structures, and the abandonment of one roost site due to mine closure activities (U.S. Fish and Wildlife Service 2010). The 2009 and 2008 BOs for implementation of the SBI*net* Ajo 1 and Tucson West Projects, including the installation, operation, and maintenance of communication and sensor towers and other associated infrastructure, each included incidental take in the form of 10 bats caused by collisions with towers and wind turbine blade-strike mortality for the life (presumed indefinite) of the proposed action. The 2007 BO for the installation of one 600 kilowatt wind turbine and one 50KW mass megawatts wind machine on Fort Huachuca included incidental take in the form of 10 bats caused by blade-strikes for the life (presumed indefinite) of the proposed action (U.S. Fish and Wildlife Service 2007c). The 2005 BO for implementation of the Coronado National Forest Land and Resource Management Plan (U.S. Forest Service) included incidental take in the form of harm or harassment. The amount of take for individual bats was not quantified; instead take was to be considered exceeded if simultaneous August counts (at transitory roosts in Arizona, New Mexico, and Sonora) drop below 66,923 lesser long-nosed bats (the lowest number from 2001 – 2004 counts) for a period of two consecutive years as a result of the action. The 2004 BO for the Bureau of Land Management Arizona Statewide Land Use Plan Amendment for Fire, Fuels, and Air Quality Management included incidental take in the form of harassment. The amount of incidental take was quantified in terms of loss of foraging resources, rather than loss of individual bats. The 2003 BO for Marine Corps Air Station–Yuma Activities on the BMGR included incidental take in the form of direct mortality or injury (five bats every 10 years). Because take could not be monitored directly, it was to be considered exceeded if nocturnal low-level helicopter flights in certain areas on the BMGR increased significantly or if the numbers of bats in the Agua Dulce or Bluebird Mine roosts decreased significantly and MCAS-Yuma activities were an important cause of the decline. The 2007 BO for Department of the Army Activities at and near Fort Huachuca (Fort), Arizona anticipated incidental take in the form of direct mortality or injury (six bats over the life of the project), harassment (20 bats per year), and harm (10 bats over the life of the project) (U.S. Fish and Wildlife Service 2007a).

The lesser long-nosed bat recovery plan (U.S. Fish and Wildlife Service 1997), listing document (U.S. Fish and Wildlife Service 1988), and the 5-year review summary and evaluation for the lesser long-nosed bat (U.S. Fish and Wildlife Service 2007b), all discuss the status of the species, and threats, and are incorporated by reference.

Environmental Baseline - Lesser Long-Nosed Bat

Action Area

As stated previously, the action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The FWS has described above the general action area for the Rosemont Mine project (see Action Area section above). The action area as it relates specifically to the lesser long-nosed bat extends beyond this general action area and includes the areas directly impacted by the Rosemont mine features identified, including utility corridors and access roads, as well as the area defined by a circle with a radius of 36 miles (the maximum documented one-way foraging distance of the lesser long-nosed bat) around the Rosemont Mine project. Lesser long-nosed bats may occur anywhere within this foraging radius around roosts occupied by lesser long-nosed bats during the time of annual occupancy in the area. The action area represents only a small portion of the lesser long-nosed bat's range. However, using this definition increases the number of lesser long-nosed bat roosts in the action area from three, as described in the various BAs, to 13, which includes 10 lesser long-nosed bat roosts in the Santa Rita, Empire, Mustang, Whetstone, Patagonia, Rincon and Santa Catalina mountains that are within 36 miles of the proposed Rosemont Mine project.

The above description of the action area for lesser long-nosed bats is supplemented by the overall description of the action area used earlier in this document (see Action Area section above) with regard to land management and vegetation community description.

Status of the Lesser Long-Nosed Bat in the Action Area

Bat surveys of the proposed action area and vicinity were conducted in 2008 (WestLand 2009f), 2009 (Buecher *et al.* 2010), 2010 (Buecher *et al.* 2011), and 2011 (WestLand 2011f). Methods included active and passive ultrasonic acoustic sampling at flowering agaves, infrared photography and observations of flowering agaves, and surveys of potential roost sites.

In 2008, 143 potential bat roost sites (i.e., caves, mine shafts, and adits) were evaluated within the action area and surrounding region (WestLand 2009f). Of these 143 sites, 59 were within the proposed action footprint, and 16 were near the proposed action footprint. Acoustic and/or roost site surveys were conducted on a total of 20 different dates between August 4 and November 12, 2008, and ultrasonic acoustic surveys and infrared surveys were conducted on five evenings between August 11 and September 16, 2008. Because lesser long-nosed bats often remain silent while foraging, several sites also were monitored in 2008 with night vision equipment to further document use of flowering agaves. Lesser long-nosed bats were documented foraging regularly on agaves in the proposed action area from late August to mid-September based on the results of acoustic and infrared surveys. Lesser long-nosed bat calls were recorded at 23 of the 27 Palmer agave sites where acoustic surveys were successful (i.e., no equipment failures), and night vision equipment was successful in detecting frequent lesser long-nosed bat visits to flowering Palmer agaves. Lesser long-nosed bats were documented roosting at three sites within the action area in 2008: Site 9 (the name was changed to Chicago Mine in Buecher *et al.* 2010), Site R-2, and the Helena Mine complex (Figure LLB-1). The Chicago Mine was visited five separate times during 2008; approximately 12 to 15 lesser long-nosed bats were present in August, and none were present in late September. The R-2 site was visited once in 2008, which resulted in the confirmed sighting of one lesser long-nosed bat. A small colony of 20 to 30 lesser long-nosed bats was roosting at the Helena Mine complex in 2008. Only one of these sites (Site 9/Chicago Mine) is within the proposed action footprint and is located within the proposed mine pit. Site R-2 is immediately adjacent to the southwestern portion of the proposed fence line of the Barrel alternative. Lesser long-nosed bats also were found at the Helena Mine complex approximately 1 mile north-northeast of the fence line for the Barrel alternative.

In 2009, 37 sites were examined during eight field visits conducted in August, September, and October (Buecher *et al.* 2010). Survey efforts in 2009 focused on sites that supported nectar-feeding bats in 2008 and sites where the potential for bats was considered high, including the following: 1) the Helena Mine complex, which is characterized by multiple entrances, supported small numbers of *L. yerbabuenae* in 2008; 2) Adit S and Adit R-47, where accumulations of insectivorous bat guano was found in 2008; 3) R-46, which was not visited in 2009 but was thought to have high potential for bat use; 4) Chicago Mine (referred to as Site 9 in WestLand 2009f), which supported small numbers of Leptonycteris in 2008; and 5) R-2 (located in Sycamore Canyon), where one *L. yerbabuenae* was found in 2008. Lesser long-nosed bats were documented at the same three roosts at which they were detected in 2008 (see LLB-1, below). The Chicago Mine was visited two times in 2009, and approximately 32 lesser long-nosed bats were documented exiting the mine. The R-2 site was visited three times in 2009. This resulted in a single lesser long-nosed bat observed on August 25, 2009, more than 50 detected with acoustic sampling and infrared video cameras on September 3, 2009, and the presence of lesser long-nosed bats on October 13, 2009. At the Helena Mine complex, more than 5,000 lesser long-nosed bats were detected during an exit count in September.

In 2010, three of the sites that were previously surveyed, including one site that contained lesser long-nosed bats in 2008 and 2009 (Helena Mine complex), were revisited (Buecher *et al.* 2011). Additionally, the BLM conducted surveys on their lands near Helvetia late in 2010, and lesser long-nosed bats were observed roosting on abandoned mine land features (Hughes 2011). Lesser long-nosed bats were documented roosting only at the Helena Mine complex site; however, the Chicago Mine and R-2 sites were not surveyed. Significantly fewer (approximately 150) lesser long-nosed bats were detected overall during exit counts in 2010 than in 2009 (more than 5,000). However, some of the emergence counts were stopped early because of inclement weather, so it is unclear whether the reduced counts were accurate representations of the number of bats at these roost locations.

In 2011, 33 sites were examined in 10 field visits in July, August, and September (WestLand 2011f). Some sites surveyed were used by bats in previous years, and additional mines not covered during prior surveys were also evaluated. Evaluations included mine entry (internal surveys) and/or external roost evaluations (emergence surveys). Lesser long-nosed bats were documented roosting at the Helena Mine complex site, the Chicago Mine, and R-2 sites (see Figure LLB-1 below). At the Helena Mine complex, approximately 4,650 lesser long-nosed bats were detected during an exit count in August; during a second emergence count in September, approximately 2,021 Lesser Long-nosed Bats were recorded. At the Chicago Mine, one lesser long-nosed bat was detected roosting in July. At the R-2 site, three lesser long-nosed bats were detected roosting in July.

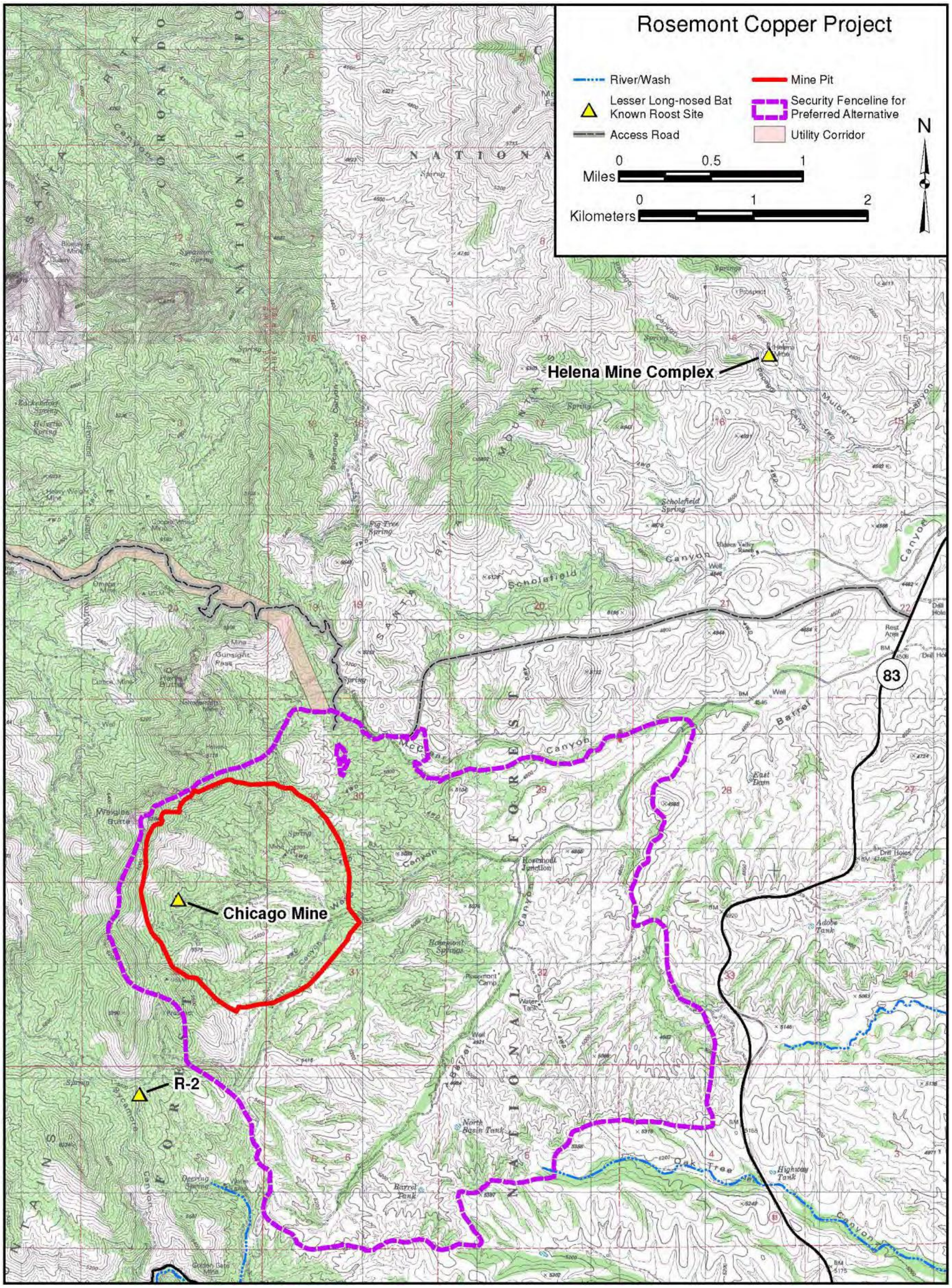

Figure LLB-1: Lesser Long-Nosed Bat roosts in the Action Area of the Rosemont Mine project

Regional monitoring of lesser long-nosed bats occurs in the vicinity of the Rosemont Mine project, including mountain ranges within 36 miles (maximum documented foraging distance for lesser long-nosed bats) of the Rosemont Mine project. Based on this regional monitoring data, 10 additional lesser long-nosed bat roosts occur within 36 miles of the Rosemont mine site. Bats from these roost sites potentially visit the Rosemont Mine area to forage on available agave plants. The number of lesser long-nosed bats using these additional roosts is generally from 1,000 – 12,000 bats. While it is unlikely that all of the lesser long-nosed bats from these roosts will use the Rosemont Mine area for foraging, it is likely that, in any given year, some of the bats from these roost sites will forage in the area of the Rosemont Mine.

In summary, the action area is located in the post-maternity dispersal region for lesser long-nosed bat (maternity colonies in southwestern Arizona disband in July and August), and there are numerous Palmer agaves and at least thirteen active roosts within the action area (three of which are within or in the immediate vicinity of the proposed action footprint). Of these roosts, only Chicago Mine is in the proposed action footprint. Although dates of arrival at post-maternity sites are variable in Arizona from one year to the next, surveys in the action area in 2008, 2009, 2010, and 2011 indicate that lesser long- nosed bats forage and occupy roosts in the area beginning at least in early August and, based on results at the Helena Complex, continuing into October. The large number of this species present at the Helena Mine complex in 2009 and 2011 indicates that this site could be a roost complex of regional importance to lesser long-nosed bats.

Lesser long-nosed bat numbers at post-maternity or transition roosts tend to fluctuate more than do numbers at maternity roosts. This fluctuation is apparently based on local forage availability (agave blooms). Agave blooming is subject to climatic conditions and during the ongoing, extended drought, some portions of the action area have been subject to forage failures. Lesser long-nosed bats are highly mobile and will switch to areas and roosts where forage is available.

A number of activities occur in the action area that could affect bats. Because of the extent of Federal lands in the action area, most activities that currently, or have recently, affected the lesser long-nosed bats or their habitat in the action area are Federal actions, many of which have undergone formal consultation. Ongoing illegal border activities are an exception. Efforts are ongoing in the action area that contribute to the conservation and protection of lesser long-nosed bat populations and habitat within the action area. For example, the National Park Service and the Coronado National Forest have constructed bat gates at two lesser long-nosed bat roosts in the Huachuca and Canelo Hills, respectively. The effectiveness of these efforts is being monitored. Research and monitoring activities funded by Customs and Border Protection on public and private lands within the action area are contributing to our knowledge of lesser long-nosed bat roost locations and developing appropriate protective measures for lesser long-nosed bat roost sites. In general, the lesser long-nosed bat populations within the action area are stable to increasing, but threats are ongoing, and in some cases increasing (climate change, invasive species, border activities, etc.)

Effects of the Action - Lesser Long-Nosed Bat

<u>Effects to Roosts</u>

The proposed action will directly affect and result in the permanent loss of at least one known lesser long-nosed bat post-maternity roost site (Chicago Mine) within the footprint of the proposed mine, which in August 2008 contained approximately 12 to 15 lesser long-nosed bats, in 2009 contained approximately 32 lesser long-nosed bats, and in July 2011 contained one roosting lesser long-nosed bat. Any individual lesser long-nosed bats present within the footprint of the mine infrastructure (including the pit, buildings, roads, tailings or waste piles, etc.) will either be crushed or forced to relocate. Rosemont will close the Chicago Mine when lesser long-nosed bats are not present in the Chicago Mine (excluded); therefore, no lesser long-nosed bats would be killed by the construction of the mine pit, if no individuals are in the mine during closure.

Given the anticipated levels of project related activity and associated disturbance from noise, vibrations, and light, there exists the potential for effects on two additional lesser long-nosed bat post-maternity roosts adjacent to the proposed mine footprint (i.e., R2 [immediately adjacent to the southwestern portion of the proposed fence line of the proposed action] and the Helena Mine complex [approximately 1 mile north-northeast of the fence line for the proposed action]). At the R2 site, one lesser long-nosed bat was detected each year in 2008 and 2009, and three lesser long-nosed bats were detected there in 2011. More than 5,100 lesser long-nosed bats were counted at the Helena Mine complex in 2009, and approximately 4,650 lesser long-nosed bats were detected in 2011. Any individuals present adjacent to the mine footprint would experience effects from light, noise, and vibrations. Although Rosemont has developed a light pollution mitigation plan (Monrad *et al.* 2012), light from artificial illumination will increase light levels at night, and specific impacts of light on lesser long-nosed bats in the habitat within the project and actions areas are unknown; therefore, increased light levels could disrupt this nocturnal species, resulting in changes in dispersal, reproductive behavior, communication patterns, and decreased foraging success (Longcore and Rich 2004). Similarly, noise and vibrations from construction of the mine or blasting will disturb lesser long-nosed bats, likely causing changes in dispersal, reproductive behavior, communication patterns, decreased foraging success, increased predation and stress response, and possibly damaged hearing if the noise is loud enough (NoiseQuest 2011; Pater *et al.* 2009). The magnitude of impacts from noise, vibration, and light are uncertain, but these impacts are expected to decrease as the distance from the mine increases.

While not addressing impacts to lesser long-nosed bat roosts from light, noise, blasting, etc., Rosemont will include a conservation measure as part of the proposed action that addressed the threat of human intrusion at these sites. Rosemont will fence or implement some other form of roost protection at the Helena Mine roost site and the R-2 Adit roost site. While these actions will potentially provide long-term protection of these known lesser long-nosed bat roost site, the fencing or other protective measures may also affect the use of these sites by lesser long-nosed bats. Such measures may alter the microclimate of the roosts, create impediments or hazards within the flight paths of bats entering and exiting the roosts, increase the vulnerability of lesser long-nosed bats to predators, or attract additional human activity to the sites. Rosemont has committed to coordinating these efforts with FWS and AGFD so that appropriate measures that minimize effects to lesser long-nosed bats will be selected. Many of the potential negative effects of these measures can be avoided or significantly reduced with the selection of appropriate measures and the proper design and implementation of those measures. We are confident that we can work with Rosemont to develop appropriate protective measures for these roost sites, which will also present us with an opportunity to evaluate the effectiveness of the selected protective measures with regard to lesser long-nosed bat roost conservation. Nonetheless, the implementation of protective measures at known lesser long-nosed bat roost sites will have effects and, potentially, take that must be evaluated in this BO.

Effects to Forage

The proposed action will affect lesser long-nosed bats through the removal of potential lesser long-nosed bat forage plants (i.e., paniculate agaves) in the late summer range of the species. Based on surveys, it is estimated that between 196,268 and 306,209 Palmer agave rosettes will be impacted as a result of the proposed action (WestLand 2009e). In terms of acres of lesser long-nosed bat foraging habitat, the mine pit and associated facilities, including roadways, will remove approximately 5,400 acres of foraging habitat. Effects on lesser long-nosed bat forage plants may also result from an increase in dust levels adjacent to access roads and mining areas. Agaves could be negatively impacted by windborne fugitive dust coating leaves, resulting in reduced photosynthetic activity. Physical effects of dust on plants may include blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle (Goodquarry 2011). Reduced food sources could result in reduced reproduction success or could result in the abandonment of the action area and nearby roosts by lesser long-nosed bats. Known lesser long-nosed bat maternity roosts are all more than 75 miles from the proposed action area; therefore, no effects on lesser long-nosed bat maternity roosts are anticipated.

In some of the WestLand technical reports, particularly WestLand (2012j), various aspects of livestock grazing management on Forest Service-managed allotments that are leased by Rosemont are proposed as a conservation measure to increase the availability of agave flower stalks. The grazing proposals address issues relative to grazing intensity and duration, as well as stock tank management. The proposal to reduce grazing pressure is proposed as a measure (in addition to agave planting) to compensate for the effects of the project on forage of lesser long-nosed bat under the premise that reduced livestock grazing pressure during the agave bolting period will increase the number of available agave flower stalks when compared to the current livestock grazing approach. As outlined in Coronado National Forest's second supplemental BA, we agree that the revised grazing management cannot completely compensate for the loss of agaves in the project area, nor can any of the other proposed conservation measures (reclamation using agaves and additional agave planting) completely compensate for the loss of agaves. We agree with the rationale outlined in the second supplemental BA emphasizing that (1) some of the project area capable of growing agaves will be permanently removed from the landscape by the action (e.g., formation of the pit); (2) there are uncertainties about the ability to grow, transplant, and recruit Palmer's agave on the potentially capable areas following disturbance (e.g., waste rock facilities, roads, plant site); (3) previous consultation on livestock grazing has shown "no adverse effect" to lesser long-nosed bats from grazing anyway; (4) only 10% of the agaves lost from the project will be mitigated for by being planted; (5) seed mixes containing agave seeds are untested; (6) limited offsite, disturbed areas lacking agaves are proposed for restoration; and (7) conservation lands are not expected to differ significantly from the surrounding areas, with or without grazing (although easements could preclude future development or other actions with negative effects to lesser long-nosed bats). Nevertheless, FWS, like the Coronado National Forest, does support the concept of reduced grazing to help offset the effects of the action on Palmer agaves, the primary food source of the lesser long-nosed bat, although we do not have specific data to determine the extent of this reduction or the potential benefit to lesser long-nosed bats. Additionally, we have found in previous section 7 consultations that there has not been an adverse affect to lesser long-nosed bat from grazing on Palmer agave.

As part of the proposed action, Rosemont will reroute portions of the Arizona Trail. On the one hand, this will reduce the potential for human disturbance at the Helena Mine lesser long-nosed bat roost site, but it will also result in new disturbance of lesser long-nosed bat foraging habitat and increase the human disturbance along the new Arizona Trail route. The proposed reroute of the Arizona Trail will encompass approximately 13 miles and 19 acres of disturbance. The proposed trail reroute will not occur in proximity to any additional, known lesser long-nosed bat roosts. Effects to vegetation will occur, including the possibility of additional impacts to agaves. Rosemont has included the potential planting or revegetation with agaves of the old Arizona trail alignment. This will help offset the additional impacts to lesser long-nosed bat foraging habitat.

Effects from Noise and Lighting

Artificial light from the mine activities was recognized as a source of effects to lesser long-nosed bats in the Coronado National Forest's June BA and October Supplemental BA. The proposed action is expected to produce approximately 6.15 million lumens, which takes into account all lighting sources, including equipment-mounted lighting systems. To date, there is limited information on the existing condition, other than the qualitative observation that there is little existing artificial light, so the area is fairly dark. Because the project will operate around the clock, additional light pollution is of concern to astronomical interests and to the environmental community in general, particularly with regard to nocturnal species such as the lesser long-nosed bat. In the BA and Supplemental BA, there was some information on environmental consequences of light from the mine, but the existing technical reports targeted effects of "light pollution" and sky glow, primarily for astronomy and observatory concerns. More recently, WestLand produced another technical report related to the quantification of effects of the lighting associated with the Rosemont Mine Project (Westland 2012f). This report helped to quantify the intensity and attenuation of light within twelve miles of the project area, using predictive modeling based on known and assumed lighting sources and the topography of the area. This report displayed predicted increases in horizontal light from artificial sources at the proposed copper mine.

Increases in light were displayed as increases to ambient light levels in terms of natural light levels (i.e., increase in artificial night light, based on different phases in the moon). The report also made it easier for us to envisage the amount of light at night from sky glow—it stated the artificial light would emit about the same number of lumens as the towns of Sells or Ajo, Arizona. That can be compared to the previous expectation (related to the initial Mine Plan of Operation) of sky glow similar to Nogales, Arizona. The Monrad (2012) and WestLand (2012g) reports both emphasize the improvements in the most recent lighting plan. The design features (which are not considered species-specific conservation measures) in the revised lighting plan are somewhat responsive to mitigating effects of lighting on plants and animals (Rich and Longcore 2006). In particular, part of this edited book that focuses on birds, Gauthreaux and Belser (2006, p. 87) lists the following "lighting control strategy options" (albeit more geared to office buildings than mines):

• Installing motion-sensitive lighting
• Using desk lamps and task lighting
• Reprogramming timers
• Adopting lower-intensity lighting

Other taxa accounts in Rich and Longcore (2006) mention how certain wavelengths of emitted light can be adjusted to decrease effects to certain animals. At least some of the design features that employ these measures are discussed in Monrad (2012) and WestLand (2012g). These reports do show that there was a significant effort on the part of the proponent to reduce lighting effects, but artificial night-lighting will still affect the lesser long-nosed bat for the next 25 to 30 years, despite the fact that Rosemont has committed to use light sources that minimize short wavelengths of light in an effort to reduce potential effects to wildlife.

Vehicular traffic will be present on SR 83, the west and east access roads, and within the project area. It is important to consider synergistic effects of human activity related to artificial night lighting. Vehicular light, especially, will be compounded by noise at the source of activity. As an example, for a moving vehicle at night, effects of artificial lighting are synergistic with noise pollution and motion, resulting in a loud, bright, moving object).

The Rosemont Mine project will create an epicenter of relatively intense lighting, similar to the light output of "the towns of Sells and Ajo", as mentioned above. This new occurrence of light in an area where such lighting has not occurred in the past can impact wildlife. For example, a migratory bird flying over the area could be affected by this epicenter of artificial light from the project (see Gauthreaux and Belser 2006). Certainly artificial night light in proximity to the source would have a more significant impact on nocturnal species, such as the lesser long-nosed bat, than areas where the light becomes more diffused, such as in areas peripheral to the light source. Another aspect that cannot be readily quantified is the amount of light at an angle above the horizontal, but below the vertical. This is a possible issue for volant species. For example, when lesser long-nosed bats exit their roosts, they will quickly be above the horizontal, in an area experiencing elevated artificial light levels; spatially, this would be an area larger than that depicted by the figures presented by WestLand (2102g).
There are many ways that plants and animals can be affected by artificial night lighting. Beier (2006) discussed some of the major physical and behavioral effects to mammals:

• Disruption of foraging behavior
• Increased risk of predation
• Disruption of biological clocks
• Increased deaths in collisions on roads
• Disruption of dispersal movements
• Disruption of corridor use

While the specific effects of the lighting associated with the proposed Rosemont mine are largely unknown and discussed in terms of our best professional judgment, we do anticipate a real effect on the use of the area in the vicinity of the mine by foraging lesser long-nosed bats, and, potentially, effects on the use of roost sites affected by the lighting of the proposed mine.

In the past century, the extent and intensity of artificial night lighting has increased such that it has substantial effects on the biology and ecology of species in the wild (Longcore and Rich 2004). Recent studies have shown that artificial lights affect the movements of bats through the landscape, particularly slower flying bats. Stone *et al.* (2009) and Rydell (1992) showed in separate studies that street lighting disturbed and even prevented movements by certain species of bats; primarily bats with slower flight behavior. Recent telemetry research conducted by the Arizona Game and Fish Department (AGFD) on foraging lesser long-nosed bats in the Tucson Basin shows that foraging bats travel along washes as they move between foraging areas and roost locations. The AGFD believes that the washes provide areas of reduced lighting that provide pathways for movement while reducing the likelihood of predation and other threats (AGFD 2009). Lesser long-nosed bats use a hovering, slow flight while foraging and, as the AGFD research suggests, may be avoiding areas with artificial lighting. A study by Scanlon and Petit (2008) showed that urban parks without artificial lighting had higher bat use and bat species diversity than urban parks with artificial lighting, further indicating that artificial lighting can affect bat use and movements. A number of other studies also show negative effects on bat emergence, roost sites, movements, feeding behavior, and prey relationships (Boldogh *et al.* 2007, Holsbeek 2008, Fure 2006, Bat Conservation Trust 2008, Downs *et al.* 2003). During a study on a nectar feeding bat species more closely related to the lesser long-nosed bat, Winter *et al.* (2003) found that *Glossophaga soricina* locates forage using ultraviolet light reflected by forage species. Because this attribute has not been researched in lesser long-nosed bats, it is not known whether lesser long-nosed bats have this same ability. However, these bats are in the same taxonomic family, and artificial light may cause interference or redirect foraging lesser long-nosed bats keying on ultraviolet light sources or reflections. We do not, however, have enough information to definitively evaluate this potential effect. Ongoing research by AGFD and others may provide additional information in the future regarding this issue. Information specific to the effects of lighting on lesser long-nosed bats are limited. We know that lesser long-nosed bats forage in areas which have increased levels of light compared to non-urbanized areas. However, given the observations of telemetered lesser long-nosed bats using areas of little or no urban lighting to move within the landscape, we anticipate that the light emitted as a result of the Rosemont will have effects to foraging and, potentially, roosting lesser long-nosed bats evidenced by reduced use or abandonment of the area.

Noise effects to lesser long-nosed bats are related to blasting and drilling, ore processing, and waste rock and tailings placement. Day-to-day operations of the plant and associated travel by trucks and other equipment also contribute to noise impacts in the vicinity of the Rosemont Mine project. While much of the more intense activity will occur during daylight hours, the proximity of known lesser long-nosed bat roosts make it likely that day-roosting bats will be affected by the increased noise levels of the proposed mine. Lighting and noise disturbance will also affect foraging lesser long-nosed bats in the vicinity of the mine as some mine activity will occur around the clock.

<u>Changes in Lesser Long-Nosed Bat Status Within the Action Area</u>

Lesser long-nosed bats exhibit high fidelity to maternity roosts, returning year after year. Fidelity to post-maternity roost sites, such as those located within the action area of the Rosemont Mine project, is not as strong. The numbers of lesser long-nosed bats using post-maternity roost sites varies from year to year, and some sites may not be used every year. This is apparently in response to variability in the quantity and location of available forage resources. In some ways, this makes the conservation and protection of known post-maternity sites equally as important as the protection of maternity roost sites. The availability of post-maternity roost sites distributed across the landscape allows lesser long-nosed bats to take advantage of variable and ephemeral food resources. Without the flexibility of multiple roost sites from which to select, the most efficient and effect use of forage resources by lesser long-nosed bats may be precluded. As a result, altered timing of migration and inability to obtain adequate resources may result in migrating lesser long-nosed bats in poor condition which can contribute to increased mortality and reduced productivity.

A number of the lesser long-nosed bat roosts within the action area occur on private lands and may or may not be subject to section 7 consultation for actions that could be proposed on these lands and which could affect lesser long-nosed bat roost sites. Lesser long-nosed bat roosts on public lands have been affected despite the efforts to protect those sites and despite the fact that such actions underwent section 7 consultation. In recent years, lesser long-nosed bat use at known roost locations has been affected by the occurrence of large wildfires and activities associated with illegal border crossing at these roost sites. These threats to lesser long-nosed bat roosts are not expected to diminish in the future. Ten additional post-maternity lesser long-nosed bat roost sites are located outside of the immediate vicinity of the Rosemont Mine project, but within the action area. Effects to any of these roost sites from fire, illegal border activities, poor forage production, or other threats may necessitate the use of the roost sites near the Rosemont Mine project. The converse is also true if the effects of the Rosemont Mine cause the roost sites near the mine to be abandoned or the use of those roosts to be reduced, necessitating the need for those bats to find and use alternative roost sites within the action area. If lesser long-nosed bats are unable to find alternative roost sites, their migratory patterns, body condition, and, ultimately, productivity may be affected.

We conclude that the availability of post-maternity roost sites across the range of the lesser long-nosed bat is crucial to this species' ability to meet its life history requirements. In particular, this availability contributes to the lesser long-nosed bat's ability to use an ephemeral and variable forage resource, as well as find protection afforded by roost sites if other roost sites within the range of the bat become compromised. The roost sites affected by the Rosemont Mine may reduce the availability of post-maternity roosts in this area of the lesser long-nosed bat's range, and correspondingly reduce options for this species to meet its life history requirements.

The *Lesser Long-nosed bat Recovery Plan* (FWS 1991) states that reclassification of the species from endangered to threatened would be warranted if all of the following criteria are met: (1) each major roost population in Arizona and Mexico is monitored for at least five years; (2) the results of that monitoring show that population numbers are stable or increase over the higher set of population figures appearing in this recovery plan; (3) sufficient progress has been made in the protection of roosts and forage plants from disturbance or destruction; (4) no new threats to the species or its habitat have been identified or there are no increases to currently recognized threats; and (5) the [FWS] Service determines the species is no longer endangered. The *Lesser Long-Nosed Bat* (Leptonycteris curasoae yerbabuenae) *5-Year Review: Summary and Evaluation* (FWS 2007) considered additional data collected since the Recovery Plan was prepared and stated that the primary recovery actions are to monitor and protect known roost sites and foraging habitats.The proposed action will result in the loss of a single roost site as well as an appreciable acreage of forage resources, but the lesser long-nosed bat's flexibility in selecting roosts an foraging areas, the protection of roosts elsewhere, the partial replacement of forage resources on-site, and the continues presence of roosts and forage plants in areas not affected by the Rosemont Copper Mine, make it unlikely that the ability to recover the species (meet the recovery criteria) will be diminished.

Cumulative Effects - Lesser Long-Nosed Bat

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The majority of lands within the action area are managed by Federal agencies; thus, most activities that could potentially affect lesser long-nosed bats are Federal activities that are subject to section 7 consultation. The Coronado National Forest and BLM manage approximately 45% of the lands within the action area and administer projects and permits on those lands; therefore, some of the activities that could potentially affect lesser long-nosed bats are likely Federal activities subject to additional Section 7 consultation under the ESA. The effects of these Federal activities are not considered cumulative effects.

Residential and commercial development, farming, livestock grazing, actions resulting in the invasion of buffelgrass, surface mining and other activities occur on these lands and, while difficult to predict and quantify, are expected to continue into the foreseeable future. Other non-Federal actions expected to occur include continued road maintenance, grazing activities, and recreation in the action area, current and future development, other nearby mining projects, and unregulated activities on non-federal lands, such as trespass livestock and inappropriate use of OHVs, which can cumulatively adversely affect the lesser long-nosed bat. Additional cumulative effects on lesser long-nosed bats include recreation without a Federal nexus and cross-border activities that include the following: human traffic; deposition of trash; new trails from human traffic; increased fire risk from human traffic; and water depletion and contamination.

These actions, the effects of which are considered cumulative, may result in loss or degradation of lesser long-nosed bat foraging habitat, and potential disturbance of roosts, and are reasonably certain to occur in the action area considered in this BO.

Conclusion - Lesser Long-Nosed Bat

After reviewing the current status of the lesser long-nosed bat; the environmental baseline for the action area; the effects of the proposed action; and the cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the lesser long-nosed bat. No critical habitat has been designated for this species; therefore, none will be affected. Our conclusion is based on the following:

1. Take of lesser long-nosed bats will occur as a result of the proposed action. Direct take of individuals is possible related to potential collisions with fencing or other protective structures and/or increased predation associated with the proposed conservation measures

related to the Helena and R-2 roost sites. Other direct take associated with the proposed action is not anticipated because of certain proposed conservation measures, including survey and exclusion, which is included in the project design. Indirect take is expected in the form of harm or harass as a result of the complete loss of one lesser long-nosed bat roost site, and effects to two adjacent lesser long-nosed bat roost sites from increased human activity, and associated noise and light effects. Additional indirect take is anticipated from the significant loss of forage resources within the mine footprint, and the reduced availability of forage resources for some distance around the mine due to increased human activity, and associated noise and light effects. However, Rosemont has proposed conservation measures (see Proposed Action section above) to offset and reduce the potential for such indirect take associated with the proposed action. We conclude that these measures address the anticipated effects to lesser long-nosed bats to the extent that the proposed action will not jeopardize the continued existence of the lesser long-nosed bat.

2. Monitoring and adaptive management will be applied to evaluate the effects of the proposed action, as well as the effectiveness of proposed conservation measures. This process will allow the Coronado National Forest and FWS to evaluate and adapt the approach of the proposed conservation measures to be as effective as possible.

3. The acquisition and conservation of lands in the vicinity of the proposed mine will provide conservation benefit to the lesser long-nosed bat. Currently, these lands are subject to potential actions that could affect lesser long-nosed bat forage resources. The conservation, monitoring, and adaptive management approach for these lands will provide a conservation benefit to lesser long-nosed bats.

4. Rosemont has proposed multiple conservation measures and project actions designed to reduce the effects of noise and light on the adjacent lesser long-nosed bat roosts. If these measures are successful or, through adaptive management, can be revised to be successful, the protective measures implemented at the Helena and R-2 roost sites will reduce the potential for roost disturbance by human intrusion at these sites. This provides a conservation benefit for the lesser long-nosed bat.

5. Rosemont has proposed ongoing roost surveys and monitoring, and exclusion of bats prior to closure for small lesser long-nosed bat roosts to be lost as a result of the proposed mine. Currently, only one such small lesser long-nosed bat roost is known within the project area (the Chicago Mine). The potential for direct mortality of lesser long-nosed bats within this roost, as well as any other small lesser long-nosed bat roosts found within the construction area, will be reduced by implementing exclusion of lesser long-nosed bats prior to construction.

6. Agaves will be included in restoration and reclamation activities associated with the proposed Rosemont Mine project. While there will be a temporal loss of forage resources, these restoration and reclamation activities will reduce the long-term loss of lesser long-nosed bat forage resources. Additionally, if the proposed changes to livestock grazing management, as outlined in the conservation measures above, are effective in reducing livestock impacts to agave flowering, some level of additional lesser long-nosed

bat forage resources may be available on those allotments within the action area.

7. The effects and actions notedb under Conclusions 2 through 6, above, will make the proposed action unlikely to diminish the potential to recover the lesser long-nosed bat.

The conclusions of this BO are based on full implementation of the project as described in the "Description of the Proposed Action" section of this document, including any conservation measures that were incorporated into the project design.

INCIDENTAL TAKE STATEMENT - LESSER LONG-NOSED BAT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). "Harass" is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 CFR 17.3). "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take - Lesser Long-Nosed Bat

We anticipate incidental take of lesser long-nosed bats as a result of this proposed action in the form of direct mortality, as well as harm or harassment due to the effects of significant loss of forage resources, and to human disturbance and associated effects of noise and light. These effects are anticipated to cause lesser long-nosed bats to reduce their occupancy or abandon adjacent roost sites and move to alternate roost sites in the area, potentially affecting the regional population of lesser long-nosed bats through overuse of limited forage and roost resources.

Specifically, incidental take for the currently proposed Rosemont Mine project is anticipated as follows:

<u>Take associated with roosts</u> – It is difficult to assess take in the form of harm or harass for individual lesser long-nosed bats at roost sites because the number of individual bats fluctuates over time, and the take of individuals may actually occur away from the original roost site as a result of bats abandoning a known roost. Direct take (mortality of those bats left inside inadvertently and harm of those force to relocate) resulting from the closure of a known roost site is more easily quantified, but is still dependent on the number of bats present if the closure occurs while the roost is occupied. Even if bats are excluded prior to closure, or if closure of the roost occurs during a time of year when the bats are not present, take of lesser long-nosed bats in

the form of harm can still occur as a result of the loss of necessary habitat elements supporting the life history requirements of lesser long-nosed bats. The effects of noise, lights, and increased human activity in proximity to known lesser long-nosed bat roost sites, to the extent that such effects result in reduced occupancy or abandonment of the roost site, represents take in the form of harass. It is easier to quantify take of lesser long-nosed bats in relation to the number of roosts affected, rather than at the scale of individual lesser long-nosed bats.

For take associated with roosts, we use the number of roosts lost or affected as a surrogate for take, rather than quantifying individual bats. We anticipate the loss of the Chicago Mine roost site as a result of the proposed mine. We also anticipate the loss of the R-2 and Helena roost sites if noise and light conservation measures and best management practices outlined earlier in this BO prove to be ineffective. While there is some potential for loss of other roost sites (Rosemont will continue reconnaissance-level surveys and may close additional occupied small roosts following exclusion of the bats), we conclude this is unlikely to occur because no additional occupied roosts have been found within the action area during previous surveys. If additional roosts are found, closure would be limited to small roost sites and exclusion should eliminate direct take of the bats occupying these small sites. Total take related to lesser long-nosed bat roosts for the Rosemont Mine project is three post-maternity roosts (approximately 6,000 bats).

While the implementation of protective measures at known lesser long-nosed bat roosts should result in long-term conservation benefits to the species, these measures can also result in mortality of individual bats due to collisions with the structures (gates, fences, etc.) or increased predation due to altered exit and return behavior of the bats. We believe most of these potential issues can be avoided by proper installation and design. However, the potential exists for some mortality of lesser long-nosed bats to occur. Therefore, we anticipate that up to 10 lesser long-nosed bats may be directly taken as a result of the implementation of protective measures at known lesser long-nosed bat roosts.

<u>Indirect take associated with the loss of locally significant lesser long-nosed bat forage resources</u> – Indirect take of lesser long-nosed bats associated with the loss of important forage resources will occur in the form of harm or harass. Harm will occur due to the permanent loss of locally significant forage resources. Take in the form of harass will occur if lesser long-nosed bats are precluded from using available forage resources due to noise, light, or increased human activities associated with the proposed Rosemont Mine. Such take is difficult to quantify and document at the level of individual bats. Take related to forage resources is likely to occur over time and is difficult to document because individual bats taken may not be affected in the same area as where the loss of forage resources has occurred. Loss or reduced availability of lesser long-nosed bat forage resources can result in energetic impacts to lesser long-nosed bats. These effects can result in lesser long-nosed bats having to travel farther to find available forage resoures, thereby using additional energetic reserves. If available forage resources are more limited than those lost due to the Rosemont Mine project, energetic rewards will be reduced, potentially affecting the wellbeing of affected individuals. Because lesser long-nosed bats are migratory, the inability of individual bats to acquire the needed resources for migration, due to reduce forage availability, affects multiple aspects of this species natural history. Additional intra-specific competition for reduced forage resources may also occur. Lesser long-nosed bats have high roost fidelity and increasing the number of bats using particular foraging areas due to

lost forage resources resulting from Rosemont's ming project can lead to increased intra-specific conflicts. Increased travel distance to use available forage also exposes lesser long-nosed bats to increased risk of predation, collision, or other environmental threats. Therefore, we will use the acres of forage resources lost as a surrogate for take of individual lesser long-nosed bats. Take in the form of harm and harass due to the loss of significant forage resources is anticipated for 5,393 acres (SWCA 2013) of lesser long-nosed bat foraging habitat (acres of habitat supporting Palmer agave). This take is anticipated for the long-term loss of foraging habitat within the footprint of the mine pit and mine facilities, including roadways, utility corridors and relocation of the Arizona National Scenic Trail.

Effect of the Take - Lesser Long-Nosed Bat

In this BO, the FWS determines that this level of anticipated take is not likely to result in jeopardy to the species for the reasons stated in the Conclusions section. No critical habitat has been designated for the lesser long-nosed bat; therefore, no critical habitat will be destroyed or adversely modified.

Reasonable and Prudent Measures - Lesser Long-Nosed Bat

Rosemont has included a number of measures and design elements within their proposed action that should, if completely implemented, reduce the potential for take of lesser long-nosed bats. As long as these conservation measures and other actions related to the lesser long-nosed bat are completely implemented, we conclude that the following list of Reasonable and Prudent Measures and Terms and Conditions are sufficient to reduce the potential for take of lesser long-nosed bats from the proposed Rosemont Mine project.

The following reasonable and prudent measures are necessary and appropriate to minimize take of lesser long-nosed bats:

1. Rosemont shall work with the FS, FWS, and AGFD to permanently protect a known lesser long-nosed bat roost site within, or as close to the action area as possible.

2. In the event that either the R-2 and/or Helena lesser long-nosed bat roosts are abandoned or experience a significant reduction in occupancy (>50%), and these occurrences can be reasonably attributed to the proposed Rosemont Mine, Rosemont shall work with the FS, FWS, and AGFD to permanently protect an additional lesser long-nosed bat roost site within the action area.

3. Monitor the effectiveness of protective measures implemented at the Helena and R-2 roost sites, including effects to bat behavior, and bat mortality or predation, and occupancy of the sites. Monitoring shall also occur at any other lesser long-nosed bat roosts where protective measures are implemented as part of the conservation measures outlined in the proposed action.

4. In addition to the agave planting outline in Conservation Measure 11 for lesser long-nosed bats, implement additional agave planting and monitoring within the action area to help offset losses of lesser long-nosed bat forage resources associated with the proposed

action.

5. Implement conservation measures and Reasonable and Prudent Measures, except for survey and monitoring activities, during the times of year when lesser long-nosed bats are not present.

6. Rosemont shall annually report to the FWS the results of the implementation and results of the Terms and Conditions outlined below.

Terms and Conditions - Lesser Long-Nosed Bat

In order to be exempt from the prohibitions of section 9 of the Act, the Coronado National Forest and Rosemont must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The following terms and conditions implement Reasonable and Prudent Measures 1 and 2 for the lesser long-nosed bat:

   a. Rosemont shall implement protective measures at a known lesser long-nosed bat roost site within, or as close to the action area as possible. The known roost where this term and condition will be applied, as well as the appropriate associated protective measures, will be evaluated and selected through coordination with FWS and AGFD.
   b. Based on information gathered as outlined in the Conservation Measures for lesser long-nosed bats earlier in this document, if the Coronado National Forest or Rosemont or their agents observe a significant decline in the numbers of lesser long-nosed bats or roost abandonment at either the R-2 or Helena lesser long-nosed bat roosts, the adaptive management as described in Conservation Measure 9 will include selection of protective measures to be applied to another known lesser long-nosed bat roost within or as close to the action area as possible. Known roosts and associate protective measures will be evaluated and selected through coordination with FWS and AGFD.
   c. Protective measures agreed upon by the Coronado National Forest, the FWS, and AGFD at the selected roost sites shall include completion of any environmental compliance requirements and implementation within one year of roost site selection.
   d. Pre- and post-implementation monitoring will occur at these roost sites, with an annual report to the FWS for a period of four years (1 season of pre-implementation monitoring and 3 seasons of post-implementation monitoring).

2. The following term and condition implements reasonable and prudent measure #3 for the lesser long-nosed bat:

   a. With input from the FWS and AGFD, Rosemont shall implement a monitoring program to evaluate the effectiveness of protective measures implemented at known lesser long-nosed bat roosts as part of the conservation measures included

in the proposed action. Monitoring shall include a minimum of three visits per season and include methods to evaluate:
- as appropriate, any collisions, increased predation, or other sources of lesser long-nosed bat mortality associated with the protective measures.
- the long-term integrity of structures installed as part of the protective measures.
- any impacts to exit and return behavior of lesser long-nosed bats that may be caused by the protective measures.
- the effectiveness of the protective measures in reducing disturbance and other impacts to lesser long-nosed bat roosts.
Results of this monitoring program shall be reported in the annual report to FWS as outlined in the Conservation Measures section of this BO.

3. The following terms and conditions implement reasonable and prudent measure #4 for the lesser long-nosed bat. The objective of these terms and conditions is to seek to restore an equivalent acreage of agave habitat affected by the proposed action:

    a. Rosemont shall reclaim the short road segment leading to the R-2 Adit roost site, including the use of agave planting if appropriate, to reduce the likelihood of human intrusion at this roost site.

    b. Rosemont shall investigate the feasibility of agave plantings at appropriate sites on proposed conservation lands, including Sonoita Creek Ranch, Davidson Canyon Watershed parcels, and Helvetia Ranch North parcels. Plant agaves at appropriate densities and conduct follow-up monitoring at sites where such plantings are feasible and have a high likelihood of success. The status and success of these efforts should be included in the annual report to FWS as outlined in the Conservation Measures section of this BO.

4. The following term and condition implements reasonable and prudent measure #5 for the lesser long-nosed bat:

    a. Implement conservation measures related to known lesser long-nosed bat roost protection measures to rerouting of the Arizona Trail, reclamation and revegetation, and any other project activities that will occur in proximity to known lesser long-nosed bat roosts during the time of year when lesser long-nosed bats are not present in the project action area. Such activities could typically be carried out from November 1 to July 1 of each year.

5. The following term and condition implements reasonable and prudent measure #6 for the lesser long-nosed bat:

    a. In addition to the reporting requirements already specified as part of the proposed action, the Coronado National Forest, Rosemont, or their agents shall report to FWS:

    The monitoring and adaptive management process outlined in the BA and this BO is key to reducing take of lesser long-nosed bats resulting from the implementation of this project. Therefore, Coronado National Forest and Rosemont shall report to the FWS the results of all monitoring and adaptive management actions undertaken as a result of this project. Annually, and in compliance with the reporting deadlines outlined above in this BO, the Coronado National Forest and Rosemont shall provide a report to FWS that includes a) any new lesser long-nosed bat roosts documented as a result of monitoring, b) monitoring data for all roost sites occupied by lesser long-nosed bats including dates and numbers of lesser long-nosed bats counted, c) classification of each lesser long-nosed bat roost monitored with regard to season of use, d) any documented negative effects of the protective measures as discussed in Term and Condition #2 above, e) any recommendations to remove or alter the roost protective measures or change the monitoring protocol, f) results of monitoring to document the effectiveness of the roost protection measures implemented at the Helena and R-2 roost sites, as well as any additional lesser long-nosed bat roost protected as a result of the implementation of the conservation measures outlined in the proposed action, and g) any other pertinent information related to monitoring and adaptive management under this project. Additionally, the Biological Monitor shall report to the FWS all data received from Rosemont related to the monitoring of known lesser long-nosed bat roosts and reconnaissance level surveys within 10 working days of each monitoring or survey effort. The Biological Monitor shall report the intent to close any feature that supports 30 or more lesser long-nosed bats to FWS at least 30 days prior to initiating exclusion and closure of the feature.

Review requirement: The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. The Coronado National Forest must immediately provide an explanation of the causes of the taking and review with the FWS the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations-Lesser Long-Nosed Bat

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the Coronado National Forest participate in the development of a revised long-term monitoring protocol for the lesser long-nosed bat as outlined in the most recent Lesser Long-Nosed Bat 5-year review and the recently completed evaluation by the University of Arizona (Cerro 2012).
2. We recommend that the Coronado National Forest participate in the development of a range-wide agave monitoring program with a standardized monitoring protocol.

3. We encourage the Coronado National Forest to initiate or participate in additional lesser long-nosed bat research related to the foraging patterns, roost occupancy patterns, and seasonal behavior of lesser long-nosed bats in southern Arizona.
4. We encourage the Coronado National Forest to work with Border Patrol and the Department of Homeland Security to assess and minimize the impacts of border fences and other facilities on the lesser long-nosed bat.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

STATUS OF THE SPECIES- JAGUAR

Legal Status

In 1972, the jaguar (*Panthera onca*) was listed as endangered (37 FR 6476; March 30, 1972) in accordance with the Endangered Species Conservation Act of 1969 (ESCA), a precursor to the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq.*). Under the ESCA, the FWS maintained separate listings for foreign species and species native to the United States. At that time, the jaguar was believed to be extinct in the United States; thus, the jaguar was included only on the foreign species list. On July 25, 1979, the FWS published a notice (44 FR 43705) stating that, through an oversight in the listing of the jaguar and six other endangered species, the United States populations of these species were not protected by the Act. The notice asserted that it was always the intent of the FWS that all populations of these species, including the jaguar, deserved to be listed as endangered, whether they occurred in the United States or in foreign countries. Therefore, the notice stated that the FWS intended to take action as quickly as possible to propose the U.S. populations of these species (including the jaguar) for listing. On July 25, 1980, the FWS published a proposed rule (45 FR 49844) to list the jaguar and four of the other species referred to above in the United States. The proposal for listing the jaguar and three other species was withdrawn on September 17, 1982 (47 FR 41145) stating that the Act mandated withdrawal of proposed rules to list species which have not been finalized within 2 years of the proposal. On July 22, 1997, the FWS published a final rule clarifying that endangered status for the jaguar extended into the United States (62 FR 39147).

Life History

The jaguar, a large member of the cat family (Felidae), is an endangered species that currently occurs from southern Arizona and New Mexico to southern South America. Jaguars are muscular cats with relatively short, massive limbs and a deep-chested body. They are cinnamon-buff in color with many black spots; melanistic (dark coloration) forms are also known, primarily from the southern part of the range.

The life history of the jaguar has been summarized by Seymour (1989, entire) and Brown and López González (2001, entire), among others. Jaguars breed year-round rangewide, but at the southern and northern ends of their range there is evidence for a spring breeding season. Gestation is about 100 days; litters range from one to four cubs (usually two). Cubs remain with their mother for nearly 2 years. Females begin sexual activity at 3 years of age, males at 4.

Studies have documented few wild jaguars more than 11 years old, although a wild male jaguar in Arizona was documented to be at least 15 years of age (Johnson *et al*. 2011, p. 12), and in Jalisco, Mexico, two wild females were documented to be at least 12 and 13 (Núñez 2011, pers. comm.). The consensus of jaguar experts is that the average lifespan of the jaguar is 10 years.

Prey

The list of prey taken by jaguars throughout their range includes more than 85 species (Seymour 1989, p. 4). Known prey include, but are not limited to, collared peccaries (javelina (*Pecari tajacu*)), white-lipped peccaries (*Tayassu pecari*), capybaras (*Hydrochoerus* spp.), pacas (*Agouti paca*), agoutis (*Dasyprocta* spp.), armadillos (*Dasypus* spp.), caimans (*Caiman* spp.), turtles (*Podocnemis* spp.), white-tailed deer (*Odocoileus virginianus*), livestock, and various other reptiles, birds, and fish (sources as cited in Seymour 1989, p. 4; Núñez *et al*. 2000, pp. iii–iv; Rosas-Rosas 2006, p. 17; Rosas-Rosas *et al*. 2008, pp. 557–558). Jaguars are considered opportunistic feeders, especially in rainforests, and their diet varies according to prey density and ease of prey capture (sources as cited in Seymour 1989, p. 4). Jaguars equally use medium- and large-size prey, with a trend toward use of larger prey as distance increases from the equator (López González and Miller 2002, p. 218). Javelina and white-tailed deer are thought to be the mainstays in the diet of jaguars in the United States and Mexico borderlands (Brown and López González 2001, p. 51).

Home Range and Movement

Like most large carnivores, jaguars have relatively large home ranges. According to Brown and López-González (2001), their home ranges are highly variable and depend on sex, topography, available prey, and population dynamics. However, little information is available on this subject outside tropical America, where several studies of jaguar ecology have been conducted. Data compiled from studies in Brazil, Venezuela, and Belize found mean home range areas for males to vary from 12.8 to 140 square kilometers (km^2)(5 to 52 square miles [mi^2]) during the wet season and 28 to 165.8 km^2 (11 to 64 mi^2) during the dry season. For females, the ranges were smaller, with less variation between seasons (Rabinowitz and Nottingham 1986, Crawshaw and Quigley 1991, Brown and López-González 2001, Cavalcanti and Gese 2009). In the tropical deciduous forest of Jalisco, Mexico, mean home range size for two males was 100.3 +/- 15.0 km^2 (38.7 +/- 5.8 mi^2) and four females was 42.5 +/- 16 km^2 (16.4 +/- 6.2 mi^2) (Núñez-Pérez 2006).

Only one limited home range study using standard radio-telemetry techniques has been conducted for jaguars in northwestern Mexico. Telemetry data from one adult female tracked for four months during the dry season in the municipality of Sahuaripa, Sonora, indicated a home range size of 100 km^2 (39 mi^2) (López-González 2011, pers. comm.). Additionally, camera trap data indicated that the average male home range in the municipality of Sahuaripa, Sonora, was 84 km^2 (32 mi^2) (López-González 2011, pers. comm.). Also using camera traps, in Nacori Chico, Sonora, Rosas-Rosas and Bender (2012) estimated the home range for one adult male jaguar encompasses about 200 km^2 (77 mi^2).

No home range studies have been conducted for jaguars in southwestern U.S. using standard radio-telemetry techniques. The home ranges of borderland jaguars are presumably as large or larger than the home ranges of tropical jaguars (Brown and López González 2001, p. 60), as jaguars in this area are at the northern limit of their range and the arid environment contains resources and environmental conditions that are more variable than those in the tropics (Hass 2002, as cited in McCain and Childs 2008, p. 6). Therefore, jaguars require more space in arid areas to obtain essential resources such as food, water, and cover.

In coastal Jalisco, jaguars moved up to 20 km (12.4 mi) in one night and one juvenile male dispersed about 70 km (43.5 mi) to the north (Núñez *et al*. 2002). The mean one-day movement of radio-collared jaguars in the Pantanal region of southwestern Brazil was 2.4 +/- 2.3 km (1.5 +/- 1.4 mi), with that of one male being significantly larger (3.3 +/- 1.8 km [2.0 +/- 1.1 mi]) than that displayed by females (1.8 +/- 2.5 km) (Crawshaw and Quigley 1991). Additionally, the mean distance travelled by all animals during one-day intervals in the dry season (2.7 +/- 2.5 km [1.7 +/- 1.5 mi]) was significantly greater than the mean one-day movement for all other months combined (1.6 +/- 2.1 km [1.0 +/- 1.3 mi) (Crawshaw and Quigley 1991). In Brazil, male jaguars have been documented to disperse up to 64 km (Rabinowitz and Zeller 2010).

Habitat

Jaguars are known from a variety of vegetation communities (Seymour 1989). Toward and at middle latitudes, they show a high affinity for lowland wet communities, including swampy savannas or tropical rain forests. Swank and Teer (1989) stated that jaguars prefer a warm, tropical climate, usually associated with water, and are rarely found in extensive arid areas. However, jaguars have been documented in arid areas, including thornscrub, desertscrub, lowland desert, mesquite grassland, Madrean oak woodland, and pine-oak woodland communities of northwestern Mexico and southwestern U.S. (Boydston and López-González 2005, McCain and Childs 2008, López-González and Brown 2002). The more open, dry habitat of southwestern U.S. has been characterized as marginal in terms of water, cover, and prey densities (Rabinowitz 1999). Brown and López-González (2001) report that the major habitat requirement appears to be a closed vegetative structure and that jaguars usually avoid open country like grassland or desertscrub. For this reason, jaguars rarely occur above 2,591 m (8,500 ft) (Brown and López-González 2001).

Conde *et al.* (2010) found significant differences in habitat use between male and female jaguars in the Mayan Forest of the Yucatan Peninsula by modeling occupancy as a function of land cover type, distance to roads, and sex. Although both male and female jaguars prefer tall forest, short forest was used by females but avoided by males. Other studies have also shown that jaguars selectively use large areas of relatively intact habitat away from certain forms of human influence. Zarza *et al*. (2007) report that towns and roads had an impact on the spatial distribution of jaguars (jaguars used more frequently than expected by chance areas located more than 6.5 km [4 mi] from human settlements and 4.5 km [2.8 mi] from roads) in the Yucatan peninsula. In the state of Mexico, Monroy-Vichis *et al*. (2007) report that one male jaguar occurred with greater frequency in areas relatively distant from roads and human populations. In some areas of western Mexico, however, jaguars (both sexes) have frequently been recorded near human settlements and roads (Núñez-Pérez, August 2, 2011, email to FWS.). In Marismas Nacionales, Nayarit, a jaguar den was recently located very close to an agricultural field, apparently 1 km (0.6 mi) from a small town (Núñez-Pérez, August 2, 2011, email to FWS). Jaguar presence is affected in different ways by various human activities; however, direct persecution likely has the most significant impact.

No formal habitat use studies have been conducted (with the exception of Núñez *et al*.'s (2002) examination of arroyo use) in the northwestern most portion of the jaguar's range. However, results of a study in the municipality of Nácori Chico, Sonora, showed that jaguar kill sites of wild prey (i.e., white-tailed deer and peccary) (Rosas-Rosas, August 6, 2011, email to FWS) and cattle were positively associated with oak forest and semi-tropical thornscrub vegetation types, whereas they were negatively associated with upland mesquite (Rosas-Rosas *et al*. 2010). Sites of cattle kills were also positively associated with proximity to permanent water sources and roads (Rosas-Rosas *et al*. 2010). General jaguar habitat associations have been described in this region by various authors. In western Mexico, including Nayarit and Jalisco, jaguars primarily occur in tropical deciduous forest, although other formerly important habitats are the mangrove forests and swamps of the Agua Bravo and Marismas Nacionales straddling the borders of Nayarit and Sinaloa (Brown and López-González 2001). In Jalisco, oak and pine forest are used by jaguars, some of them located between 2,700 and 2,800 m (8,858 ft and 9,186 ft) in elevation (Núñez-Pérez, August 2, 2011, email to FWS). Although jaguars are not primarily associated with these vegetation communities, it is important to consider oak woodlands and pine forests as potential jaguar corridors (Núñez-Pérez, August 2, 2011, email to FWS).

Several studies have helped refine a general understanding of habitats that have been or might be used by jaguars in Arizona and New Mexico, including studies by the Sierra Institute Field Studies Program (2000), Hatten *et al*. (2002 and 2005), Menke and Hayes (2003), Boydston and López-González (2005), Robinson *et al*. (2006), McCain and Childs (2008), Grigione *et al*. (2009), Sanderson and Fisher (2013). As Johnson *et al*. (2011) explain, however, any conclusions about the conservation importance of the habitat types in which jaguars have occurred or might occur in Arizona and New Mexico are preliminary and can vary widely, depending on what assumptions are factored into the analyses, such as the number and reliability of jaguar occurrence records and the significance of single "point in time" occurrence observations as predictors of habitat use by jaguars.

Hatten *et al*. (2005) used Geographic Information System (GIS) to characterize potential jaguar habitat in Arizona by overlaying 25 historic jaguar sightings on landscape and habitat features believed important (e.g., vegetation biomes and series, elevation, terrain ruggedness, proximity to perennial or intermittent water sources, human density). The amount of Arizona land area identified as potential jaguar habitat ranged from 21 to 30 percent, depending on the input variables. One hundred percent of jaguar records were observed in four biomes. Of these, 56 percent were observed in scrub grasslands of southeastern Arizona, 20 percent in Madrean evergreen forest, 12 percent in Rocky Mountain montane conifer forest, and 12 percent in Great Basin conifer woodland. Related to water, when springs, rivers, and creeks were combined, 100 percent of the jaguar records were within 10 km (6.2 mi) of a water source. Sixty percent of jaguars were observed between 1,220 and 1,829 m (4,003 and 6,001 ft) in elevation, largely in the scrub grassland biome of southeastern Arizona. The remaining jaguar sightings were between 1,036 and 2,743 m (3,399 and 8,999 ft). With respect to topography, 92 percent of jaguar sightings occurred in intermediately rugged to extremely rugged terrain, with the remainder (8 percent) in nearly level terrain.

More recently, Sanderson and Fisher (2013) modeled jaguar habitat in the Northwestern Jaguar Recovery Unit (NRU) (see description below) following a variant of the Hatten *et al*. (2005)

method. Habitat factors used to characterize potential jaguar habitat were 1) percentage of tree cover, 2) ruggedness index, 3) human influence, 4) ecoregion, 5) elevation (some model versions only), and 6) distance from water. Altogether, 13 habitat model versions were produced with input from the Technical Subgroup of the Jaguar Recovery Team. The habitat models were also translated into carrying capacity. The final habitat model (version 13) suggests a potential carrying capacity of more than 3,400 jaguars over an area of over 226,000 km^2. This capacity was further broken down into smaller geographic areas or "subunits" of the NRU which, from south to north, may have the potential to contain: ~1,318 jaguars in the Jalisco Core Area, ~929 jaguars in the Sinaloa Secondary Area, ~1,124 jaguars in the Sonora Core Area, and ~42 jaguars in the Borderlands Secondary Area (which include portions of northern Sonora, southern Arizona, and southeastern New Mexico). The current populations are substantially below these carrying capacities, but are not zero according to recent observations in all four subunits (Sanderson and Fisher 2013).

Distribution, Abundance, Population Trends

The only Neotropical large carnivore with a distribution extending north into the Madrean Archipelago is the jaguar. Historically, the jaguar inhabited 21 countries throughout the Americas, from the United States south into Argentina, but currently the jaguar is found in 19 of those countries (no longer in El Salvador and Uruguay) (Caso *et al*. 2008). The population trend of jaguars is decreasing (Caso *et al*. 2008), although the rate of decline is unknown and likely highly variable throughout the jaguar range. To better understand abundance and population trends, research, inventories, and monitoring programs are being implemented in some parts of the jaguar range (Caso *et al*. 2008, Wildlife Conservation Society 2007, Chávez *et al*. 2007, Panthera 2011). During a symposium in November 2009 titled "The Jaguar in the XXI Century: The Continental Perspective", experts estimated that there are still probably more than 30,000 jaguars (Medellin 2009) and that Mexico has an estimated 4,100 jaguars (Zarza *et al*. 2010). Sanderson *et al*. (2002) found that the jaguar is known to be extant in about 8.75 million km2 (3.4 million mi2), which represents 46 percent of its historical global range. Jaguars are known to be extirpated in 37 percent of their historical range, and their status in another 18 percent is unknown (Sanderson *et al*. 2002). The probability of long-term survival of the jaguar is considered high in 70 percent of the currently occupied range (over 6 million km2 or 2.3 million mi^2) (Sanderson *et al*. 2002). Zeller (2007) updated Sanderson *et al*.'s (2002) work and found that the jaguar is known to be extant in about 11.7 million km^2, which represents 61% of its historical range, likely reflecting simply a greater representation of knowledge rather than actual range expansion. Within the currently occupied range, 90 Jaguar Conservation Units (JCUs) were identified representing a total area of 1.9 million km2 (0.7 million mi2) (Zeller 2007). JCUs were defined either as 1) areas with a stable prey community, currently known or believed to contain a population of resident jaguars large enough (at least 50 breeding individuals) to be potentially self-sustaining over the next 100 years, or 2) areas containing fewer jaguars but with adequate habitat and a stable, diverse prey base, such that jaguar populations in the area could increase if threats were alleviated (Sanderson *et al*. 2002, Zeller 2007).

In northwestern and western Mexico, jaguars occur from the border of Colima and Jalisco north through Nayarit, Sinaloa, southwestern Chihuahua, and Sonora to the border with the U.S. Breeding populations currently occur in Jalisco, Nayarit, Sinaloa, and Sonora. The most northern recently documented breeding population of jaguars occurs in Sonora near the towns of

Huasabas and Sahuaripa, about 210 km (130 mi) south of the U.S./Mexico international border (Valdez *et al*. 2002, Brown and López-González 2001). Since 2009, two jaguars have been documented at Rancho El Aribabi, Sonora, about 48 km (30 mi) southeast of Nogales, and one jaguar has been documented in the Sierra Los Ajos within the Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe, about 48 km (30 miles) south of the U.S. border near Naco, Mexico. Estimates in the Sonora and Jalisco JCUs were 50-100 and >500, respectively (Zeller 2007). Results of the Mexican National Jaguar Census (Manriquez, July 15, 2011, email to FWS) indicate there are an estimated 271 jaguars in Sonora, 211 in Sinaloa, 92 in Nayarit, and 176 in Jalisco.

In the United States, jaguars historically occurred in California, Arizona, New Mexico, Texas, and possibly Louisiana (62 FR 39147). The last jaguar sightings in California, Texas, and Louisiana were documented in the late 1800s into the early 1900s, with the last confirmed jaguar killed in Texas in 1948 (Nowak 1975). While jaguars have been documented as far north as the Grand Canyon, Arizona, occurrences in the U.S. since 1963 have been limited to south-central Arizona and extreme southwestern New Mexico. Three records of females with cubs have been documented in the U.S. (all in Arizona), the last in 1910 (Lange 1960, Nowak 1975, Brown 1989), and no females have been confirmed in the U.S. since 1963 (Brown and López-González 2000, Johnson *et al*. 2011). As a result, jaguars in the U.S. are thought to be part of a population, or populations, that occur largely in Mexico.

From 1996 through 2013, several individual adult jaguars have been documented in the U.S. (i.e., within Arizona and New Mexico). One adult male was observed and photographed on March 7, 1996, in the Peloncillo Mountains in New Mexico near the Arizona border (Glenn 1996, Brown and López-González 2001). The Peloncillo Mountains run north-south to the Mexican border, where they join the foothills of the Sierra San Luis and other mountain ranges connecting to the Sierra Madre Occidental. Another jaguar was photographed in 2004; however, it could not be determined if the animal was a unique individual. Another adult male was observed and photographed on August 31, 1996, in the Baboquivari Mountains of southern Arizona (Childs 1998, Brown and López-González 2001). In February 2006, another adult male jaguar was observed and photographed in the Animas Mountains in Hidalgo County, New Mexico (McCain and Childs 2008). From 2001 to 2009, two jaguars, both adult males, were photographed (one repeatedly) using infra-red camera traps in south-central Arizona, near the Mexico border, one of which, was the male observed and photographed in 1996 in the Baboquivari Mountains. More specifically, these two jaguars were documented in three different mountain range complexes in southeastern Arizona, over an area extending from the U.S./Mexico international border north 66 km (47 mi) and 63 km (39 mi) east to west (McCain and Childs 2008). Furthermore, they were found using areas from rugged mountains at 1,577 m (5,174 ft) to flat lowland desert floor at 877 m (2,877 ft) (McCain and Childs 2008). A male jaguar was seen and photographed by a hunter in the Whetstone Mountains in 2011. Detections of jaguars as recent as March of 2013 have been documented in southern Arizona, within and near the proposed action area (see Environmental Baseline section below).

The rugged and arid conditions at the northern limit of this distribution contrast sharply to lush tropical forests to the south (Boydston and López González 2005). Importantly, populations at the edge of a species' range play a role in maintaining the total genetic diversity of a species (Jaguar Recovery Team 2012a, pp. 19–20); in some cases, these peripheral populations persist the longest as fragmentation and habitat loss impact the total range (Channell and Lomolino 2000, pp. 84–85). The United States and northwestern Mexico represent the northernmost extent of the jaguar's range, with populations persisting in distinct ecological conditions (xeric, or extremely dry, habitat) that occur nowhere else in the species' range (Sanderson *et al*. 2002, entire). Peripheral populations such as these are an important genetic resource in that they may be beneficial to the protection of evolutionary processes and the environmental systems that are likely to generate future evolutionary diversity (Lesica and Allendorf 1995, entire). This may be particularly important considering the potential threats of global climate change. Citing Young and Clarke (2000), Grigione *et al*. (2009) suggest that conservation of peripheral populations, such as the jaguar in the northernmost portion of its range, plays a role in maintaining the total genetic heterozygosity of a species. The ability for jaguars in the NRU to utilize physical and biological habitat features in the Northern Management Unit (NMU; a sub-area of the NRU, as described below) is ecologically important to the recovery of the species; therefore, maintaining connectivity to Mexico is essential to the conservation of the jaguar.

Boydston and López-González (2005) estimated the potential geographic distribution of jaguars in the southwestern U.S. and northwestern Mexico by modeling the jaguar ecological niche from occurrence records (100 male records from Arizona [42], New Mexico [6], Chihuahua [8], and Sonora [39] and 42 female records from Arizona [6] and Sonora [36]). They report that eastern Sonora appeared capable of supporting male and female jaguars with potential range expansion into southeastern Arizona, while New Mexico and Chihuahua contained environmental characteristics primarily limited to the male niche and thus may be areas into which males occasionally disperse. They found significant differences between land cover within the female distribution and the available landscape. The predicted distribution of female jaguars was mainly across areas of shrubland, deciduous broadleaf forest, and grassland, but deciduous broadleaf forest and mixed forest composed more of the female distribution than expected by chance when compared to the available land cover for the study area. Shrubland was a smaller proportion of the female distribution than expected, and grassland and needleleaf forest were present in proportion to their availability. Boydston and López-González's (2005) results indicated that the availability of areas meeting females' environmental requirements may be an important factor limiting the distribution of northern jaguars.

Grigione *et al.* (2009) conducted a mapping study to construct a blueprint of priority conservation areas for jaguars, as well as ocelots and jaguarundis, in the U.S. – Mexico border region. For the jaguar in the western bioregion of the study area (including Arizona, New Mexico, Sonora, Chihuahua, and Sinaloa), four units were identified (two very high priority, one high priority, and one low priority), including two in the U.S. and two in Mexico (totaling 102,530 km^2 [39,587mi^2]). Within these four units, currently 19.8 percent of the area has any form of protection (Grigione *et al.* 2009). A very high priority corridor was identified between the two Mexican units; otherwise the connections between the units are poorly understood and consequently two corridors needing further study were identified. Two underpasses were identified as being needed in northern Sonora, where jaguars are believed to be crossing roads as they disperse north. The authors conclude that the region to the south of Arizona and New Mexico is especially critical for the recovery of the jaguar in the southwestern U.S. because the source population is likely in central Sonora. Citing Brown and López-González (2001) and List (2007), Grigione *et al.* (2009) explain that to reach the U.S., jaguars need to travel through Sonora and Chihuahua, where there are many challenges to jaguar survival and movement, including the U.S. –Mexico border fence. In summary, the Sky Islands Unit was ranked as "very high priority" for a conservation area for jaguars (Grigione *et al.* 2009:83).

Threats

In addition to the numerous anthropogenic threats affecting jaguars, the species has a number of intrinsic biological factors that limit its recovery, including being a K-selected species (i.e., species with large body size, long life expectancy, and the production of fewer offspring, which often require extensive parental care until they mature) and having large spatial requirements. Small and isolated jaguar populations do not appear to be highly persistent (Haag *et al*. 2010, Rabinowitz and Zeller 2010). However, persistence of relatively small populations appears to increase with connectivity to other populations and reduction of threats within a corridor (Rabinowitz and Zeller 2010). The prospects for the jaguar being self-sustaining in the wild are favorable; however conservation of key jaguar habitats and populations is critical to this sustainability.

Illegal killing of jaguars is one of the two most significant threats to the jaguar (Medellin 2009, Chávez and Ceballos 2006, Medellín *et al*. 2002, Núñez *et al*. 2002, Nowell and Jackson 1996) and, to recover jaguars, likely requires the most immediate response (FWS 2012a). Experts from throughout the jaguar range agree that one of the most severe causes of mortality is the direct hunting of jaguars, either because jaguars have caused some conflict by killing livestock or to sell the jaguar as a trophy or its skin or teeth (Medellin 2009). This illegal and indiscriminate killing eliminates hundreds or even thousands of jaguars each year in Latin America and must be controlled to reduce the risk of extinction (Medellin 2009).

Range wide, habitat destruction and modification form the other of the two most significant threats to the jaguar (Medellin 2009, Chávez and Ceballos 2006, Medellín *et al.* 2002, Núñez *et al*. 2002, Nowell and Jackson 1996). To recover jaguars, addressing this threat of habitat loss requires immediate response. The jaguar is classified as "Near Threatened" on the Red List of the International Union for the Conservation (IUCN) due to a number of factors, including habitat loss and fragmentation of populations across portions of the range (Caso *et al*. 2008). Various factors, particularly habitat loss, have caused a considerable reduction in the historical range of the jaguar (Sanderson *et al*. 2002, Zeller 2007, Rabinowitz and Zeller 2010). Most loss of occupied range has occurred in the southern U.S., northeastern Mexico, northern Brazil, and southern Argentina (Sanderson *et al.* 2002). Deforestation rates are high in Latin America and fragmentation of forest habitat isolates jaguar populations so that jaguars are more vulnerable to human persecution (Nowell and Jackson 1996). Medellin *et al*. (2002) report that loss, fragmentation, and modification of jaguar habitat have contributed to population declines throughout much of the species' range, including northern Mexico.

Human population growth has both direct and indirect impacts on jaguar survival and mortality. For example, human growth and development tend to fragment habitat and isolate populations of jaguars and other wildlife. For carnivores in general, the impacts of high road density have been well documented and thoroughly reviewed (e.g., Noss *et al.* 1996, Carroll *et al.* 2001, as cited by Menke and Hayes 2003). Roads may have direct impacts to carnivores and carnivore habitats, including mortality caused by vehicles, disturbance, habitat fragmentation, changes in prey numbers or distribution, and provision of increased access for legal or illegal harvest

(Menke and Hayes 2003, Colchero *et al*. 2010). These threats are relevant to jaguars throughout most of their range; however, no jaguars have been documented in collisions with vehicles in the U.S. despite the fact that they have documented to cross roads, including two lane highways in Arizona.
Habitat fragmentation may disrupt original patterns of gene flow and lead to drift-induced differentiation among local population units andtop predators, such as the jaguar, may be particularly susceptible to this effect, given their low population densities, leading to small effective sizes in local fragments (Haag *et al*. 2010). Large-scale habitat removal and fragmentation of once contiguous habitat can cause the reduction of genetic diversity in jaguar populations (Haag *et al*. 2010). To avoid the negative demographic and genetic consequences of small population size caused by habitat fragmentation, connectivity should be restored to ensure gene flow is maintained (Haag *et al*. 2010). Citing a number of sources, Rabinowitz and Zeller (2010) explain that reduction or loss of genetic exchange leads to smaller effective population sizes, increased levels of genetic drift and inbreeding, and potential deleterious effects on sperm production, mating ability, female fecundity, and juvenile survival. Furthermore, they state that such effects eventually compromise adaptive potential, reduce fitness, and contribute to extinction risk for a population and, ultimately, for the species. To ensure genetic health and long-term viability of jaguars rangewide, it is critical to maintain gene flow among populations through maintaining and restoring connectivity. Corridors can provide one of the most basic requirements for species persistence–genetic exchange (Rabinowitz and Zeller 2010). Boydston and López-González (2005) suggest that range expansion to the north of eastern Sonora could help prevent genetic isolation and extinction of the northern jaguars and also increase chances for long-term survival of this species in the face of global anthropogenic changes.

Overall, the threat of human encroachment cannot be eliminated, but through conservation planning and implementation efforts, it can be reduced. Conservation of key habitat areas is critical to the recovery of jaguars. There are many opportunities and methods (i.e., creation of new reserves, incentive programs, etc.) to continue to conserve jaguar habitat; however, they will require significant international, national, and local cooperation, as well as financial support.
The jaguar is classified as "Near Threatened" on the Red List of the IUCN in part due to poaching of prey (Caso *et al*. 2008). According to experts across the jaguar range, hunting of the most important prey, such as peccaries and deer, is one of the primary factors negatively affecting the jaguar (Medellin 2009). An estimated 27 percent of jaguar range has a depleted wild prey base (WCS 2008 as cited by Caso *et al*. 2008). Illegal hunting of potential jaguar prey species is one of the main threats to long-term conservation of jaguars in northwestern Mexico (Rosas-Rosas 2006). Human population growth can put pressure on game populations that are used for human consumption. These same game populations are often prey for jaguars. Furthermore, overhunting of natural prey may cause an increase in jaguar predation on livestock and consequently increase human-jaguar conflicts, including continued negative attitudes toward jaguars and illegal killing of jaguars.

Jaguar Recovery Planning

The species has a recovery priority number of 5C, meaning that it has a low potential for recovery with a relatively high degree of conflict. Recovery for the jaguar was originally addressed in *Listed Cats of Texas and Arizona Recovery Plan (with Emphasis on the Ocelot)* (U.S. Fish and Wildlife Service 1990), but only general information and recommendations to assess jaguar status in the U.S. and Mexico, and protect and manage occupied and potential habitat in the U.S. were presented. No specific recovery recommendations or objectives for the jaguar were presented. In 2007, the FWS made a 4(f)(1) determination that development of a formal recovery plan at this time would not promote the conservation of the jaguar. The rationale for this determination was that for the purposes of formal recovery planning, the jaguar qualifies as an exclusively foreign species. The FWS was subsequently litigated on this determination and the presiding judge remanded the decision regarding recovery planning back to the FWS. Subsequently, in 2010, the FWS made a new determination that development of a recovery plan would contribute to jaguar conservation and that, therefore, the FWS should prepare a recovery plan.

In 2012, a Recovery Outline for the jaguar (FWS 2012b) was finalized by the FWS. The outline, prepared by the Technical Subgroup of the Jaguar Recovery Team in conjunction with the Implementation Subgroup of the Jaguar Recovery Team and the FWS, serves as interim guidance for the FWS to direct recovery efforts, including recovery planning, for the jaguar until a full recovery plan is developed and approved. The Recovery Team is currently developing a draft recovery plan and thus, the Recovery Outline for the Jaguar represents the best available scientific information for this consultation.

The goal for the Recovery Outline is to conserve and protect the jaguar and its habitat so that its long-term survival is secured and it can be considered for removal from the list of threatened and endangered species (delisted). Although the recovery outline does not include Recovery Criteria, the Preliminary Recovery Strategy does include eight Preliminary Recovery Objectives, which collectively describe the specific conditions under which the goals for recovery of the jaguar (i.e., delisting) will be met. These objectives are:

1. Assess, protect, and restore sufficient habitat to support viable populations of jaguars in the two recovery units.
2. Mediate or mitigate the effects of human population growth and development on jaguar survival and mortality where possible.
3. Reduce direct human-caused (i.e., illegal and legal killing) mortality of jaguars.
4. Reduce illegal hunting of jaguar prey and improve regulation of legal hunting where appropriate (i.e., in cases where hunting is leading to significant reductions of jaguar prey).
5. Maintain or improve genetic fitness, demographic conditions, and health of the jaguar.
6. Assure the long-term viability of jaguar conservation through partnerships, the development and application of incentives for landowners, application of existing regulations, and public education and outreach.
7. Practice adaptive management in which recovery is monitored and recovery tasks are revised by the FWS in coordination with the Jaguar Recovery Team as new information becomes available.
8. Support international efforts to ascertain the status and conservation needs of the jaguar in the two recovery units.

The 2012 Recovery Outline for the Jaguar describes two recovery units for the jaguar across its range, the Northwestern (see Figure 1 below) and Pan American Recovery Units (FWS 2012a, p. 58). Recovery units are subunits of the listed species' habitat that are geographically or otherwise identifiable and essential to the recovery of the species (FWS 2012a, p. 20). Recovery units for the jaguar are further divided into core, secondary, and peripheral areas (FWS 2012a, pp. 20–23). Core areas have both persistent verified records of jaguar occurrence over time and recent evidence of reproduction. Secondary areas are those that contain jaguar habitat with either or both historical or recent records of jaguar presence with no recent record or very few records of reproduction. In peripheral areas, most historical jaguar records are sporadic, and there is no or minimal evidence of long-term presence or reproduction that might indicate colonization or sustained use of these areas by jaguars.

Northwestern Recovery Unit (NRU)

The NRU is approximately 222,197 km^2 (85,791 mi^2); with (32,081 km^2 [12,386 mi^2] in the U.S. and 190,116 km^2 [73,404 mi^2] in Mexico). The Northern Management Unit (NMU) lies within the NRU and is approximately 74,832 km^2 (28,893 mi^2); with (32,081 km^2 [12,386 mi^2] in the U.S. and 42,751 km^2 [16,506 mi^2] in Mexico), see Figure 1. Within the U.S., jaguar habitat in the NRU primarily occurs on tribal (Tohono O'odham Nation) lands and federally and state owned lands, including those managed by the U.S. Forest Service (Coronado National Forest), Bureau of Land Management, National Park Service, FWS, and Arizona State Land Department. The remaining non-state and non-federal lands within the NRU are privately owned.

Within Mexico, jaguar habitat within the NRU primarily occurs on privatelyowned, ejido (communal), and indigenous community (i.e., Yaqui) lands. Although there are natural protected areas (ANP) designated by the Comisión Nacional de Áreas Naturales Protegidas (CONANP [National Commission for Natural Protected Areas]) within the NRU, they overlap privately-owned and communal lands. The protected status of these ANPs does not change the land ownership status but instead imposes use restrictions on the lands. At this time, at least eight Federally recognized protected areas have been established within the NRU in Mexico that provide for jaguar protection (see Conservation Assessment below for more detailed information on protected areas).

As mentioned above, the U.S. lands within the secondary area of the Northwestern Recovery Unit are also located within the Northwestern Management Unit. Management units, as described in the Recovery Outline, are areas within a recovery unit that might require different management, be managed by different entities, or encompass different populations (Jaguar Recovery Team 2012:40). The U.S. lands located within the NMUNMU simply acknowledge the existence of different species management on either side of the International Border with Mexico. This additional description of the U.S. lands as part of the NMU does not mean that the habitat in United States has any less significance within the secondary area of the recovery unit.

Proposed Critical Habitat

Six units are proposed for designation as critical habitat (in the U.S only); these are considered occupied at the time of listing and contain the components of the primary constituent elements in the appropriate quantity and spatial arrangement sufficient to support the life-history needs of the species. Two of these units also contain subunits considered unoccupied at the time of listing, but according to the proposed rule (FWS 2012b) were included as "areas essential for the conservation of jaguars outside of occupied areas" because they connect an area that may have been occupied that is isolated within the U.S. to Mexico, either through a direct connection to the international border or through another area that may have been occupied. The six units proposed as critical habitat are: (1) Baboquivari Unit divided into subunits (1a) Baboquivari-Coyote Subunit, including the Northern Baboquivari, Saucito, Quinlan, and Coyote Mountains, and (1b) the Southern Baboquivari Subunit; (2) Atascosa Unit, including the Pajarito, Atascosa, and Tumacacori Mountains; (3) Patagonia Unit, including the Patagonia, Santa Rita, and Huachuca Mountains and the Canelo Hills; (4) Whetstone Unit, divided into subunits (4a) Whetstone Subunit, (4b) Whetstone-Santa Rita Subunit, and (4c) Whetstone-Huachuca Subunit; (5) Peloncillo Unit, including the Peloncillo Mountains both in Arizona and New Mexico; and (6) San Luis Unit, including the northern extent of the San Luis Mountains at the New Mexico-Mexico border. The units affected by the proposed action, Units 3 and 4, are described below.

Unit 3: Patagonia Unit

Unit 3 consists of 138,821 ha (343,033 ac) in the Patagonia, Santa Rita, and Huachuca Mountains, as well as the Canelo Hills, in Pima, Santa Cruz, and Cochise Counties, Arizona. Unit 3 is generally bounded by Interstate 19 to the west; Interstate 10 to the north; Cienega Creek, the Mustang Mountains, and Highways 90 and 92 to the east; and the U.S.-Mexico border to the south. Land ownership within the unit includes approximately 116,080 ha (286,839 ac) of Federal lands; 5,618 ha (13,883 ac) of Arizona State lands; 17,115 ha (42,291 ac) of private lands; and 8 ha (20 ac) of other lands. The Federal land is administered by the Coronado National Forest, Bureau of Land Management, and Fort Huachuca. We consider the Patagonia Unit occupied at the time of listing (37 FR 6476; March 30, 1972) based on the 1965 record from the Patagonia Mountains, and it is currently occupied based on a series of confirmed sightings from 2011 May 11, 2013through insert last date. The mountain ranges within this unit contain all primary constituent elements of the physical or biological feature essential to the conservation of the jaguar.

The primary land uses within Unit 3 include military activities associated with Fort Huachuca, as well as Federal forest management activities, border-related activities, grazing, and recreational activities throughout the year, including, but not limited to, hiking, camping, birding, horseback riding, picnicking, sightseeing, and hunting. Special management considerations or protections needed within the unit address human disturbances through such activities as military ground maneuvers and increased human presence in remote locations through mining and development activities, construction of impermeable fences, and widening or construction of roadways, power lines, or pipelines to ensure all PCEs remain compatiblecompatible with jaguar use.

Subunit 4a: Whetstone Subunit

Subunit 4a consists of 24,012 ha (59,335 ac) in the Whetstone Mountains in Pima, Santa Cruz, and Cochise Counties, Arizona. Subunit 4a is generally bounded by Cienega Creek to the west, Interstate 10 to the north, Highway 90 to the east, and Highway 82 to the south. Land ownership within the subunit includes approximately 16,406 ha (40,541 ac) of Federal lands; 4,684 ha (11,575 ac) of Arizona State lands; and 2,921 ha (7,219 ac) of private lands. The Federal land is administered primarily by the Coronado National Forest. We consider the Whetstone Subunit occupied at the time of listing (37 FR 6476; March 30, 1972) based on photographs taken in 2011, and it may be currently occupied although the animal recently photographed in the Santa

Ritas is the same male photographed in the Whetstones in 2011. The mountain range within this subunit contains all primary constituent elementsessential to the conservation of the jaguar, except for connectivity to Mexico.
The primary land uses within Subunit 4a include Federal forest management activities, grazing, and recreational activities throughout the year, including, but not limited to, hiking, camping, birding, horseback riding, picnicking, sightseeing, and hunting. Special management considerations or protections needed within the subunit addresshuman disturbances through development activities, and widening or construction of roadways, power lines, or pipelines to ensure all PCEs remain compatiblecompatible with jaguar use.

Subunit 4b: Whetstone-Santa Rita Subunit

Subunit 4b consists of 10,686 ha (26,406 ac), including the Empire Mountains, between the Santa Rita Mountains and northern extent of the Whetstone Mountains in Pima County, Arizona. Subunit 4b is generally bounded by the Santa Rita Mountains to the west, Interstate 10 to the north, the Whetstone Mountains to the east, and Wood Canyon to the south. Land ownership within the subunit includes approximately 1,577 ha (3,897 ac) of Federal lands; 6,543 ha (16,168 ac) of Arizona State lands; and 2,566 ha (6,341 ac) of private lands. According to the proposed rule, the Whetstone-Santa Rita Subunit provides connectivity from the Whetstone Mountains to Mexico and was not known to be occupied at the time of listing, but is essential to the conservation of the jaguar because it contributes to the species' persistence by providing connectivity to occupied areas that support individuals during dispersal movements during cyclical expansion and contraction from the nearest core area and breeding population in the NRU (FWS 2012b).

The primary land uses within Subunit 4b include grazing and recreational activities throughout the year, including, but not limited to, hiking, camping, birding, horseback riding, picnicking, sightseeing, and hunting.

Subunit 4c: Whetstone-Huachuca Subunit

Subunit 4c consists of 7,995 ha (19,756 ac) between the Huachuca Mountains and southern extent of the Whetstone Mountains in Santa Cruz and Cochise Counties, Arizona. Subunit 4c is generally bounded by Highway 83 to the west, Highway 82 to the north, Highway 90 to the east, and the Huachuca Mountains to the south. Land ownership within the subunit includes approximately 1,575 ha (3,892 ac) of Federal lands; 3,009 ha (7,436 ac) of Arizona State lands; and 3,411 ha (8,428 ac) of private lands. The Federal land is administered by the Coronado National Forest, Bureau of Land Management, and Fort Huachuca. According to the proposed rule, the Whetstone-Huachuca Subunit provides connectivity from the Whetstone Mountains to Mexico and was not occupied at the time of listing, but is essential to the conservation of the jaguar because it contributes to the species' persistence by providing connectivity to occupied areas that support individuals during dispersal movements during cyclical expansion and contraction of the nearest core area and breeding population in the NRU (FWS 2012b).
The primary land uses within Subunit 4c include military activities associated with Fort Huachuca, as well as Federal forest management activities, grazing, and recreational activities throughout the year, including, but not limited to, hiking, camping, birding, horseback riding, picnicking, sightseeing, and hunting.

Models Used for Proposing Critical Habitat

When we are determining which areas should be designated as critical habitat, the FWS's primary source of information is generally the information developed during the listing process for the species. Additional information sources may include the recovery plan for the species, articles in peer-reviewed journals, conservation plans developed by States and counties, scientific status surveys and studies, biological assessments, other unpublished materials, or experts' opinions or personal knowledge.

The criteria used by the FWS to identify critical habitat included reviewing available information and supporting data that pertained to the habitat requirements of the jaguar. Much of this information was compiled in the Recovery Outline for the Jaguar (Jaguar Recovery Team 2012, entire) and Digital Mapping in Support of Recovery Planning for the Northern Jaguar report (Sanderson and Fisher 2011:1–11), which the FWS regarded as the best available information for the jaguar and its habitat needs in the northern portion of its range. Additionally, the FWS relied on information provided through modeling exercises for Arizona (Hatten *et al*. 2005) and New Mexico (Menke and Hayes 2003; Robinson *et al*. 2006) to further refine the habitat features available in the United States. Because jaguars are secretive animals and generally tend to avoid highly disturbed areas (Quigley and Crawshaw 1992; Hatten *et al*. 2005:1025), human density was afactor considered in jaguar habitat modeling exercises for Arizona (Hatten *et al.* 2005, p. 1025), New Mexico (Menke and Hayes 2003:9–13; Robinson *et al*. 2006, pp. 10, 15, 18–20), and the habitat model developed by Sanderson and Fisher (2011:5–11) for the northwestern Mexico and the U.S.-Mexico borderlands area.

The habitat model developed by Sanderson and Fisher (2011:5–11) included a human influence index (HII) criterion. HII values, calculated worldwide by combining eight input layers (human population density per square km, railroads, major roads, navigable rivers, coastlines, stable nighttime lighting, urban polygons, and land cover) can range from 0 to 64, with 0 representing no human influence and 64 representing the maximum human influence possible (see SEDAC 2012 for more information on how HII was calculated worldwide). Within the region considered for their habitat model, Sanderson and Fisher (2011, pp. 5–11) found that roughly 90 percent of the 333 jaguar records used in their model were located in areas where the HII was less than 30 out of 64. They therefore considered lands with an HII of less than 30 as potential jaguar habitat within their modeling exercise, while lands with an HII equal to or greater than 30 were excluded. Similarly, in our analysis of 130 reports of jaguar locations in the United States, we found that approximately 99 percent occurred in areas where the HII was 20 or less. Therefore, based on this information, the FWS identified areas in which the HII calculated over 1-square km (0.4-square mi) is 20 or less as an essential component of the physical or biological feature essential for the conservation of the jaguar in the United States. These areas are characterized by minimal to no human population density, no major roads, or no stable nighttime lighting over any 1-square km (0.4-square mi) area. Please note that the HII criterion is explained in detail because the propose action will increase human population density, require relatively heavy travel of existing and new roads, and implement stable nighttime lighting during mine operations (see effects analyses, below).

Primary Constituent Elements for Jaguar Critical Habitat

The primary constituent elements of critical habitat are found in the physical or biological featuresfeatures essential to the conservation of jaguar which consists of expansive open spaces in the southwestern United States of at least 84 to 100 square kilometers (32 to 37 square miles) in size. The primary constituent elements are those which:

1. Provide connectivity to Mexico;

2. Contain adequate levels of native prey species, including deer and javelina, as well as medium-sized prey such as coatis, skunks, raccoons, or jackrabbits;

3. Include surface water sources available within 20 km (12.4 mi) of each other;

4. Contain 3 to 40 percent woody species canopy cover within Madrean evergreen woodland, generally recognized by a mixture of oak, juniper, and pine trees on the landscape, or semidesert grassland vegetation communities, with a woody species overstory and an understory usually characterized by *Pleuraphis mutica* (tobosagrass) or *Bouteloua eriopoda* (black grama) along with other grasses;

5. Are characterized by intermediately, moderately, or highly rugged terrain; and

6. Are characterized by minimal to no human population density, no major roads, or no stable nighttime lighting over any 1-square-km (0.4-square-mi) area.

Jaguar Recovery Planning in Relation to Critical Habitat

Jaguar habitat in the U.S. – Mexico borderlands area is part of the secondary area of the NMU within the NRU for the jaguar (see Figure 1) (FWS 2012a:58). The United States portion of the NRU is considered a secondary area that provides a recovery function benefitting the overall recovery unit (FWS 2012a:40, 42). By Jaguar Recovery Team guidelines (FWS 2012a), a secondary area for jaguars is an area meeting the following conditions: (1) compared to core areas, secondary areas are generally smaller, likely contain fewer jaguars, maintain jaguars at lower densities, and exhibit more sporadic current and historical records of jaguars; some of the secondary areas may not have not been surveyed through the use of defined survey protocols, thus resulting in the unknown current status of jaguars in some secondary areas; (2) there is no or little evidence of recent reproduction (within 10 years); and (3) quality and quantity of jaguar habitat is lower compared to core areas. Jaguar habitat is likely less optimal due to one or more or a combination of these variables important for jaguar presence, including increased human impact, smaller amount of contiguous habitat, different vegetation types, and lower prey populations. The Jaguar Recovery Team hypothesized that secondary areas may contribute to jaguar persistence by providing habitat to support jaguars during dispersal movements, by providing small patches of habitat (perhaps in some cases with a few resident jaguars), and as areas for cyclic expansion and contraction of the core areas (FWS 2012a).

Because such a small portion of the jaguar's range occurs in the United States, it is anticipated that recovery of the entire species will rely primarily on actions that occur outside of the United

States; activities that may adversely or beneficially affect jaguars in the United States are less likely to affect recovery than activities in core areas of their range (FWS 2012a:38). However, according to the proposed rule, specific areas within this secondary area that provide the physical and biological features essential to jaguar habitat can contribute to the species' persistence and, therefore, overall conservation. As described in the Recovery Outline for the Jaguar, the Northwestern Recovery Unit is essential for the conservation of the species; therefore, consideration of the spatial and biological dynamics that allow this unit to function and that benefit the overall unit is prudent. Providing connectivity from the United States to Mexico is a key element to maintaining those processes

ENVIRONMENTAL BASELINE - JAGUAR

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions that are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

In the environmental baseline analysis, we discuss the current condition of the critical habitat units in the action area, the factors responsible for that condition, and the conservation roles of the units. In particular, we discuss the relationship of the affected units in the action area to the entire proposed critical habitat with respect to the conservation of the jaguar.

Action Area

The action area is defined as the area within which effects to the listed species and its critical habitat (if any is designated) are likely to occur and is not limited to the actual footprint of the proposed action. The proposed project falls within the northern-most secondary area of the NRU, or the NMU, as defined in the Jaguar Recovery Outline (FWS 2012) and at least one jaguar has recently occurred near the project area. For the purposes of the jaguar analysis, we use the Forest Service ActionAction Area definition (i.e., defined by hydrology).

Terrain, Vegetation Communities, and Climate in the Action Area

The Action Area subsection of the Description of the Proposed Conservation Measures section, above, includes descriptions of the terrain, vegetation communities, and climate in the action area.

Status of the Species within the Action Area

Life History and Habitat

Life history of the jaguar is described above in the Status of the Species. Generally, life history elements are similar throughout their range, although some, such as diet and vegetation community use, vary by region (see Status of the Species).

Distribution and Abundance

Confirmed jaguar detections have recently occurred within and near the proposed project and action area. The detections were from trail cameras placed by resident hunters, the Arizona Game and Fish Department, and researchers from the University of Arizona – jaguar survey and monitoring project funded by the Department of Homeland Security via the U.S. Fish and Wildlife Service. All detections, captured by photographs at night, were located on lands administered by the Coronado National Forest within proposed critical habitat (Units 3 and 4). Analysis by jaguar experts of the comparison of rosette patterns concluded that the photographs are of the same male jaguar. The male jaguar photographed by a mountain lion hunter in the Whetstone Mountains (within proposed critical habitat Unit 4 – Whetstone Unit) in November 2011 was later detected in the Santa Rita Mountains (within proposed critical habitat Unit 3 – Patagonia Unit) by the trail cameras. Detections of this male jaguar have occurred in the Santa Rita Mountains from September 2012 to May 2013.

The Forest Service hypothesizes that this single resident male jaguar has established a territory that includes most of the Santa Rita Mountains (which includes the proposed action area) and possibly the Whetstone Mountains as well (from the June 2012 BA and February 2013 Supplemental BA). To move between the Whetstone and Santa Rita mountains, the male jaguar would have had to cross a two-lane highway, possibly State Route 83, although its exact movement pattern is unknown.

Threats

Threats to the jaguar in the action area are generally similar to threats to the species throughout its range as described under "Status of the Species"; however, in the United States, the threat of illegal killing is not currently thought to be a problem (FWS 2012a). Other threats to jaguars in this region are international border issues such as: (1) infrastructure along and near the U.S. - Mexico border, including pedestrian and vehicle barriers and towers and their associated roads and lighting; and (2) illegal and U.S. Border Patrol traffic (pedestrian and vehicle). Fences designed to prevent the passage of humans (i.e., pedestrian barriers) also prevent passage of jaguars. Other infrastructure (e.g., vehicle barriers, towers, roads, and lighting) and human activity may limit jaguar movement across the border, but it is uncertain if and how much this is affecting that movement. McCain and Childs (2008) identified open-pit mines as a threat to jaguars in the species core habitats in the southwestern U.S. specifically mentioning the Patagonia and Santa Rita mountains; this threat was reiterated in the BA. Connectivity to Mexico is essential for maintaining jaguars in the NMU in Arizona and New Mexico.

Proposed Critical Habitat within the Action Area as Defined by the Forest Service

Current Condition of Proposed Critical Habitat - The action area as defined by the Forest Service occurs within the Patagonia Unit (Unit 3) (Figure 2) which consists of 138,821 ha (343,033 ac) in the Patagonia, Santa Rita, and Huachuca Mountains, as well as the Canelo Hills, in Pima, Santa Cruz, and Cochise Counties, Arizona. The mountain ranges within this unit contain all primary constituent elements essential to the conservation of the jaguar.
A portion of the project is also located in the Whetstone-Santa Rita Unit (Subunit 4b) (Figure 2) which consists of 10,686 ha (26,406 ac) between the Santa Rita Mountains and northern extent

of the Whetstone Mountains in Pima County, Arizona. The Whetstone-Santa Rita Subunit may provide connectivity from the Whetstone Mountains to Mexico through Unit 3, was not known to be occupied at the time of listing (FWS 2012b),and is not known to have ever been used by jaguars.

Factors Responsible for the Current Condition of Proposed Critical Habitat - The Patagonia Unit was proposed as critical habitat because areas such as the Santa Rita Mountains contain the primary constituent elements essential to the conservation of the jaguar. In the jaguar habitat model developed for northwestern Mexico and the U.S.-Mexico borderlands area, Sanderson and Fisher (2011:11) described how low human influence is perhaps the most important feature defining jaguar habitat, as jaguars most often avoid areas with too much human pressure. The Santa Rita Mountains, where the proposed project is located, was identified by the model as having HII values between 14 and 18. As stated above, an HII value of 20 or less was the parameter identified as an essential component for the conservation of the jaguar in the United States.

According to the proposed rule, connectivity between the United States and Mexico is necessary if viable habitat for the jaguar is to be maintained (FWS 2012b). The intent of Unit 4b is to connect Unit 4a to Mexico via Unit 3, although connectivity is also provided through Subunit 4c, which is not affected by the proposed action. Jaguar habitat and the features essential to their conservation are threatened by the direct and indirect effects of increasing human influence into remote, rugged areas, as well as projects and activities that sever connectivity to Mexico. These may include, but are not limited to: significant increases in border-related activities, both legal and illegal; widening or construction of roadways, power lines, or pipelines; construction or expansion of human developments; mineral extraction and mining operations; military activities in remote locations; and human disturbance related to increased activities in or access to remote areas (FWS 2012b).

Conservation Role of the Proposed Critical Habitat Units – The FWS considers the Patagonia Unit 3 to have been occupied at the time of listing based on the 1965 record from the Patagonia Mountains. The Patagonia Unit is currently occupied based on the series of recent jaguar sightings in the Whetstone and Santa Rita Mountains (see above). The mountain ranges within this unit contain all primary constituent elements essential to the conservation of the jaguar. Connectivity between the United States and Mexico was referenced throughout the proposed critical habitat rule as essential for the conservation of jaguars. Therefore, the intent of the proposed rule was to provide connectivity of Unit 4a to Mexico through Unit 3 via both Subunits 4b and 4c.

Past and Ongoing Federal Actions in the Action Area

The respective Environmental Baseline sections for affected species describe completed consultations for past and ongoing Federal actions in the action area. Three projects have undergone formal section 7 consultation for effects to jaguar in southern Arizona,, but there have been no previous consultations on proposed critical habitat. Incidental take of one jaguar has been authorized and no jeopardy opinions have been issued. A summary of these consultations is below:

1. *Biological Opinion on Nationwide U.S. Department of Agriculture, Animal and Plant Health Inspection Service-Wildlife Services (USDA, APHIS-WS) Activities on the endangered Jaguar* (Consultation Number 000194RO issued on June 22, 1999)

This consultation analyzed the effects of USDA, APHIS-WS' national animal damage control activities on jaguars. Adverse effects to jaguars could occur from certain animal damage control methods, including the use of leg-hold and box traps, snares, M-44s, etc. We determined that the proposed action was not likely to jeopardize the continued existence of jaguars and anticipated that, due to animal damage control activities, there would be an undeterminable level of take as a result of harassment and injury, and the take of one jaguar as the result of direct injury or mortality. The anticipated level of take was considered to be exceeded if animal damage control activities are directed at jaguars, or if one jaguar is unintentionally trapped, injured, or killed. To minimize incidental take, a number of reasonable and prudent measures were included in the biological opinion. To date, no incidental take has been documented resulting from WS' program.

2. *Biological Opinion on the Pedestrian Fence Proposed Along the U.S. and Mexico Border near Sasabe, Naco, and Douglas* (Consultation number 22410-2007-F-0416 issued August 29, 2007)

This consultation addressed the effects of DHS's construction of a pedestrian fence (and other associated activities such as road construction and maintenance) along the U.S./Mexico international border near Sasabe, Pima County; Nogales, Santa Cruz County; and near Naco and Douglas, Cochise County. Some pedestrian fence segments that were constructed in these three areas were included in this consultation, while others did not undergo section 7 consultation. Specifically, pedestrian fence segments were constructed in Sasabe (7 mi, all of which were included in this consultation), Nogales (about 6 mi, roughly 2 of which were included in this consultation), Naco (about 25 mi, 15 of which were in this consultation), and Douglas (about 17 mi, 7 of which were included in this consultation). Adverse effects to jaguars were expected to occur from the proposed action by impeding jaguar movement between Mexico and the U.S., disturbing jaguars, and degrading their habitat. We determined that the proposed action was not likely to jeopardize the continued existence of jaguars and no incidental take was anticipated. Conservation measures, including funding for the implementation of jaguar recovery actions, were included to help offset the effects of the action on jaguars.

3. *Biological Opinion on Secure Border Initiative (SBInet) Tucson West Tower Project, Ajo, Tucson, Casa Grande, Nogales, and Sonoita Stations Area of Operation, U.S. Border Patrol, Tucson Sector, Arizona* (Consultation number 22410-2008-F-0373 issued September 4, 2008)

This consultation addressed the effects of the construction, operation, and maintenance of communication and sensor towers, roads, and mobile surveillance systems, as well as the deployment of unattended ground sensors. Adverse effects to jaguars were expected to occur from the proposed action by disturbing jaguars and degrading their habitat. We determined that the proposed action was not likely to jeopardize the continued existence of jaguars and no incidental take was anticipated. Conservation measures, including funding for jaguar monitoring, were included to help offset the effects of the action on jaguars.

In addition to the aforementioned activities, DHS/CBP has constructed a number of vehicle barriers and pedestrian fences in the action area that have not undergone formal consultation. Furthermore, CBP – Tucson Sector regularly conducts patrol activities within the action area that likely affect jaguar and, with the exception of patrol activities associated with the Tucson West Towers Project, have not undergone formal consultation.

Under section 10 of the Act, which prescribes permits for scientific purposes or incidental take while carrying out lawful activities, the following has been authorized for specific approved activities of the Arizona Game and Fish Department: 1) incidental take of one jaguar in the form of mortality or harm, and 2) unlimited take in the form of harass.

EFFECTS OF THE ACTION - JAGUAR

The effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR §402.02). Indirect effects occur later in time but are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR §402.02). In the effects of the action analysis, we also characterize the direct and indirect effects of the action and those of interrelated and interdependent actions on the proposed critical habitat. We describe how the primary constituent elements or habitat qualities essential to the conservation of the species are likely to be affected and, in turn, how that will influence the function and conservation role of the affected critical habitat unit(s).

Effects of the Action on the Jaguar

As analyzed at length in the BA, Supplemental BA, and Second Supplemental BA, and supported by additional analyses, below, the proposed project will result in degradation of jaguar habitat and disturbance to jaguars. Construction and operations of the mine, including the associated roads, will result in removal, destruction, and degradation of jaguar habitat and jaguar prey habitat and is likely to disturb jaguars, causing changes in, among other things, their habitat use and movement patterns. Conservation measures included in the project description may help offset adverse effects to jaguars to some extent.

1. Project Construction

The BA defines the project area (Figure 3) as all areas in which any ground disturbance would take place as a result of the proposed project, including the mine pit, waste rock piles, tailings, access roads, utility corridors, and on-site facilities (i.e., the mine “footprint” or area within the security fence plus roads, corridors, and trails). The project area acreage, expected to result in direct impacts owing to project activities, is 5,401 acres (22 km^2), which includes areas within the security fence (4,228 acres), the primary access road (226 acres), the utility line corridor (889 acres), new forest roads (39 acres) including the Sycamore connector road, and the rerouted Arizona National Scenic Trail (19 acres). Vegetation types within this area are Madrean evergreen woodland and semidesert grassland, both important vegetation types for jaguars in the

NMU. Therefore, the project will result in the direct removal of about 5,401 acres of jaguar habitat.

Although we do not know the home range size of jaguars in Arizona, considering jaguar home ranges in Sonora range from 84 to 100 km^2 (20,757 to 24,710 acres), an equivalent of about 0.22 to 0.26 (one quarter) of a jaguar home range may be directly impacted (eliminated) by the project footprint assuming no overlap in home ranges. Throughout most of the jaguar distribution, we know that home ranges most often overlap (Seymour 1989); however, we have not documented this overlap in Arizona so do not know whether the project footprint will impact additional jaguar home ranges. The definition of home range varies, but it is generally considered the area over which an animal normally travels, searches for food, and cares for young. Given the recent, continuous use of the Santa Rita Mountains by a male jaguar, we hypothesize that he has established a home range in the U.S. that encompasses these mountains. Due to loss of habitat and additional human disturbance near the project area (e.g. lights, noises, etc. - see below for further discussion), the male jaguar detected in the Santa Rita Mountains will most likely adjust its home range southward..

In addition to eliminating jaguar habitat, the project will also result in the direct removal of about 5,401 acres of jaguar prey habitat, leading to a reduced prey base for jaguars. According to AGFD (2012), the proposed project will result in the estimated loss of 14 white-tailed deer and 56 javelina, both key prey species for jaguar. This loss was calculated by multiplying the average density of these species per square mile by the total square miles directly impacted by the project. Also, while it did not take into consideration the potential indirect impacts (future) of the project on prey species, it likely did not consider the postclosure state of the project area, at which point only the mine pit may remain unsuited to thesese prey species.

Outside of the security fence, a perimeter barbed-wire fence will be constructed. The perimeter fence will encompass 66,990 acres of land; however, except where specific features such as the primary access and utility maintenance roads are located, the land between the perimeter fence and the security fence will not be disturbed. Given the influence of human and vehicular activity, noise, and lighting (see discussion below for information on effects of noise, lights, and traffic on jaguars) within the perimeter fence, we anticipate that jaguars will likely avoid most or all areas within the perimeter fence. If this is the case, then the mine will impact about 0.28 to 0.34 (one quarter to one third) of a jaguar home range.

Construction activities associated with all aspects of the project may disturb jaguars and cause them to flee and/or avoid the area, particularly jaguars that have established a home range in the area encompassing the mine such as we suspect the recently detected male has done. Dispersing jaguars or jaguars moving through the proposed project area may exhibit greater tolerance for some disturbance; however, we anticipate they would still generally avoid areas of high human influence. Once project construction is complete and operations are underway, jaguars would be excluded from the area as it will be devoid of habitat, as described above. Following operations, and presuming tailings piles are successfully revegetated, jaguars will be excluded from the pit area. Jaguar avoidance of the project area, particularly jaguars that have a previously established a home range in the area, may cause them to shift southward, possibly into less suitable habitat resulting in increased home range size, energy expenditure, and risk for encounters with humans, vehicles, potential competitors (i.e., cougars and other jaguars), and other stresses.

2. Lighting

In addition to the direct project footprint, jaguars that occur within the vicinity of the project may be adversely affected by light associated with the project; this likelihood was explored in detail in the Second Supplemental BA (USFS 2013a) The area in and adjacent to the project area currently is dark at night because there are few artificial light sources and no developed areas to affect night sky views or the natural light conditions and cycles that are important to native plants and animals. Although overall sky brightness has been studies (STEM Laboratory 2011) there is little other information on the current baseline light levels at night. According to the Forest Service, the majority of the action area (as defined by the Forest Service) is relatively dark on moonless nights; the Border Patrol Station near Sonoita does illuminate the sky (STEM Laboratory 2011), but the lights of the Station and greater Tucson metropolitan area are blocked by the surrounding topography in the project area (Monrad 2012). Background lighting in the action area comes from a number of sources, including headlights from vehicles traveling at night along SR 83 and along forest roads; adjacent private lands; mine exploration activity; and an existing limestone quarry (Imerys) located just west of the proposed mine. The Imerys quarry occupies approximately 22 acres and roughly twenty truckloads of materials depart the mine site each day (Green Valley Recreation Hiking Club 2013). According to the Green Valley Recreation Hiking Club, the mine operates 24 hours a day, seven days a week; however according to the BLM work occurs during the daytime only; however lights are operated 24 hours per day. The proposed action includes the use of night lighting which will originate from the mine site itself (i.e., a high level of mine-site illumination is needed for conducting mining operations, per Mine Safety and Health Administration standards) as well as from vehicle headlights on roads associated with the mine.

Although Rosemont Copper Company has developed a light pollution mitigation plan, artificial illumination will increase light levels at night, which could impact jaguars, resulting in a wide variety of effects, including, but not limited to changes in behavior, habitat use, and movement patterns; disruption of dispersal movements, corridor use, and circadian clocks; and increased deaths in collision on roads (Beir 1995, Longcore and Rich 2004, Beier 2006). Artificial lighting, which will be persistent at night for 20 years of operation plus a period of reclamation and closure, will originate from mine-site illumination and also from vehicles in the project area and beyond. Horizontal light will extend to at least 12 miles beyond the project, in some areas, and sky glow from the project is expected to be comparable, but less than, sky glow from Ajo, Arizona (a town of about 3,300 people) (WestLand Resources, Inc, 2012). The light intensity will be highest at the mine and attenuate farther from the mine. Many areas within a 12-mile radius will be blocked from line of sight horizontal light emanating from the project area (WestLand Resources, Inc, 2012) (Figure 4); however, jaguars are mobile animals that travel over hills and ridgetops, and therefore would likely see the lighting (horizontal) during regular movement activities or during dispersal. Additionally, sky glow will likely be visible to jaguars in the vicinity of the mine at all times of night. In addition to the lighting from the proposed action, the active mine known as Imerys Quarry will also contribute to nighttime lighting (see Figures 5 and 6).

Although the specific effects of artificial lighting on jaguars are not known, the effects of human disturbance and artificial night lighting on large felids have been documented by several studies.

Beier (1995) for example found dispersing pumas (*Puma concolor*) avoided night-lights in conjunction with open terrain, suggesting that pumas were moving away from city lights and urban glow and navigating toward the darkest horizon. Ngopresert *et al*.'s (2007) regression model showed that leopard (*Panthera pardus*) habitat use increased with distance from human settlements. In addition, a manual on the problem of depredation caused by jaguars and puma on cattle ranches states that the installation of lights in livestock corrals is a useful measure to deter jaguars from killing livestock (Hoogesteijn 2010). Although lighting intensity in a corral would likely bemore intense than the lighting spillingspilling outside the perimitter fence, the above studies suggest some avoidance of lighted areas by large felids.

Because jaguars are extremely secretive and generally avoid human-disturbed areas, we anticipate that the jaguar may be reluctant to regularly use areas wherever horizontal light and possibly sky glow from the mine is visible. It is difficult to understand how sky glow may be perceived by jaguars; however according to the DEIS, nocturnal animals may be adversely affected by the light glow in night skies (USDA 2012:5). Sky glow may increase the ambient illumination in the area, which we anticipate could adversely affect jaguars to some degree.
In conclusion, while much of the light will be confined to the pit area and thus minimally affect jaguars, the additional escaped horizontal lighting and sky glow may have an impact on jaguar movements. Jaguars may curtail their movements around the mine due the influence of nighttime lighting. If they do attempt to go through the narrower corridor between the two mines, movement may be made more difficult due to the existing topography between the proposed mine and the Imerys mine. In areas with rugged terrain, large carnivores' (including jaguars') travel patterns generally follow canyon bottoms and ridgelines (Beier 1995). Consistent with Beier's findings, Dickson *et al*. (2005) found that cougars consistently used travel paths that were less rugged than their general surroundings. This suggests that individuals consider the energetic cost of alternative paths; hunting or traveling individuals minimize energetic expense by frequenting landscape features that cost the least. Based on the aforementioned information, jaguars moving through or within the proposed project area likely follow the numerous canyon bottoms occurring throughout the area within the proposed perimeter fence. The canyon bottoms and ridgelines in the aforementioned constricted corridor between the proposed mine and Imerys mine, however, generally run north-south, meaning that, after project construction, if a jaguar attempted to move through the corridor it would likely have to travel perpendicular to its normal travel patterns (i.e., up and down slope faces instead of via canyon bottoms and ridgelines). However, while this travel pattern could result in increased energetic cost to jaguars, jaguars are known to move large distances in rugged terrain, so this topography would not present a barrier to jaguar movement. Because areas immediately south of the mine contain habitat less suitable for jaguars (i.e. closer proximity to Sonoita, SR 83, vegetative considerations), it is less likely that jaguar will move around the mine to the south.

3. <u>Noise</u>

In addition to lights, jaguars that occur within the vicinity of the project may also be adversely affected by noise associated with the project. There will be increased noise associated with the proposed project due to construction,machinery, vehicle traffic, and blasting. Blasting will typically occur once a day and be limited to daylight hours. Some noise- management techniques and operational tools to minimize noise generated during mine operations have been incorporated into the project design.

The nature of anthropogenic noise is multifaceted and complex in terms of how it affects wildlife. Noise is typically presented in terms of decibels (dB), and for the majority of noise assessments, including the one completed for the proposed project (Tetra Tech 2008, 2009c), it is quantified in terms of dBA, which is an "A-weighted" sound level scale that more closely describes how a person perceives sound. Thus, the sound level when defined as dBA does not always transfer to wildlife since species groups have different hearing sensitivities and ranges (Pater *et al*. 2006). Weighting is species-specific, and received sound levels depend on many factors (e.g., distance from source to receiver, source emission strength, source directivity, atmospheric attenuation, terrain, ground cover, weather, and frequency energy) (Pater *et al*. 2009).

According to the WestLand Resources, Inc. November 9, 2012, memo, much of the maximal intermittent equipment noise associated with the project will be within the perimeter fenceline, with the exception of low noise contours (30-40 dBA) that extend to the south across Box Canyon Road (Tetra Tech 2009). Blasting will generate brief maximum noise levels that would drop from about 52 to 57 dBA at three (3) miles from the Open Pit to about 41 to 47 dBA at locations six (6) miles from the center of the proposed Open Pit, and to 36 to 42 dBA at eight (8) miles from the center of the Open Pit. These noise levels would be comparable to or less than the maximum noise levels of 55 to 60 dBA that currently occur several times per hour during daytime periods (Tetra Tech 2009). Noise levels (measured in dBA) associated with increased traffic volumes on SR 83 are predicted to increase, but it is not known how these will be perceived by jaguars. Increased noise levels due to traffic on the Sycamore connector road and the primary and utility maintenance roads, as well as possible increased traffic on Box Canyon road were not analyzed.

Noise from construction and operation of the mine, including blasting and vehicle noise, is anticipated to disrupt jaguars' normal movement patterns, possibly causing, among other things, changes in home range (size and location), habitat use, activity, foraging patterns and increased stress response. (NoiseQuest 2013; Pater *et al*. 2009). As stated above, jaguars selectively use large areas of relatively intact habitat away from certain forms of human influence (Zarza *et al*. 2007, Monroy-Vichis *et al*. 2007) and are therefore likely to avoid human disturbance such as noise produced by the proposed project. As with lighting, the magnitude of impacts from noise is uncertain, but these impacts are expected to decrease as the distance from the mine increases. In the same or similar manner that noises affect jaguars, these anthropogenic disturbances may also adversely affect jaguar prey, leading to a reduced prey base for jaguars. Sawyer *et al*. (2006) reported mule deer were significantly more likely to select habitat away from noise producing oil and gas developments. Barber *et al*. (2009) document the costs of chronic noise exposure for terrestrial organisms and state that animal responses probably depend upon the intensity of perceived threats rather than on the intensity of noise. So, while the project will directly impact and result in the permanent estimated loss of 14 white-tailed deer and 56 javelinas, we anticipate the project may also result in changes in prey distribution.

4. <u>Roads and Utility Maintenance Corridor</u>

The detrimental effects of roads have been reported for a wide variety of large carnivores (Noss *et al*. 1996). Because large carnivores occur at low densities and have low reproductive rates, the effects of human disturbance are often magnified (Kerley *et al*. 2002). Roads are a serious threat to many large-carnivore populations because they can lead to increased mortality from vehicles strikes, disturbance, habitat fragmentation, access for legal or illegal harvest, and decreased prey numbers or changed prey distribution (Murphy 1983, Beier and Barrett 1993, Caso 1994, Menke and Hayes 2003, Colchero *et al*. 2010). The effects of roads can vary among large carnivore species and among sex and age classes within species. Colchero *et al*. (2010) note that jaguars move preferentially to undisturbed forests and that females avoid moving close to roads and to areas with even low levels of human occupation, while males also avoid roads, but to a lesser degree. According to Conde *et al*. (2010), female jaguars avoided roads while males appeared less likely to avoid them. Monroy-Vichis *et al*. (2007) report that jaguars occur with greater frequency in areas relatively distant from roads and human populations. Zarza *et al*. (2007) report that towns and roads have an impact on the spatial distribution of jaguars (jaguars used more frequently than expected by chance areas located more than 6.5 km from human settlements and 4.5 km from roads). However, inin recent times, male jaguars in Arizona are known to have crossed roads, including two lane highways in Arizona.

Vehicle strikes are a significant source of mortality for some felid populations (Beier and Barrett 1993, FWS 2010). For example, in the Santa Ana Mountain Range in Southern California, vehicle collisions are the leading cause of mortality of cougars, comprising 32% of all deaths of radiotagged cougars and their offspring (Beier and Barrett 1993). Less is known about the level of mortality of jaguars caused by vehicle strikes. Jaguar road kill has been documented (Colchero *et al*. 2010), but not in the U.S.

Pursuant to the Forest Service's first supplemental Biological Assessment, no major paved roads are expected to be built to accommodate the mine, but the nearby major road (State Route 83) will experience an increase in traffic, and problems associated with traffic, such as more cars, more lights, more trucks, closer distance between vehicles, and so on. Mine-related traffic on SR 83 during operations will primarily consist of trucks carrying supplies to the proposed project, trucks carrying concentrate from the proposed project, and employee traffic. A summary of mine-related truck traffic reports that 69 truck trips per day (455 per week) will occur on SR 83 and the primary access road for the life of the project. This does not include other forms of vehicular access, such as by mine staff entering and leaving the site. The largest concentrated volume of mine traffic during a 24-hour period will occur during workforce shift change which will vary between 6 a.m. to 8 a.m. and 4 p.m. to 6 p.m. Vehicular use of SR 83 associated with the proposed project is anticipated day and night, although according to Rosemont, heavy vehicular use of SR 83 and primary access road generally will not occur at night.

Traffic during the pre-mining phase will use SR 83 and existing Forest Road 231 to access the project area until the new primary access road is constructed. This may require an upgrade to Forest Road 231 within the existing easement, in addition to an upgrade of the entrance to SR 83. At the intersection of SR 83 and the primary access road (see below), SR 83 will be widened and provided with additional lanes. As anticipated by the Forest Service in the BA, to accommodate such increases in traffic, additional portions of SR 83 may need to be upgraded. If this occurs, SR83 may further fragment jaguar habitat and lead to an increased risk of vehicle collision with jaguars. Additionally, if travelers attempt to avoid heavier traffic on SR 83, they may use Box Canyon Road as an alternative route. Increased traffic on SR 83 (regardless of widening) and possibly on Box Canyon will lead to an increased risk of jaguars being struck by vehicles.

However, because jaguars in Arizona are scarce and no jaguars are known to have been struck by a vehicle in Arizona, it seems unlikely that there is great risk of vehicles striking jaguars on either road.

While we are aware that male jaguars will cross roads, increased traffic on SR 83 may also lead to increased avoidance of areas near the road which may prevent them from crossing the road and using habitat on either side (Monroy-Vichis *et al*. 2007, Zarza *et al*. 2007, Conde *et al*. 2010). After mine closure and reclamation/restoration activities end, the mine should cease being an influence on traffic on SR 83 and Box Canyon Road.

Increased vehicular traffic on these roads will also likely lead to increased collisions with jaguar prey. Rosemont will monitor road-kill weekly on SR 83, adjacent to mine site, from the northern extent of currently proposed critical habitat to Gardner Canyon Road, to assess loss of jaguar, ocelot, or jaguar prey base (white-tailed and mule deer, javelina, and white-nosed coati, in particular). Monitoring will begin at the commencement of mine construction and continue through the second year of mine operation, a total of four years.

The primary access road to the mine will be a newly constructed, two-lane paved road which will provide access to SR83 see (Figure 3). During mine operations, the primary access road between the perimeter fence and the mine will be closed to the public; however, after mine closure, it will be open to public use. The primary access road will experience all mine-related traffic and some level of public use while the mine is in operation. Once operations have concluded and the primary access road between the perimeter and security fences is opened to public use, it will experience an unknown, but likely small level of vehicular use. Although we anticipate that jaguars will generally avoid the project area due to human disturbance associated with the mine, operation of this new road may increase the likelihood of vehicle collisions with jaguars. However, because jaguars in Arizona are scarce and no jaguars are known to have been struck by a vehicle in Arizona, it seems unlikely that there is great risk of vehicles striking jaguars on the primary access road. Vehicles couldcould collide with potential jaguar prey; however, we do not anticipate it will have a significant impact on the jaguar prey base. The road will fragment suitable habitat between the mine footprint and areas to the north (Figure 3). However, we anticipate jaguars will avoid most or all areas within the perimeter fence given the human influence between the project footprint and perimeter fence.

The utility maintenance road, located within the utility corridor (Figure 3) to serve as access to the power supply line, water supply line, and water booster pump stations, crosses through semidesert grassland northwest of the mine. Vehicle traffic on this road is expected to be much lighter in comparison to that on the primary access road. Therefore, we anticipate the chance of vehicles colliding with jaguars is even lower than on the primary access road. The road will be closed to the public during mine construction and operation; however, after the mine is closed, portions of the road may be reopened to the public. Because we do not know if it will be reopened or, if reopened, the extent of public use that will occur on the road, it is impossible to predict the effects to jaguars that may occur from this road in the future. That said, in general, roads can lead to increased public access to areas, in this case to areas of jaguar habitat, which could lead to somewhat increased 1) disturbance to jaguars in the area2) habitat degradation, 3) risk of human-caused fire, and 4) risk of illegal killing of jaguars and their prey. Additionally, the public may illegally use the road during mine operations and thereby increase the risk of the four aforementioned threats to jaguars. The Forest Service has indicated that illegal off-road vehicle use has been a problem for the Imerys mine.

The Sycamore connector road (Figures 3 and 5) will be a new road constructed from a point on the primary access road outside the north edge of perimeter fence, to connect with National Forest System Road (NFSR) 4050-0.36R-1 (which intersects NFSR 4050 about 0.3 mile farther west). NFSR 4050-0.36R-1 is a road that traverses the aforementioned narrowed corridor between the proposed mine and Imerys mine. Per the Forest Service, the Sycamore connector road is needed because the proposed perimeter fence will cut off legal public access to NFSRs in the Sycamore Canyon area, north of the project area. The Sycamore connector road will be about 12,184 feet long (2.3 miles) and impact about 26 acres. The NFSRs in Sycamore Canyon currently connect to public roads out the bottom (north) end of the canyon. However, the roads cross numerous private ownerships, and a public easement for the road does not exist. Public access from this direction into Sycamore Canyon is thereby controlled by these private landowners. While public access is sometimes granted, it cannot be guaranteed. Constructing the Sycamore Connector Road as a NFSR will continue to provide legal public access to the roads that currently exist on Forest Service lands in this area. Improved accessibility in this area will likely result in increased public access to jaguar habitat which may lead to an increase in the four aforementioned threats above plus increased human presence in remote areas (i.e., roads may facilitate increased off-road vehicle and pedestrian traffic in the area). Likely increased traffic and resulting human disturbance would occur in an area already narrowed by the proposed project (i.e., between the proposed mine and Imerys mine).

Disturbed ground will be susceptible to colonization by invasive nonnative plants such as buffelgrass and Lehmann lovegrass. Nonnative species may out-compete native species and the introduced grasses also carry fire better and burn hotter than the native species, which would degrade jaguar habitat. We note, however, that the proposed action's invasive species management plan includes a goal to manage invasive plants (see Invasive Species Control Plan, above, and Appendix B to this BO)..

5. Increase in Human Disturbance

As stated above, jaguars avoid areas of human activity. The project and action areas could subjectively be classified as relatively unpopulated; the action area has a low human density and contains no large communities. The major road in the vicinity is SR 83 immediately east of the project area, a paved two-lane highway between Sonoita and the Tucson metropolitan area. A certain level of recreation already exists in the area and thus, the primary adverse effect from an increase in human disturbance to the jaguar will be from the activities associated with the mine such as human presence, machinery, lighting, noise from blasting, and increased vehicles using SR 83. Due to the construction of two access roads and a connector road, there will be an increased possibility of legal and illegal access to the area which increases the risk of threats to jaguars as described above.

In the same or similar manner that human activity affects jaguars, this anthropogenic disturbance may also adversely affect jaguar prey, leading to a reduced prey base for jaguars. So, as stated above, while the project will directly impact and result in the estimated loss of 14 white-tailed deer and 56 javelinas during the mine's active construction and operation period; this may include additional impacts to prey due to increased human disturbance and possible increased legal and illegal access to the area. Upon conclusion of mining, and presuming that revegetation is effective over the long term, the area-based prey base losses will be reduced to only those attributable to the pit.

Effects of the Action on Proposed Critical Habitat

Role and definitions of occupied (at the time of listing) versus unoccupied (at the time of listing) critical habitat

According to the proposed rule, the conservation role or value of jaguar critical habitat (both occupied and unoccupied at the time of listing) is to provide areas to support some individuals during transient movements by providing patches of habitat (perhaps in some cases with a few resident jaguars), and as areas for cyclic expansion and contraction of the nearest core area and breeding population in the Northwestern Recovery Unit (FWS 2012b). As explained in the proposed rule (FWS 2012b), occupied critical habitat requires all PCEs to be present; however if PCE 1 (connectivity to Mexico) is not present, then it must be provided by an unoccupied unit. Per the proposed rule, unoccupied critical habitat (i.e., areas essential for the conservation of jaguars outside of occupied areas) does not require the presence of all PCEs; however it must 1) connect an area that may have been occupied that is isolated within the United States to Mexico, either through a direct connection to the international border or through another area that may have been occupied; and 2) contain low human influence and impact, and either adequate vegetative cover or rugged terrain.

The effects of the action on proposed critical habitat, including each of the primary constituent elements, are discussed below.

Overarching requirement for jaguar critical habitat

<u>Expansive open spaces in the southwestern United States of at least 84 to 100 square kilometers (32 to 37 square miles; 20,757 to 24,710 acres)</u>

The proposed action will impact open spaces because the security fence will encircle and directly, though temporarily, affect 3,102 acres of proposed critical habitat in Unit 3 and the roads will directly affect (permanently remove) 504 acres within Unit 3 and 50 acres in Unit 4b (a total loss of 3,656 acres). This represents a relatively long-term loss of 1.1% of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.44% of all proposed critical habitat rangewide. Outside of the security fence, a perimeter barbed-wire fence will be constructed. The perimeter fence plus roads outside the fence will impact 5,349 acres of land within Unit 3 and 50 acres within Unit 4b (total of 5,399 acres). This represents an impact to 1.6% of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.64% of all proposed critical habitat rangewide. Except where specific features such as the primary or secondary access roads are located, the land between the perimeter fence and the security fence will not be physically disturbed. However, given the influence of human and vehicular activity, noise, and lighting (see discussion above for information on effects of noise, lights, and traffic on jaguars) within the perimeter fence, we anticipate that jaguars will likely avoid most or all areas within the perimeter fence. Although the proposed action will diminish the amount of expansive open space in Unit 3, it will still contain sufficient open space to retain its function (i.e., the proposed project will not reduce the remaining size of Unit 3 to less than 84 km^2).

Primary Constituent Elements

PCE 1: Connectivity to Mexico

The location of the proposed project in the northern portion of Patagonia Unit 3 would restrict connectivity between Patagonia Critical Habitat Unit 3 and the Whetstone-Santa Rita Subunit 4b which, as stated in the proposed critical habitat rule (FWS 2012b), may provide connectivity from the Whetstone Mountains to Mexico via the western portion of Unit 3 (see Figure 5 below above). We note, however, that no jaguar has ever been documented using Subunit 4b, and that other, more direct connectivity to Mexico would be through Subunit 4c (which also does not have documented jaguar occurrence records). The mine (measured from the edge of the perimeter fence) would constrict the connection within proposed critical habitat between Unit 3 and Subunit 4b to a strip approximately 1.5 km (0.93 mi) in width from its present minimum width of 3.6 km (see Figure 8 below). The 1.5 km area of semidesert grassland would thus be between the existing mine (Imerys Quarry) and the proposed action.

As explained above under Effects of the Proposed Action on the Jaguar, a portion of this 1.5 km bottlenecked area will be impacted by noise, lights, vehicle traffic, and human recreation from the proposed project, making it less likely that jaguars will travel through the area. Refer to figures 4, 5 and 6 in the December 7, 2012 WestLand Resources report on the potential effects of lighting from the Rosemont project for a depiction of simulated light levels within jaguar critical habitat (Figure 6 from this report is included below as Figure 4). Furthermore, construction and operation of the Sycamore connector road will ensure legal (to the extent that current access involved private lands) public access (vehicle and pedestrian) to the 1.5 km constricted corridor. The direct (noise, lights, dust) and indirect effects (likely increased public access and resulting increase in threats to jaguars) of this road will likely further reduce the likelihood that jaguars will travel through the narrowed corridor between the proposed mine and critical habitat. The secondary access road, although not situated in the narrowest corridor, will be constructed/reconstructed across a narrowed portion of the corridor between the mine and edge of critical habitat and may permit modest increases in access (in that current access involves private lands). The effects of this road (presence and use) will likely further reduce the likelihood that jaguar will travel through the corridor between the mine and critical habitat. If jaguars avoid movement through this narrowed corridor, they will be unable to move from the Whetstones to Mexico via subunit 4b.

Figures 3, 4, and 5 from Tetra Tech (2009) depict the noise contours of surface blasting, pit blasting, and construction, respectively, and are included here as Figures 9, 10, and 11. Some level of increased sound will enter the corridor between the proposed action and the Imerys Quarry. We reiterate that Tetra Tech (2009) stated the modeled noise values will not exceed current noise maxima at the site, but also that jaguars' hearing sensitivities and ranges may differ from humans (Pater *et al*. 2006).

As explained above, we acknowledge that the effects of human influence from the proposed project may reduce the likelihood that jaguars will move through the corridor between the two mines. However, we do not have enough information on the ability of jaguars to move through habitat affected by human influence in Arizona to determine definitively whether or not a jaguar will move through the constricted corridor between the mines. Depending on jaguar response to the mine (i.e., if they will move through the constricted corridor or not), the possible effects to critical habitat from the proposed project would vary. For example, if jaguars will move through the constricted corridor, then the most significant effects of the proposed project would stem from the direct loss of critical habitat acres due to the project footprint. However, if jaguars will not move through the constricted corridor, then the role of Unit 4b, as defined in the proposed critical habitat rule (i.e., to connect Unit 4a to Mexico via Unit 3) would be lost, in addition to the direct loss of critical habitat from the project footprint. That said, connectivity of Unit 4a to Mexico would still exist via Unit 4c. Further, there is no evidence that jaguars ever have used this area for travel and we cannot speculate whether they will use this area for travel in the future.

At this time, we are uncertain which direction a jaguar may move to travel between the Whetstone Mountains and Mexico (i.e., via 4b or 4c), therefore, maintaining all critical habitat that allows for this movement could be important to jaguar conservation. We note that jaguar movement in the U.S. is poorly understood, but also that no established movement pathways have been documented here. However, if the constricted corridor creates a barrier to jaguar movement, the function of the northern portion of Unit 3 (i.e., the portion of Unit 3 from the constricted corridor to Unit 4b) would also be lost because the habitat patch would be reduced to a size below 84 km^2 (this would affect the overarching critical habitat requirement discussed above). Again, however, the remaining portion of Unit 3 (i.e., south of the mine) would still remain functional.

PCE 2: Adequate levels of prey species

Please refer to the discussion of this effect under the Effects of the Proposed Action on the Jaguar section, above.

PCE 3: Surface water sources within 12.4 miles (20 km) of each other

In the action area (as defined by the Forest Service) perennial streams are known to exist at Box Canyon, Empire Gulch, and Cienega Creek; all of these are intermittent during dry periods (early summer low flow and drought) but tend to have some pools remaining. There are several named ephemeral streams (e.g., Barrel, McCleary, Scholefield, Wasp, and Davidson Canyons), numerous constructed waters (primarily stock tanks and drinkers), and some seeps with surface water in the project and action areas.

All surface water will be eliminated within the footprint of the mine and thus impact PCE 3. As a result of groundwater drawdown after the life of the mine, the amount or volume of water within regional perennial pools could decrease, which could result in indirect effects on PCE 3. Disruptions of surface water flow resulting from the capture of runoff in the pit are expected to occur along the Barrel Canyon drainage through Davidson Canyon to its confluence with Cienega Creek. Groundwater flow models were designed to simulate conditions prior to pit development, during pit dewatering, and for a 1,000-year post-closure period of groundwater level recovery and potential pit lake development (Montgomery and Associates 2010; Tetra Tech

2010c), and it was determined that groundwater level drawdown could result in the dewatering of streams, seeps, and springs, which may serve as water sources for jaguars. Uncertainties in the variables used to build the models, however, could be manifested as greater reductions of groundwater and greater impact to surface water levels (e.g., lower water level, more extensive dry reaches) and riparian vegetation than modeled. Conversely, impacts may not prove to be as severe. The timing and amount of groundwater drawdown at Box Canyon–Dam Structure, Ophir Gulch Well, and South Sycamore Canyon have not been modeled, but not specifically reported beyond the groundwater contour information in Tetra Tech (2010c), Montgomery (2010), and Myers (2010) and displayed in SWCA (2012) (citations refer to the Effects to Aquatic Ecosystems section). These impacts could be more pronounced during periods of low flow (May and June) because even small flow reductions could cause some portions of Cienega Creek, or other aquatic areas, to stop flowing. These modeled decreases in groundwater (less than 1 foot) would occur over a long period of time but could cause changes in riparian vegetation extent or health; if there are reductions in stream flow in a large area, this could impact jaguars, which need free-standing water sources within 20 km of each other. The Water Source Enhancement mitigation measure, however, calls for seven already-located and 23 not-yet-located water sources to be installed or enhanced. Should these sites be advantageously situated, they could prevent the 20 km distance from being exceeded.. .

Although the amount of available water will be reduced by the proposed action, there is no indication that PCE 3 will be reduced to a level that water will not be available in any 20-km area. Because of the numerous water sources such as stock tanks and drinkers, PCE 3 will not be reduced to below the threshold established in the proposed critical habitat rule. Further, Rosemont will ensure that restored or replaced springs within jaguar critical habitat are constructed in accordance with jaguar PCEs for surface water (see Proposed Conservation Measures and their effects, below.).

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PCE 4: Madrean evergreen woodland or semidesert grassland vegetation community between 3 to 40 percent canopy cover and

Within the project area (as described in the BA and above) and most of the action area (as described in the BA), the vegetation community is composed of semidesert grassland and Madrean evergreen woodland. The only part of the project area not in this vegetation type is along the spine of the mountains, where some rock outcrops and talus slopes may have less than 3% cover. The area also contains moderate to highly rugged terrain. The proposed action will affect PCE 4 within the project footprint because the security fence will encircle and directly affect and remove (for the construction and operational life of the mine) 3,102 acres of proposed critical habitat in Unit 3 and the roads will directly affect (permanently remove) 478 acres within Unit 3 and 50 acres in Unit 4b. This represents a relatively long-term loss of 1.1% of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.43% of all proposed critical habitat rangewide. Outside of the security fence, a perimeter barbed-wire fence will be constructed. The perimeter fence plus roads outside the fence will impact 5,323 acres of land within Unit 3 and 50 acres within Unit 4b. This represents an impact to 1.6 % of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.64% of all proposed critical habitat rangewide. Except where specific features such as the primary or secondary access roads are located, the land between the perimeter fence and the security fence will not be disturbed.

PCE 5: Moderate to highly rugged terrain

The area also contains moderate to highly rugged terrain. During operations, effects to ruggedness will be immaterial relative to effects to PCEs 2 (prey) and 6 (human disturbance). The proposed actions permanent effect to ruggedness, assuming the extent of the PCE related to vegetative cover (PCE 4) is adequately addressed by reclamation and revegetation, is primarily within the pit which, while topographically rugged, will be permanently excluded from access.

PCE 6: Little human influence or disturbance

This PCE was developed using research that highlights the fact that jaguars generally avoid areas of human activity. Pursuant to the proposed rule, an HII of 20 or less is an essential element of PCE 6. Specifically, this PCE includes minimal to no human population density, no major roads, and no stable nighttime lighting over any 0.4-square-mile (1-km^2) area (FWS 2012b). The proposed project and action areas currently have a low human density and contain no large communities. The proposed project is currently in an area with an HII values between 14 and 18.

As described below, as a result of the proposed project, overall human influence and disturbance (from roads, lights, etc.) will increase which will likely remove PCE 6 from the project area and a portion of the action area. Although the level of human influence will increase, at this time we cannot quantify the extent by which the HII will be affected due to the complicated way a number of variables interact to create HII. For example, road density is a component of HII, but we cannot determine if the existing roads in the area (i.e. the current Sycamore Canyon access), already drive observed human disturbance to the same extent that the proposed Primary Access Road will. Similarly, although overall human influence and disturbance will increase within the areas between Imerys Quarry and the proposed action, we do cannot determine the resulting value of the HII in that area.

As described above, primary and secondary access roads and the Sycamore connector road will be constructed as part of the proposed project. The physical construction of these roads and their associated traffic, as well as likely increased public access to and use of areas around the mine (due to the roads), will further contribute to increased human influence in the area, and possibly increased HII. Additionally, increased traffic on SR 83, possible upgrades to SR 83 (as described above), and possibly on Box Canyon will further contribute to increased human influence in the area, and possibly increased HII. Increased traffic on SR 83 may further limit jaguar access to the northern portion of Unit 3 via 4b. Lighting from the proposed mine, as discussed in detail under the Effects of the Proposed Action on Jaguar, will result in increased horizontal lighting and sky glow in jaguar habitat, will further contribute to increased human influence in the area, and possibly result in increased HII.

The presence of a jaguar in the action area in 2012 and 2013 suggests that the amount of ambient light present is not great enough to repel the jaguar, indicating the area is currently "dark enough" for jaguars. It also suggests that the current HII is currently "low enough" for jaguars. The September 2012 camera detection of the jaguar was particularly close to the proposed mine site and was approximately 6.4 km (4 mi) away from the existing mine (Imerys). However, once the proposed action is in place, jaguars may avoid the area between the proposed mine and the

Imerys mine because of the decreased width of the corridor and increased human disturbance (roads, lighting, etc.), which may further functionally narrow the corridor.

Summary of Effects to PCEs

In summary, the mine's project footprint will adversely affect all PCEs (i.e., connectivity to Mexico, prey, surface water, canopy cover, rugged terrain, and little human influence) to some degree in the northern portion of Unit 3 for 25+ years. Many PCEs outside of the project footprint but within portions of the action area will also be indirectly adversely affected by the proposed project (from increased lighting, noise, traffic, human use, etc.). While the extent to which jaguars will traverse the constricted connection within proposed critical habitat between Unit 3 and Subunit 4b is unknown, it is reasonable to conclude that access through this area will be hampered to some extent. We reiterate, however, that we are unable to predict whether jaguars will use this connection between the Whetstones and Santa Ritas. If jaguars will not move through this constricted corridor, then the role of Unit 4b, as defined in the proposed critical habitat rule (i.e., to connect Unit 4a to Mexico via Unit 3) would be lost. That said, connectivity of Unit 4a to Mexico would still exist via Unit 4c. Additionally, if the constricted corridor creates a barrier to jaguar movement, the function of the northern portion of Unit 3 (i.e., the portion of Unit 3 from the constricted corridor to Unit 4b) would also be lost because the remaining habitat patch north of the proposed action would be reduced to a size below 84 km^2 (this would affect the overarching critical habitat requirement discussed above). Again, however, the remaining portion of Unit 3 (i.e., south of the mine) would still remain functional. The direct loss of critical habitat (in Units 3 and 4b) and possible indirect loss of critical habitat (in Units 3 and 4b) will somewhat reduce the conservation value of those critical habitat units for the jaguars.

Effects to the Conservation Value of Critical Habitat with the Proposed Action

Critical habitat is defined as: (1) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) Essential to the conservation of the species and (b) Which may require special management considerations or protection; and (2) Specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. Conservation, as defined under section 3 of the Act, means to use and the use of all methods and procedures that are necessary to bring an endangered or threatened species to the point at which the measures provided under the Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking.

Specific areas within the U.S. that provide the physical and biological features essential to jaguar habitat can contribute to the species' persistence and, therefore, overall conservation by providing areas to support some individuals during dispersal movements, by providing small patches of habitat (perhaps in some cases with a few resident jaguars), and as areas for cyclic expansion and contraction of the nearest core area and breeding population in the NRU. As such, critical habitat was developed to allow the above functions to occur. Specifically, as explained above, critical habitat for the jaguar was defined as expansive open spaces in the southwestern United States with adequate connectivity to Mexico that contain a sufficient native prey base and available surface water, have suitable vegetative cover and rugged topography to provide sites for resting, and have minimal human impact (FWS 2012b). These areas are limited within the U.S. and therefore have an important conservation role for the jaguar.

Unit 3 connects with Mexico in two separate areas, through the Huachuca and Patagonia Mountains. Unit 4 contains three subunits (4a, 4b, and 4c), one of which (4a) was considered occupied at the time of listing. According to the proposed rule, the Whetstone-Santa Rita Subunit (4b) and Whetstone-Huachuca Subunit (4c) are essential to the conservation of the jaguar because they provide connectivity from the Whetstone Mountains to Mexico (FWS 2012b). Both 4b and 4c were included in critical habitat because we do not which route(s) are most conducive to providing the connectivity function. We also have no records that either Subunit has ever been used for this purpose by jaguars. Because we cannot predict which way jaguars may move between the Whetstones and Mexico, either or both subunits may be important to the conservation of jaguars in the NRU.

The loss of proposed jaguar critical habitat within the project footprint and partial loss of PCEs within portions of the action area (as described above) reduces the conservation value of Unit 3 by reducing the amount of area that may support: (1) some individual jaguars during dispersal movements, by providing small patches of habitat (perhaps in some cases with a few resident jaguars); and (2) cyclic expansion and contraction of the nearest core area and breeding population in the NRU. That said, the majority of Unit 3, and therefore its conservation value, will not be affected by the proposed action.

Although we do not know if a jaguar will move through the constricted corridor between the proposed mine and the Imerys mine, if they cannot the role of Unit 4b, as defined in the proposed critical habitat rule (i.e., to connect Unit 4a to Mexico via Unit 3) would be lost, but connectivity of Unit 4a to Mexico would still exist via Unit 4c. However, the integrity of the critical habitat complex comprised of Units 3 and 4 will be weakened to some extent.

This possible reduction in function of Subunit 4b and partial loss of function of Unit 3 will somewhat diminish the conservation value of critical habitat as a whole. As explained above, areas that provide the primary constituent elements essential to jaguar habitat are limited within the U.S. and therefore have an important conservation role for the jaguar. Losing portions of these areas (i.e., critical habitat areas), as is likely to occur with the proposed project, reduces the ability of critical habitat to function as intended by the proposed rule. That said, the majority of critical habitat will be unaffected by the proposed action and will therefore retain its function and conservation value. Further, the effects of the action on the proposed critical habitat will not considerably reduce the capability of critical habitat to be used in a way such that research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping and transplantation and other similar conservation measures are precluded.

Effects of the Action on Proposed Critical Habitat in Relation to Recovery

As described above in the Status of the Species, a draft recovery plan for the jaguar has not been finalized, thus no recovery criteria exist to date to be used in this opinion. However, the 2012 Recovery Outline for the Jaguar developed eight "recovery objectives," which provide the best scientific information we have at this time. Recovery objectives collectively describe the specific conditions under which the goals (i.e., delisting) for recovery of the jaguar, throughout its range (including within and outside of the proposed critical habitat in the U.S.).) will be met. As described below, the proposed action may impact five out of eight recovery objectives within the Jaguar Recovery Outline:

"1) Assess, protect, and restore sufficient habitat to support viable populations of jaguars in the two recovery units." A loss of less than one percent of critical habitat, and a much smaller percentage of the NRU, cannot be expected to preclude achievement of this objective.

"2) Mediate or mitigate the effects of human population growth and development on jaguar survival and mortality where possible." The proposed action will increase human influence in the portion of the range where the action would be implemented, but we have no evidence to conclude that the action will appreciably influence survival and mortality at the Recovery Unit level;; attainment of this recovery objective is not precluded by the proposed action.

"3) Reduce direct human-caused (i.e., illegal and legal killing) mortality of jaguars." Our analysis contemplates that increased human access to the action area and surrounding lands could lead to an increased risk of intentional (e.g. shooting) and unintentional (e.g., vehicle collisions) jaguar fatalities. However, this is somewhat speculative and, even if true, does not appreciably affect attainment of this objective in the NRU.

"4) Reduce illegal hunting of jaguar prey and improve regulation of legal hunting where appropriate (i.e., in cases where hunting is leading to significant reductions of jaguar prey)." Our analysis estimates a minimum estimated reduction (in carrying capacity) equaling 14 white-tailed deer and 56 javelina. This is not significant at the Recovery Unit level.

"5) Maintain or improve genetic fitness, demographic conditions, and health of the jaguar." Our analysis shows that connectivity to Mexico will remain after implementation of the proposed action, so we do not anticipate that genetic fitness, demographic conditions, or the health of the jaguar will be significantly compromised.

"6) Assure the long-term viability of jaguar conservation through partnerships, the development and application of incentives for landowners, application of existing regulations, and public education and outreach." This recovery objective is not influenced by the proposed action.

"7) Practice adaptive management in which recovery is monitored and recovery tasks are revised by the USFWS in coordination with the Jaguar Recovery Team as new information becomes available." This proposed action has no applicability to this recovery objective.

“8) Support international efforts to ascertain the status and conservation needs of the jaguar in the two recovery units.” This proposed action has no applicability to this recovery objective.

Although these objectives may be affected by the proposed project, it is unlikely that the level of the effect will lead to measurable delays in the recovery of jaguars within the the NRU,either within and outside of the proposed critical habitat.

Proposed Conservation Measures and their effects

The conservation measures that are part of the proposed action are meant to avoid or offset some adverse effects. The Forest Service provided jaguar-specific conservation measures in the BA that include:

1. Mitigation with regard to lighting (see Monrad 2012) includes the reduction of lumens to 5.2 million lumens, though we note that USFS (2013b) later revisions upward to 5.8 and 6.4 million lumens, that latter of which will appear in the Final EIS.
2. Rosemont will ensure that restored or replaced springs within jaguar critical habitat are constructed in accordance with jaguar PCEs for surface water.
3. As part of the concurrent reclamation program, Rosemont will establish 3 to 40 percent woody vegetation cover averaged over the reclamation area, excluding the pit. This shall be established as a prescriptive obligation of the concurrent reclamation program in appropriate areas as determined in conjunction with the biological monitor during project development.
4. Rosemont will monitor road-kill weekly on SR 83, adjacent to mine site, from the northern extent of currently proposed critical habitat to Gardner Canyon Road, to assess loss of jaguar, ocelot, or jaguar prey base (white-tailed and mule deer, collared peccary, white-nosed coati, in particular). Monitoring will begin at the commencement of mine construction and continue through the second year of mine operation, a total of four years. After the initial four years of monitoring, the Biological Monitor, working with Rosemont, AGFD and FWS, will determine if additional field data collection is necessary to inform determination of crossing need and location. Rosemont will report road-kill in the annual report. Smaller jaguar prey (lagomorphs, rodents) will not be reported. Mortality of any FS and BLM sensitive species will also be reported. This work may be conducted by the Biological Monitor as part of their regular site visits funded by Rosemont, with funding from the proponent. In addition to increasing knowledge regarding the movement of wildlife in the area, information collected during this investigation may identify a suitable wildlife crossing structure location.
5. Rosemont will report all jaguar and ocelot sightings immediately to the Biological Monitor.
6. Rosemont will provide $50,000 to AGFD or other suitable entity approved by the CNF to support camera studies for large predators including jaguar and ocelot. The money will be provided for additional monitoring efforts between the Santa Rita and the Whetstone Mountains and along the Santa Rita Mountains. In addition to increasing knowledge regarding the movement of wildlife in the area, information collected during this investigation may identify a suitable wildlife crossing structure location.

7. Rosemont will acquire or record restrictive covenants or conservation easements on the following parcels of land:

   a. Sonoita Creek Ranch: This land will be purchased and made available to an In-Lieu Fee Sponsor approved by the U.S. Army Corps of Engineers (Corps). It contains a total of approximately 1,200 acres of semidesert grassland, Madrean evergreen woodland, and riparian habitat along upper Sonoita Creek and includes surface water rights that support two perennial ponds and associated riparian vegetation. It is within proposed jaguar critical habitat. Sonoita Creek Ranch will be managed for conservation purposes to provide habitat and connectivity for jaguars and ocelots between the Canelo Hills/Patagonia Mountains and the Santa Rita Mountains, slightly over a mile away to the west of the ranch, in perpetuity. The southern portion of the ranch has been identified by the Arizona Wildlife Linkages Workgroup and the Arizona Missing Linkages Corridor design as a likely corridor between these two CNF land blocks.

   b. Davidson Canyon Watershed Parcels: Rosemont will record a restrictive covenant or conservation easement on these parcels. These properties consist of six parcels on the eastern side of the Santa Rita Mountains and total approximately 574 acres of semidesert grassland and associated xero- or mesoriparian habitat. All but one of these parcels are within proposed jaguar habitat (a total of 527 acres within critical habitat). These will be included as available land for the establishment of water features beneficial to listed species such as jaguars.

   c. Helvetia Ranch North: Rosemont will record a restrictive covenant or conservation easement on these parcels which contain approximately 940 acres of semidesert grassland on the west side of the northern Santa Rita Mountains near the proposed project's infrastructure corridor. The parcels are outside of proposed jaguar critical habitat. These will be included as available land for the establishment of water features beneficial to listed species such as jaguars.

The conservation measures listed above are anticipated to help avoid and offset adverse effects of the proposed project to jaguars to some extent. Sonoita Creek Ranch and five of the Davidson Canyon parcels are located within proposed jaguar critical habitat and therefore may help protect connectivity within critical habitat. The other conservation lands are not located within proposed critical habitat and thus will not contribute to the protection of connectivity within critical habitat. They will, however, likely contribute to some extent to jaguar conservation in general. Although the funding to conduct carnivore monitoring may provide some information on jaguar use of the area, $50,000 is likely only enough funding to conduct carnivore monitoring in a limited geographic area for about six months, which is generally not a sufficient amount of time to collect quality data on cryptic carnivore movement.

The Forest Service also proposed a series of general conservation measures as well as conservation measures for other listed species, some of which have elements that may provide conservation benefits to the jaguar.

The species-specific conservation measures for the Chiricahua leopard frog, as modified by the Terms and Conditions appearing in the frog's Incidental Take Statement, include establishment of new waters. The USFS (2013b) has stated that site selection for these aquatic habitats will include consideration for the between-water travel distance associated with jaguars. The Second Supplemental BA section entitled Additional Considerations for Aquatic and Riparian Species and their Habitat, and Seeps and Springs will further ensure that jaguars (and ocelots) are considered in the replacement of affected waters.

The Second Supplemental BA section entitled Mechanism for Monitoring and Adaptive Management will help ensure that measures are implemented and that their biological efficacy is monitored, with changes made to ensure their intended mitigative purpose is achieved.

Summary of Effects of the Action

Jaguar

The proposed project will directly and indirectly affect jaguars and jaguar habitat within the NMU. The proposed project (including the security fence and roads), will remove 5,401 acres of jaguar habitat, or an equivalent of about one quarter of a jaguar home range, for at least the 25-year life of the mine. A smaller proportion will be permanently lost to the pit. The perimeter fence will encompass 66,990 acres of jaguar habitat; although land between the security fence and the perimeter fence will not be disturbed, we anticipate jaguars will not use the area due to the human influence near the mine. If this is the case, then the mine will impact about one quarter to one third of a jaguar home range. The mine will also eliminate 5,401 acres of jaguar prey habitat and adversely affect another 1,589589 acres (area within perimeter fence) over a 25+ year term. At a minimum, this direct loss of habitat will result in a relatively long-term, estimated loss 14 white-tailed deer and 56 javelina, both key prey species for jaguar. However, this habitat loss will be partially offset by Rosemont's conservation commitment to protect 2,714 acres of jaguar habitat in perpetuity.

In addition to the direct habitat loss, lighting and noise from the proposed project are anticipated to disturb jaguars. Should the human activity associated with this mine disturb jaguars significantly, the result would likely be a shift in home range, perhaps to an area further south in Unit 3. These disturbances, along with additional roads and traffic, may also make jaguars reluctant to travel through the narrowed corridor near the interface of Unit 3 and Subunit 4b. The conservation measures listed above are anticipated to avoid and offset adverse effects of the proposed project to jaguars to some extent. .

Because no recovery criteria have been established for the species, we cannot determine how the proposed project will specifically affect the downlisting and delisting of jaguars; however, it may adversely impact 5 out of 8 recovery objectives,, but not to the extent that those objectives are precluded. The analyses contained in Items 1 through 8 in the section entitled Effects of the Action on Proposed Critical Habitat in Relation to Recovery, above, apply to the jaguar and the species' habitat, both within and outside of the proposed critical habitat. Also as stated in these prior analyses, although these objectives may be affected by the proposed project, it is unlikely that the level of the effect will lead to measurable delays in the recovery of jaguars within the the NRU.

Proposed Jaguar Critical Habitat

1. Direct loss of proposed critical habitat due to the proposed project footprint:

The security fence plus roads will permanently remove 3,102 acres of proposed critical habitat in Unit 3 and the roads will directly affect (permanently remove) 504 acres within Unit 3 and 50 acres in Unit 4b. This represents a permanent loss of 1.1% of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.44% of all proposed critical habitat rangewide. The perimeter fence plus roads outside the fence will impact 5,349 acres of land within Unit 3 and 50 acres within Unit 4b. This represents an impact to 1.6 % of Unit 3, 0.2% of Unit 4b (0.05 % of all of Unit 4), and 0.64% of all proposed critical habitat rangewide. Except where specific features such as the primary access road and utility maintenance road are located, the land between the perimeter fence and the security fence will not be disturbed. However, given the influence of human and vehicular activity, noise, and lighting within the perimeter fence, we anticipate that jaguars will likely avoid most or all areas within the perimeter fence. The mine's project footprint will remove and therefore adversely affect nearly all PCEs (i.e., prey, surface water, canopy cover, rugged terrain, and human influence) in the northern portion of Unit 3 for 25+ years. However, somesome conservation lands (totaling 1,727 acres) are located within proposed jaguar critical habitat and therefore may help protect offset some of this habitat loss.

2. Indirect loss of habitat and reduced connectivity due to the proposed project:

3. As described above, the location of the proposed project in the northern portion of Patagonia Unit 3 will restrict connectivity between Patagonia Critical Habitat Unit 3 and the Whetstone-Santa Rita Subunit 4b which, according to the proposed rule, provides connectivity from the Whetstone Mountains and to Mexico through Unit 3 (see Figure 5). We do not have enough information on the ability of jaguars to move through habitat affected by human influence in Arizona to determine definitively whether or not a jaguar will move through the constricted corridor between the mines. However, if jaguars will not move through the constricted corridor, then the role of Unit 4b, as defined in the proposed critical habitat rule (i.e., to connect Unit 4a to Mexico via Unit 3), would be lost. That said, connectivity of Unit 4a to Mexico would still exist via Unit 4c. Additionally, if the constricted corridor creates a barrier to jaguar movement, the function of the northern portion of Unit 3 (i.e., the portion of Unit 3 from the constricted corridor to Unit 4b) would also be lost because the habitat patch would be reduced to a size below 84 km^2 (this would affect the overarching critical habitat requirement discussed above). Again, however, the remaining portion of Unit 3 (i.e., south of the mine) would still remain functional. Further, Rosemont's permanent protection of 1,727 acres of private lands within critical habitat will further protect connectivity within critical habitat. Effects to recovery:

By definition, critical habitat is habitat determined to be essential for the conservation (i.e., recovery) of the species. Losing some of these limited critical habitat areas and possibly losing one potential pathway from the Whetstones to Mexico, as may occur with the proposed project (as described above), somewhat reduces the ability of critical habitat and the northern most secondary area (i.e., NMU) to contribute to the recovery of jaguars in the NRU. That said, the majority of proposed critical habitat will remain unaffected and therefore retain its ability to contribute to jaguar recovery in the NRU. Additionally, although some recovery objectives for the jaguar may be affected by the proposed project, it is unlikely that the level of the effect will lead to measurable delays in the recovery of jaguars within the the NRU.

4. Effects to conservation:

This possible reduction in function of Subunit 4b and partial loss of function of Unit 3 will somewhat diminish the conservation value of critical habitat as a whole. As explained above, areas that provide the primary constituent elements essential to jaguar habitat are limited within the U.S. and therefore have an important conservation role for the jaguar. Losing portions of these areas (i.e., critical habitat areas), as is likely to occur with the proposed project, reduces the ability of critical habitat to function as intended by the proposed rule. That said, the vast majority of critical habitat will be unaffected by the proposed action and will therefore retain its function and conservation value. Further, the effects of the action on the proposed critical habitat will not considerably reduce the capability of critical habitat to be used in a way such that research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping and transplantation and other similar conservation measures are precluded.

CUMULATIVE EFFECTS - JAGUAR

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act. Many lands within the action area are managed by Federal agencies; thus, many activities that could potentially affect jaguars are Federal activities that are subject to section 7 consultation. The effects of these Federal activities are not considered cumulative effects. However, a portion of the action area also occurs on private lands. Residential and commercial development, road construction, farming, livestock grazing, mining, off-highway vehicle use, and other activities occur on these lands and are expected to continue into the foreseeable future.

Critical Habitat Units 3 and 4 are closer to rapidly expanding urban areas than any other units and therefore more vulnerable to loss of connectivity. Tucson, Patagonia, and Sierra Vista are all expanding populations with increasing land development. Immediately southwest of the Mustang Mountains (Subunit 4c) is the proposed Rain Valley development. On the other (east) side of the Mustang Mountains, the community of Huachuca City is poised for additional development with the impending completion of a new wastewater treatment plant. Subunit 4b, through the Empire Mountains, lies between growth both to the north (Tucson) and the south (Patagonia and Sonoita). The aforementioned actions, the effects of which are considered to be cumulative, may result in fragmentation, loss, or degradation of jaguar habitat and disturbance to jaguars. Although not documented recently in the U.S., illegal hunting of jaguars adversely affects the species. Illegal activities associated with cross-border smuggling and illegal immigration (e.g., human traffic, deposition of trash, creation of trails and routes, and increased fire risk from human traffic) also occur in the action area. These activities can also degrade jaguar habitat and disturb jaguars.

CONCLUSIONS - JAGUAR

Jaguar

After reviewing the current status of the jaguar, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our opinion that the Rosemont Copper Mine, as proposed, is not likely to jeopardize the continued existence of the jaguar. Pursuant to 50 CFR 402.02, “jeopardize the continued existence of” means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. We base this conclusion on the following:

1. Jaguars range from southern U.S., i.e., Arizona and New Mexico, to south America, i.e., Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Venezuela (Swank and Teer 1989, Caso *et al*. 2008). Habitat loss from the proposed action will affect a miniscule amount of habitat from this global perspective. The project will affect less than xx percent of the NRU.

2. Only one jaguar is expected to be incidentally taken under the proposed action, and there are an estimated 30,000 jaguars throughout the species’ range. Sanderson and Fisher (2013) estimate a carrying capacity of 3,400 jaguars within the NRU, although actual population numbers are unknown.

3. Although abundance and population trends for the jaguar range-wide are not well known and populations throughout their range continue to be at risk, the Rosemont Copper mine will not have an appreciable impact on the population range- or NRU-wide. Thus, the proposed action is not expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of the jaguar in the wild by reducing the reproduction, numbers, or distribution of the species.

Proposed Critical Habitat

<u>Legal Standards and Definitions</u>

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat. From section 3(3) of the Endangered Species Act: "The terms ‘conserve,’ ‘conserving,’ and ‘conservation’ mean the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided under the Endangered Species Act are no longer necessary. Thus, designation of critical habitat helps ensure that proposed Federal actions will not result in the adverse modification of habitat to the point that the species will not be able achieve recovery, i.e. not able to be removed from the threatened or endangered species list.

Section 7(a)(2) of the Endangered Species Act of 1973, as amended, states: “Each Federal agency shall…insure that any action funded, authorized, or carried out…is not *likely* to…result in the destruction or adverse modification of (critical) habitat…” (emphasis added).Merriam

Webster's College Dictionary, Tenth Edition, defines "likely" as "1: having a high probability of occurring or being true; very probable." Therefore, in order to reach a conlusion of destruction or adverse modification of critical habitat from a Federal action, we must determine that preclusion of recovery is "very probable" due to that action.

We used four documents to determine how to analyze whether the threshold for destruction or adverse modification will be reached by the proposed action. These include: 1) 2004 guidance regarding the application of the "Destruction of Adverse Modification" standard under Section 7(a)(2) of the Endangered Species Act (FWS 2004); 2) Section 7 Consultation Handbook; 3) the proposed rule for jaguar critical habitat; and 4) our letter regarding Incremental Effects for the economic analysis for the proposed rule to designate critical habitat for the jaguar (FWS, August 28, 2012).

Our 2004 guidance indicates that destruction or adverse modification may be reached when critical habitat would not remain functional to serve the intended conservation role for the species.

Our Section 7 Consultation Handbook notes that the adverse modification threshold is exceeded when the proposed action will adversely affect the critical habitat's constituent elements or their management in a manner likely to appreciably diminish or preclude the role of that habitat for recovery of the species.

The 2012 proposed rule (FWS 2012b) to designate critical habitat for the jaguar states that activities that may destroy or adversely modify critical habitat are those that alter the physical or biological feature and PCEs to an extent that appreciably reduces the conservation value of critical habitat for the jaguar.

The incremental effects letter (FWS August 28, 2012) states that destruction or adverse modification is potentially reached when connectivity is severed either between the U.S. and Mexico or within a critical habitat unit or subunit. According to the incremental effects letter, "major construction projects (such as new highways, significant widening of existing highways), or construction of large facilities (such as large mining operations) could constitute adverse modification to jaguar critical habitat in both occupied and unoccupied subunits if connectivity within a critical habitat unit is severed." Additionally, the letter states that "major construction projects (such as new highways, significant widening of existing highways, or construction of large facilities) that could sever connectivity within these critical habitat subunits could constitute adverse modification. The most likely unoccupied subunits in which these activities may occur are 4b and 4c". The destruction or adverse modification of critical habitat could occur if the function of one or more critical habitat units is affected by, for example, the construction of impenetrable fencing across a portion of the currently open areas of vegetated, rugged terrain at the U.S.-Mexico border. This could create a situation in which a unit of critical habitat could become inaccessible to jaguars. The loss of one critical habitat unit would not constitute jeopardy to the species, but it could constitute destruction or adverse modification (FWS 2012 Incremental Effects letter).

Therefore, following guidance from each of these four sources and considering the effects noted above, we conclude that implementation of the proposed action will not likely destroy or adversely modify proposed critical habitat. We base this conclusion on the following rationale:

Habitat Loss

1. Although the proposed action will result in the direct loss of critical habitat, primarily in Unit 3, the majority of Unit 3 will retain its PCEs and function. The security fence plus roads will permanently remove 3,102 acres of proposed critical habitat in Unit 3 and the roads will directly affect (permanently remove) 504 acres within Unit 3 and 50 acres in Unit 4b. This represents a permanent loss of only 1.1 percent of Unit 3, 0.2 percent of Unit 4b (0.05 percent of all of Unit 4), and 0.44 percent of all proposed critical habitat rangewide. The perimeter fence plus roads outside the fence will impact 5,349 acres of land within Unit 3 and 50 acres within Unit 4b. This represents an impact to only 1.6 percent of Unit 3, 0.2 percent of Unit 4b (0.05 percent of all of Unit 4), and 0.64 percent of all proposed critical habitat rangewide. Further, proposed conservation measures will permanently protect 1,727 acres within proposed critical habitat that could otherwise be subject to development or other adverse impacts.

2. If jaguars are unable to access the northern portion of Unit 3 (but see discussion below), an additional 14,277 acres of Unit 3 would be “lost” due to the proposed action. Adding in this acreage, the total loss of acres of habitat containing all the PCEs to support jaguars would be 19,626. This would constitute less than 6 percent of Unit 3 and 2.3 percent of all proposed critical habitat rangewide. This loss is partially offset by the permanent protection of 1,727 acres mentioned above. Although the proposed action could hypothetically cause an indirect loss of function of the northern portion of Unit 3, 94 percent of Unit 3 will retain its function.

Effects to Jaguar Movement

In order to reach a conclusion that the proposed action is “likely” to result in destruction or adverse modification of critical habitat, the analysis would have to show a “high probability” for ***each*** of the following: (1) that the jaguar would be unable to traverse the constricted area at the unit 3-unit 4b interface; (2) that such a preclusion would render SubunitsSubunits 4b and 4a inaccessible to jaguars and/or preclude connectivity between the U.S. and Mexico; and (3) that both of those results would preclude or significantly diminish the conservation value of CH for jaguar recovery. It is our biological opinion that the standard of “highly probable” is not met for any of these arguments singly, let alone all of them combined.

1. Our analysis makes a plausible argument that jaguar movement between units 3 and 4b will become somewhat restricted, but does not reach the level that such movement will likely be precluded. Known male jaguars have been documented as having traveled widely around southern Arizona in recent years, apparently despite the presence of numerous roads, lit areas, and other human disturbances. Even if movement through the constricted corridor were completely blocked, our analysis would have to show that precluding such movement would appreciably reduce the functionality of the currently proposed array of critical habitat. Two arguments might be made in this regard: that both units 4a and 4b will become inaccessible to jaguars if movement through the 1.5 km strip is curtailed, thus removing another 11 percent of critical habitat; and that preclusion of

this connectivity will significantly impair jaguar movement into and out of Mexico. Neither of these arguments is adequately supported by the best available information.

2. Although we know that a jaguar moved from the Whetstones (Unit 4a) to the Santa Ritas (Unit 3), we do not know what travel pathway it took. Unit 4b connects Units 4a and 3; however, we have no evidence that 4b has ever been or ever will be used by a jaguar, and it is difficult for us to determine whether unit 4b is so important to jaguar movement that loss of this connectivity would lead to an adverse modification conclusion. Furthermore, there are other connections between units 3 and 4 within Subunit 4c. Finally, the occupied critical habitat in both the Whetstones and the Santa Ritas remains connected to Mexico through at least two mountain ranges (the Patagonia and Huachuca mountains).

3. Supposing that connectivity between Unit 3 and Subunit 4a were completely precluded, and that such preclusion would sever connectivity to Mexico, we would then analyze the effect these factors would have on the conservation (recovery) of the jaguar. Three of the four guidance documents mentioned above - the 2004 guidance regarding the application of the "Destruction of Adverse Modification" standard under Section 7(a)(2) of the Endangered Species Act (FWS 2004), the Section 7 Consultation Handbook, and the proposed rule for jaguar critical habitat) - refer to either "conservation" or "recovery" of the species under analysis.

The question then becomes "What constitutes jaguar recovery?" The Jaguar Recovery Team, in its Recovery Outline for the species (FWS 2012a), recognizes the "Northwestern Recovery Unit" (NRU). By definition, the NRU is Essential to the recovery of the species rangewide. Therefore, we are analyzing the effect of the overall impact to critical habitat at the recovery unit level rather than rangewide. As described above, the proposed action may impact five out of eight recovery objectives in the Jaguar Recovery Outline (FWS 2012a), including the following: (1) Assess, protect, and restore sufficient habitat to support viable populations of jaguars in the two recovery units; (2) Mediate or mitigate the effects of human population growth and development on jaguar survival and mortality where possible; (3) Reduce direct human-caused (i.e., illegal and legal killing) mortality of jaguars; (4) Reduce illegal hunting of jaguar prey and improve regulation of legal hunting where appropriate; and (5) Maintain or improve genetic fitness, demographic conditions, and health of the jaguar. Although these objectives may be affected by the proposed project, by itself, it is unlikely that the level of the effect will lead to measurable delays in the recovery of jaguars within the the NRU.

We also examined the effects of the proposed action in relation to the definition of "conservation". Conservation, as defined under section 3 of the Act, means "to use and the use of all methods and procedures that are necessary to bring an endangered or threatened species to the point at which the measures provided under the Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking". The proposed action should have no significant effect on any of these activities.

Finally we examine the "Incremental Effects memo" which postulates, for purposes of assessing the economic impacts of proposed critical habitat, scenarios where an adverse modification opinion may occur. That memo says, in part, that adverse modification may result if "major construction projects (such as new highways, significant widening of existing highways), or construction of large facilities (such as large mining operations) could constitute adverse modification to jaguar critical habitat in both occupied and unoccupied subunits if connectivity within a critical habitat unit is severed." Additionally, the letter states that "major construction projects (such as new highways, significant widening of existing highways, or construction of large facilities) that could sever connectivity within these critical habitat subunits could constitute adverse modification. The most likely unoccupied subunits in which these activities may occur are 4b and 4c". The best available information indicates that connectivity is not likely to be "severed" by the proposed action.

Losing a portion of Unit 3 and possibly reducing connectivity to Subunit 4a, both areas considered by the proposed rule as essential to the conservation of jaguars, reduces the ability of critical habitat to function as intended by proposed rule and somewhat diminishes the conservation value of critical habitat as a whole. That said, because the vast majority of critical habitat will be unaffected by the proposed action, its value will not be appreciably reduced. Overall, critical habitat will retain its function and ability to contribute to survival and recovery of the jaguar.

INCIDENTAL TAKE STATEMENT - JAGUAR

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act, prohibit take of endangered or threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be included by the USFS as binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The USFS has a continuing duty to regulate the activity that is covered by this Incidental Take Statement. If the USFS (1) fails to assume and implement the terms and conditions, or (2) fails to require the applicant to adhere to the terms and conditions of this incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USFS, or the applicant must report the progress of the action and its impact on the species as specified in the Incidental Take Statement (see 50 CFR 402.14(I)(3)).

Amount or Extent of Take Anticipated

Confirmed jaguar detections have occurred within the action area. The detections were from trail cameras placed by resident hunters and/or researchers from the University of Arizona – jaguar and ocelot survey and monitoring project funded by the FWS and the Department of Homeland Security. All detections were located on lands administered by the Coronado National Forest, photographed at night, and all are suspected to be of a single male jaguar. One of the detections was from a trail camera located to the west of and adjacent to the proposed action area. Thus, because trail cameras have detected the presence of a male jaguar within the action area, incidental take is likely to occur.

Incidental take of one jaguar over the life of the project in the form of harassment is anticipated for the following activity:

1. Disturbance of jaguars due to construction, operation, and restoration of the mine and associated roads which disrupts normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Construction and operation of the mine is anticipated cause jaguars to shift home range location and travel longer distances, possibly through less suitable habitat. Extra travel would require jaguars to expend additional energy and increase the potential for encounters with humans, vehicles, potential competitors, and other stresses.

We anticipate the above anticipated incidental take will be difficult to detect. However, monitoring and reporting requirements will allow us to assess the effects of proposed project activities. In addition, Rosemont will report to us any mortality or injury of jaguars due to collisions with vehicles or other activities. The amount of anticipated incidental take will have been exceeded, triggering a requirement for reinitiation (50 CFR 402.16[c]) if, for example:

1. Based on the annual and emergency reporting on the status of the proposed project:
    a. A jaguar is injured or killed through collision with a vehicle(s) associated with the proposed project;
    b. Unanticipated events occur that are attributable to the proposed action (e.g. toxic spills or plumes, wildfires, landslides) that are reasonably certain to have resulted in take; or
    c. Additional jaguars are documented in the action area that are reasonably certain to be taken by the proposed action.

Effect of the Take

We conclude that this level of anticipated take is not likely to result in jeopardy to the jaguar, for the effects are not expected to appreciably reduce the survival and recovery of the species. Jaguars range from southern United States all the way to Brazil and thus, take of one jaguar in the form of harassment in the U.S. will not jeopardize the species.

REASONABLE AND PRUDENT MEASURES

The FWS believes the following Reasonable and Prudent Measures are necessary and appropriate to minimize impacts of incidental take of jaguar:

1. Monitor jaguars in the Santa Rita Mountains.
2. Monitor incidental take resulting from the proposed action and report to the FWS the findings of that monitoring.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the Act, the USFS must comply with the following Terms and Conditions, which implement the Reasonable and Prudent Measures described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

1. The following Term and Conditions implement Reasonable and Prudent Measure Number 1:
   implements
   a. Perform monitoring to obtain additional information on jaguar movements in the vicinity of the mine and to enable operations to take into account the presence of jaguars in the immediate vicinity. Ensure that jaguars in the vicinity of proposed project area and within jaguar habitat in a 6.4 km radius around the perimeter fence of the mine are detected and monitored for the life of the project. We note that 6.4 km is the radius of an average jaguar home range in the northern portion of its range [see Home Range and Movement section, above, and López-González (2011, pers. comm.) and Rosas-Rosas and Bender (2012)]. All aspects of the monitoring plan and implementation of the monitoring (including, but not limited to, who will conduct the study, how the study will be conducted, and when reports will be due) must be coordinated with FWS and AGFD and approved by FWS. Additionally, all monitoring efforts must be coordinated with the FWS, AGFD, the existing University of Arizona jaguar survey and monitoring study, and any other jaguar and carnivore monitoring projects that may be active in the area.

b. The following Term and Condition implementsimplements Reasonable and Prudent Measure Number 2:

   a. The Forest Service will ensure that Rosemont will monitor the impacts of the action and report these to the FWS for the life of the project. A report will be due to the FWS annually on March 1. TheThe report will include a description of the action implemented, including conservation measures and reasonable and prudent measures. Emergencies and any unanticipated events that may cause take to be exceeded will be reported immediately (at a maximum within 24 hours) to the Arizona Ecological Services Office Field Supervisor via email and telephone.

Review requirement: The FWS believes that no more than one jaguar will be incidentally taken (in the form of harassment) as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. FS must immediately provide an explanation of the causes of the taking and review with the FWS-AESO the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS - JAGUAR

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend that the Forest Service and Rosemont Copper Company further minimize the effects of night lighting and noise within the action area by:

a. Minimizing the light levels and the distance light emanates from the project site through the use of techniques such as decreasing the use of bright lights, employing methods to deflect lights coming out of project site, and minimizing the lights coming from buildings at the project site;
b. Minimizing noise, especially at night, through the use of techniques such as prohibiting horn use and avoiding loud operations at night;
c. Limiting speeds on the primary and secondary access roads and the Sycamore connector road and employ the use of wildlife crossing signs. Speed limits will be made known to employees and contractors during safety training or equivalent and via the use of speed limit signs; and
d. Coordinating the aforementioned Conservation Recommendations with FWS and AGFD before the measures are employed.

Tables and Figures - Jaguar

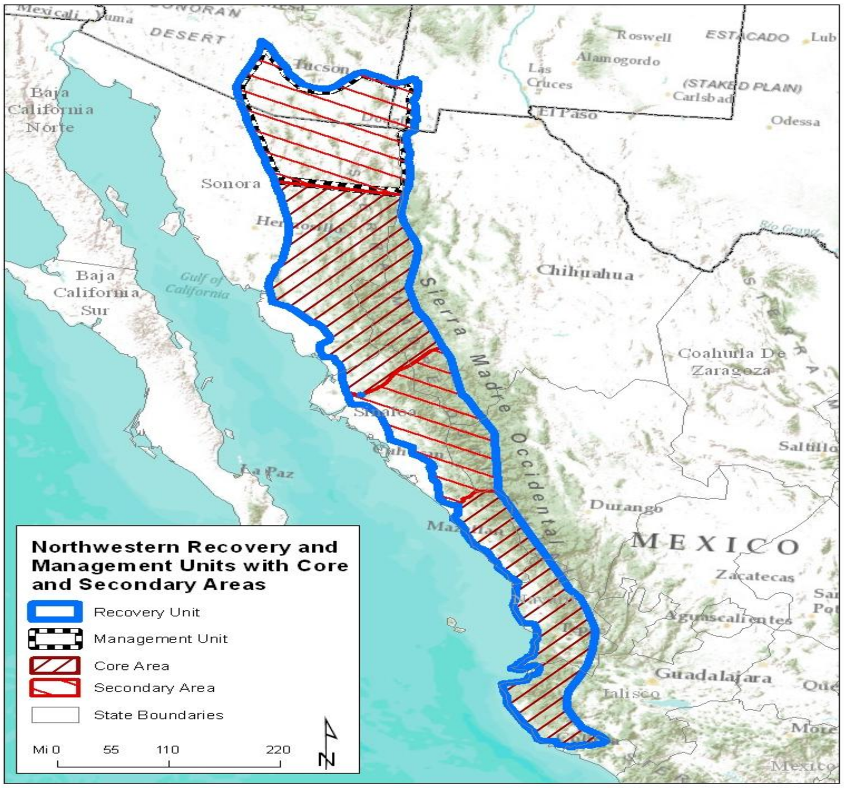


Figure J-1. Northwestern Jaguar Recovery Unit.

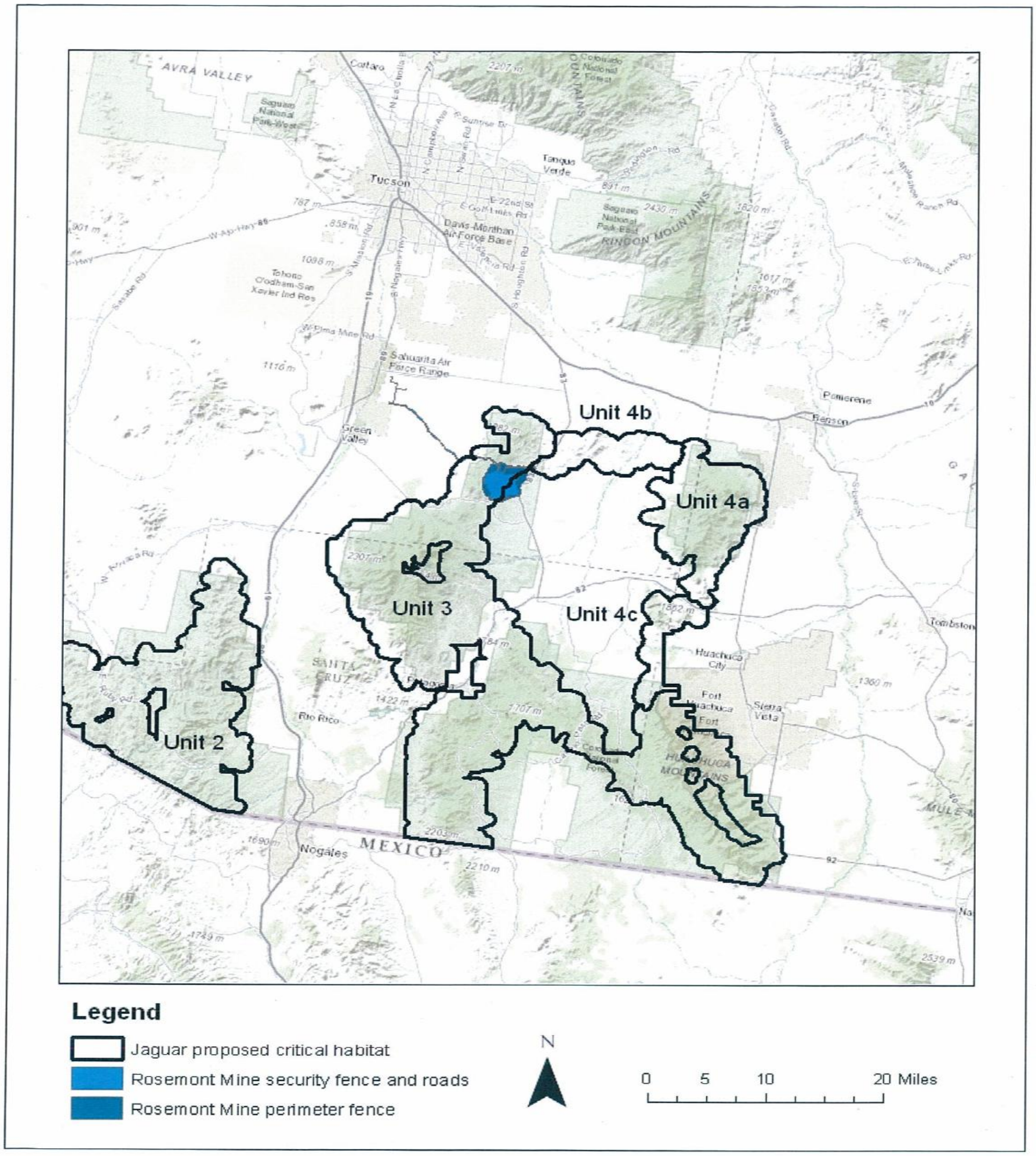


Figure J-2. Map showing the proposed action within proposed critical habitat Unit 3 in relation to Critical Habitat Units 4b, 4a, and 4c.

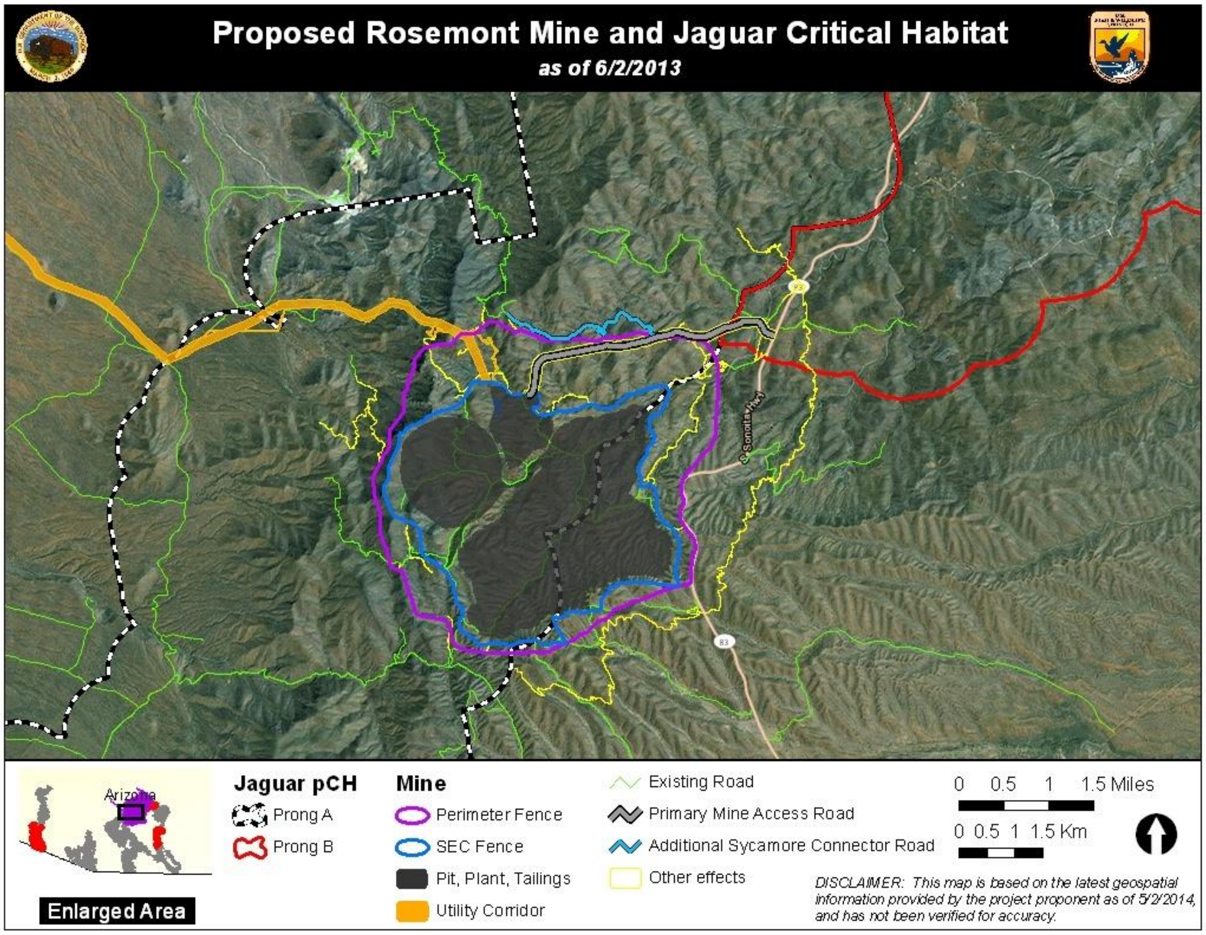


Figure J-3. Proposed Rosemont Mine Project and Jaguar Critical Habitat. Note that the terms Prong A and Prong B are artifacts of the process used to designate the proposed Critical Habitat (FWS 2012), not indicators of differing management direction.

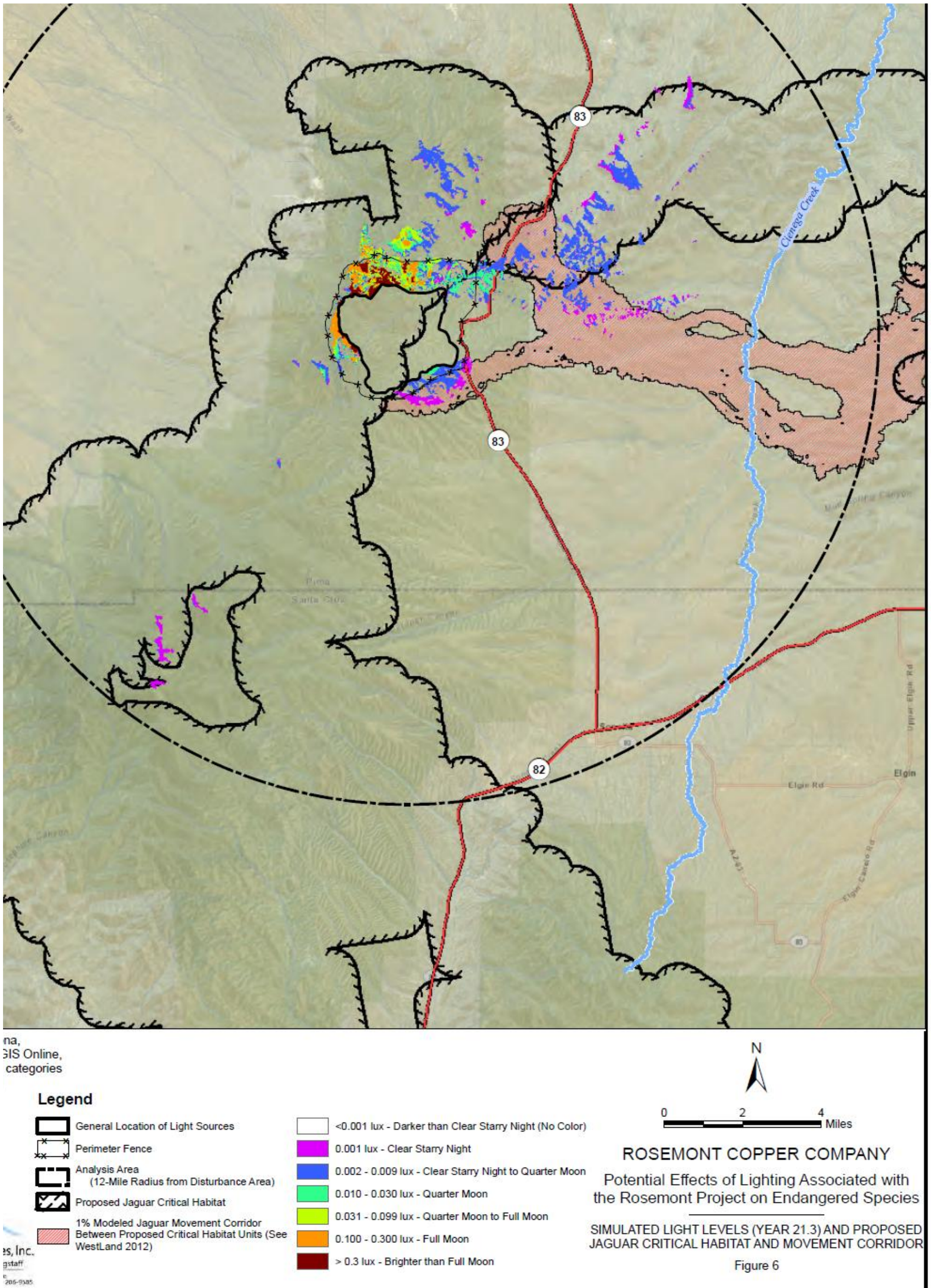


Figure J-4. Simulated light (horizontal) levels as a result of the proposed Rosemont Mine project in relation to jaguar critical habitat (Figure 6 of WestLand Resources Inc, 2012).

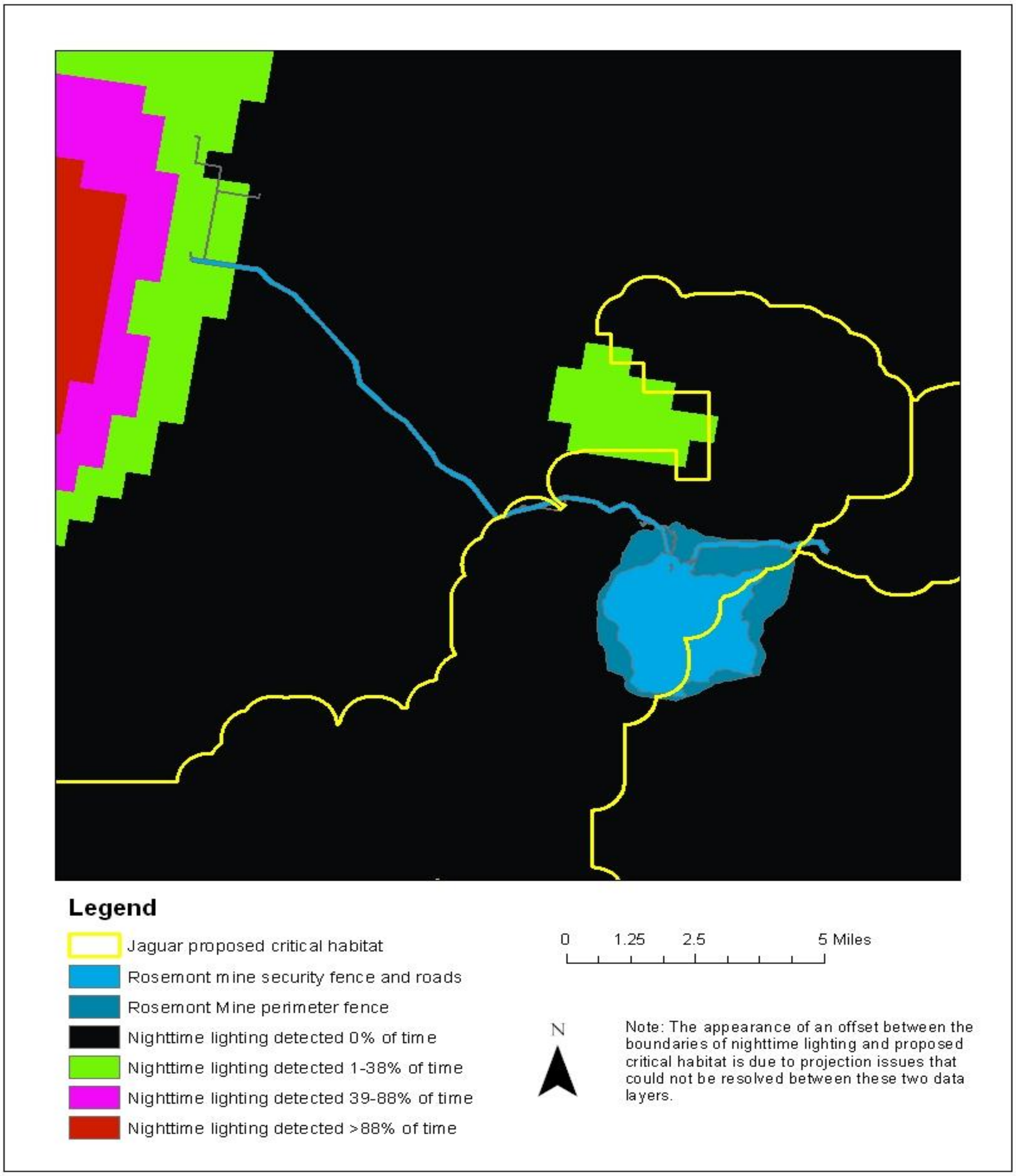
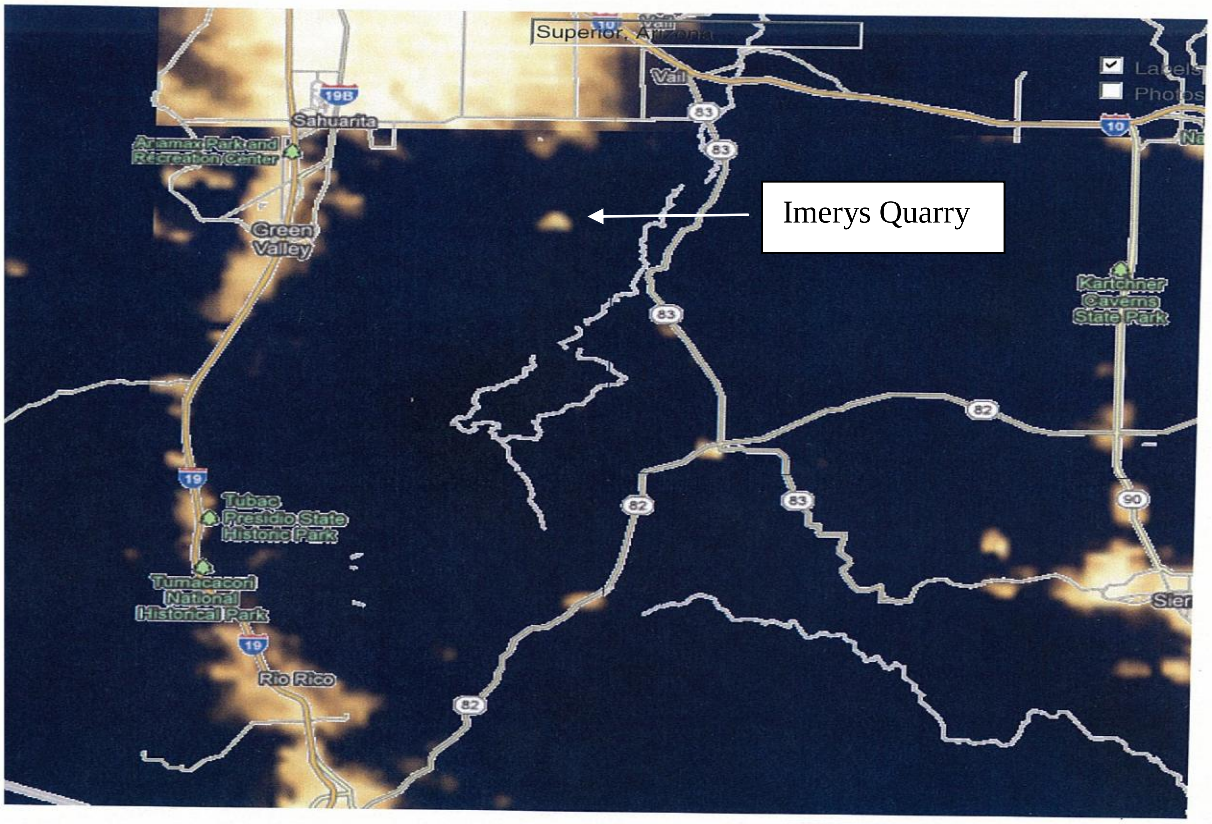


Figure J-5. Map showing nighttime lighting from the current Imerys Quarry mine shown in green and the proposed Rosemont mine shown in blue (the security and perimeter fence boundaries are shown only; no modeled horizontal light is shown).

Blue Marble Navigator - Night Lights 2012 Page 1 of 1



Google 10 km 10 mi Night-lights imagery by NASA's Earth Observatory

http://www.blue-marble.de/nightlights/2012

Figure J-6. Image of the currently operating mine known as Imerys Quarry located north of the proposed action at night. Image is from Blue Marble Navigator 2012 (http://www.blue-marble.de/nightlights/2012).

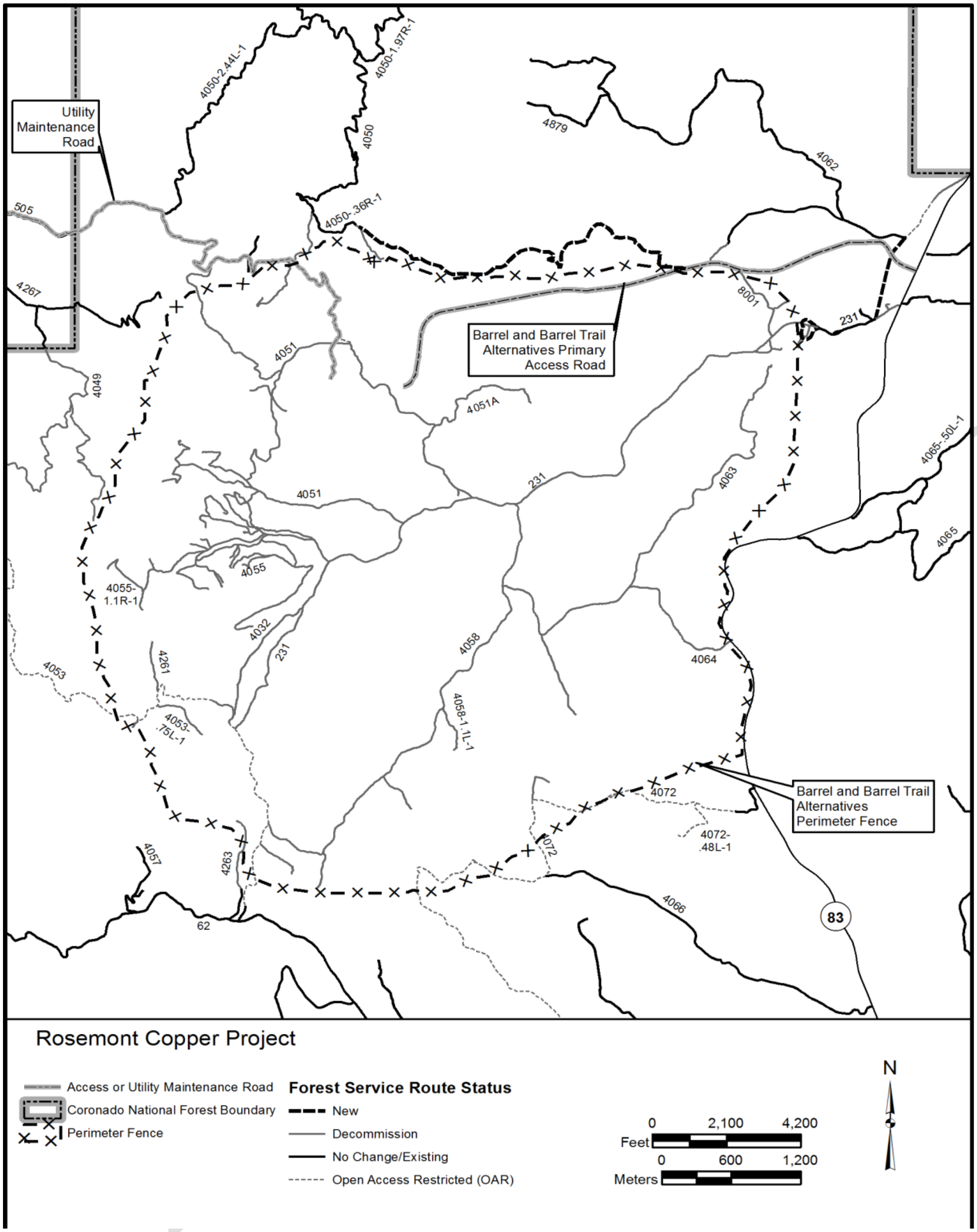


Figure J-7. Proposed location of the Sycamore Canyon Connector Road and existing National Forest System Roads.

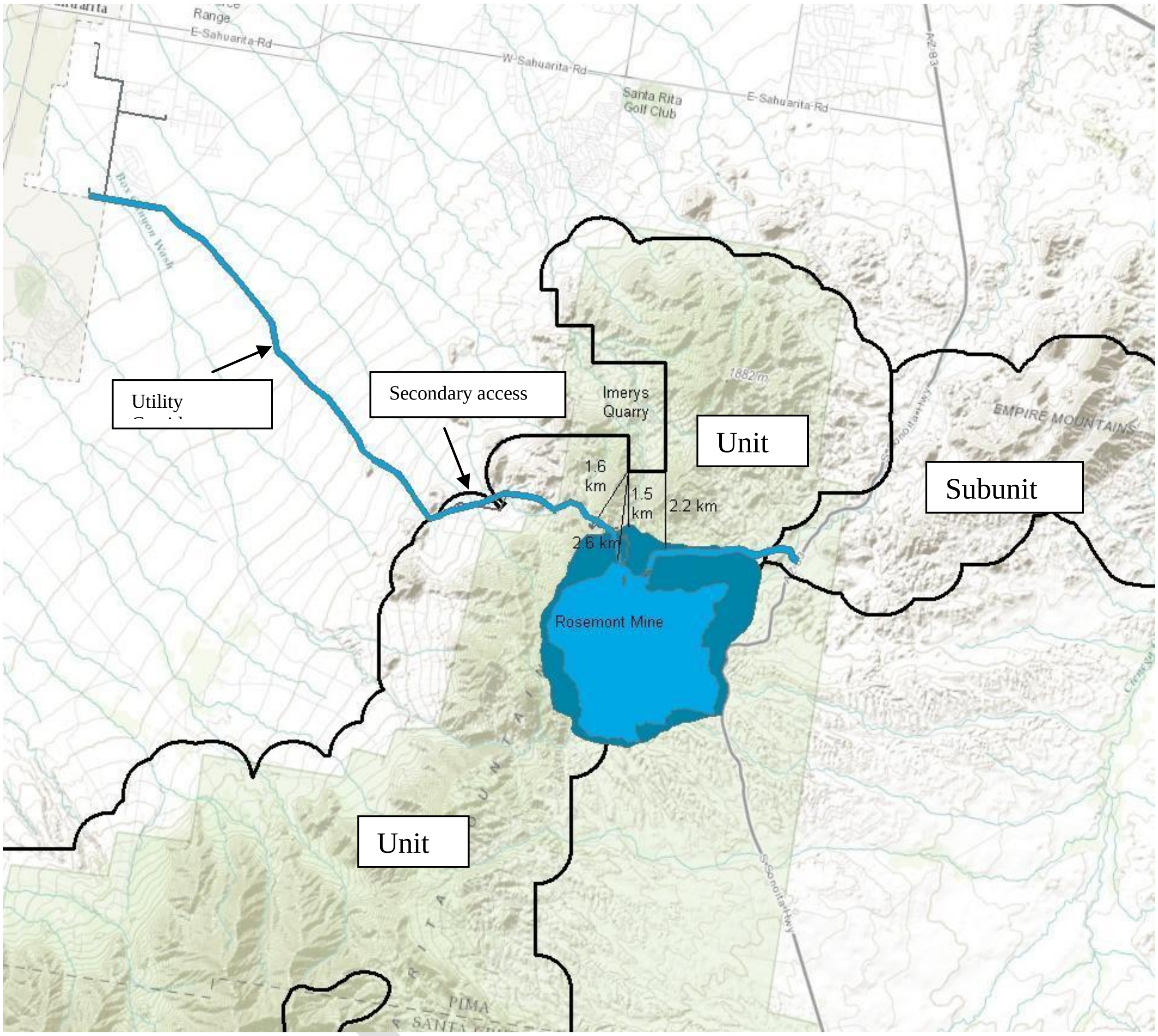
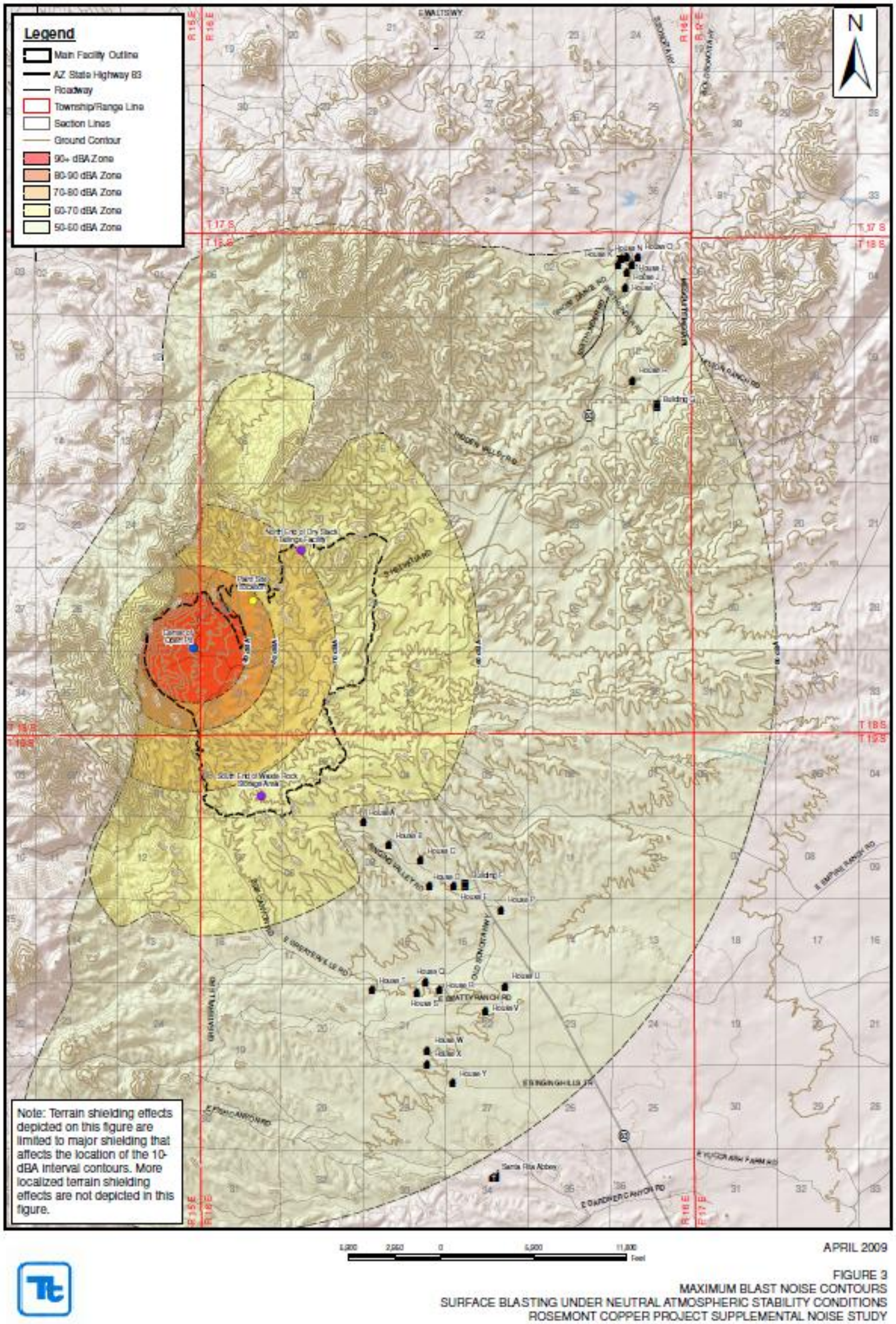


Figure J-8. The proposed action within proposed critical habitat Unit 3 and the distances between the perimeter fence of the proposed action and the active mine to the north (i.e., Imerys Quarry).



Figure

Figure J-9. Maximum noise contours for surface blasting (Tetra Tech 2009)

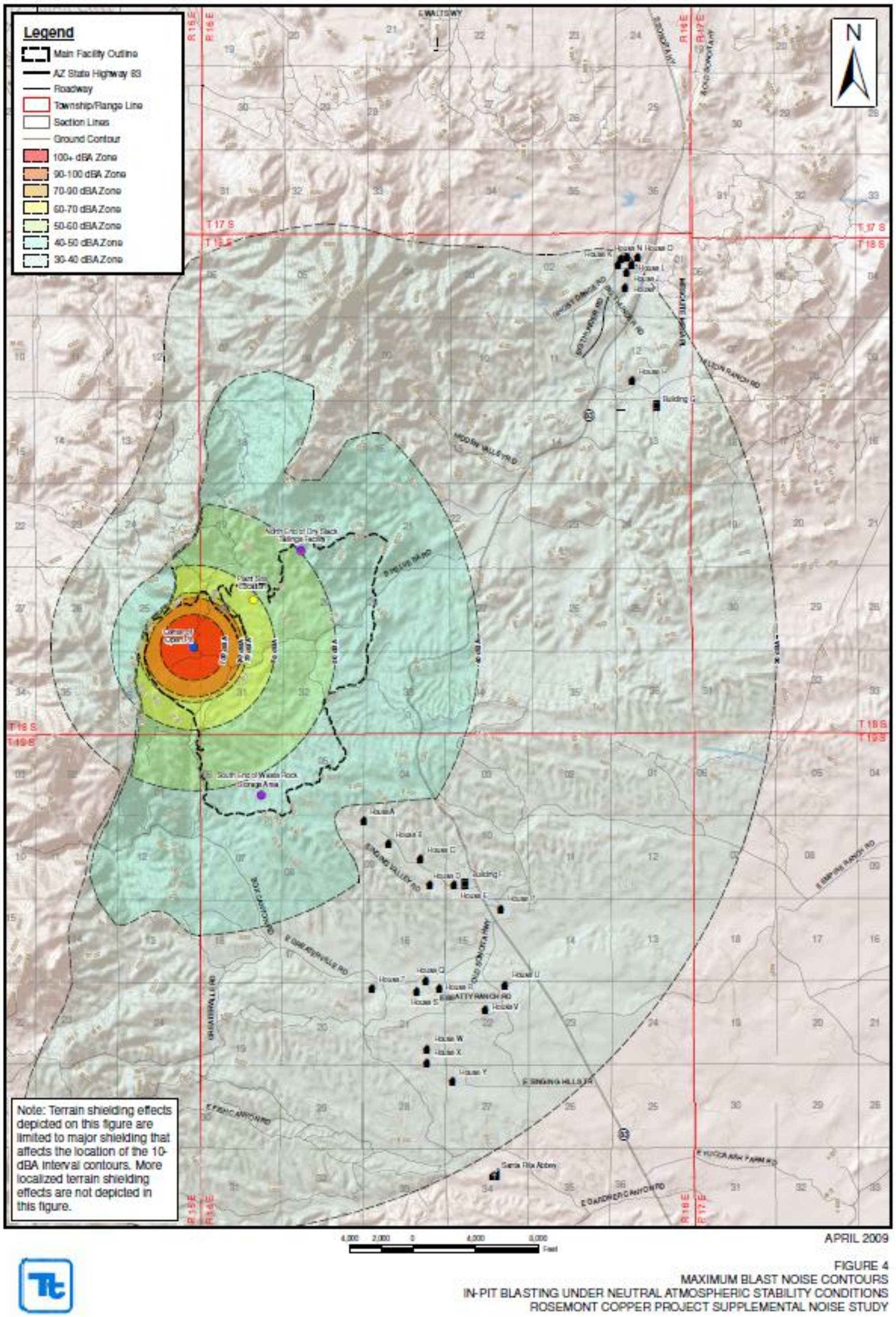


Figure J-10. Maximum noise contours for in-pit blasting (Tetra Tech 2009)

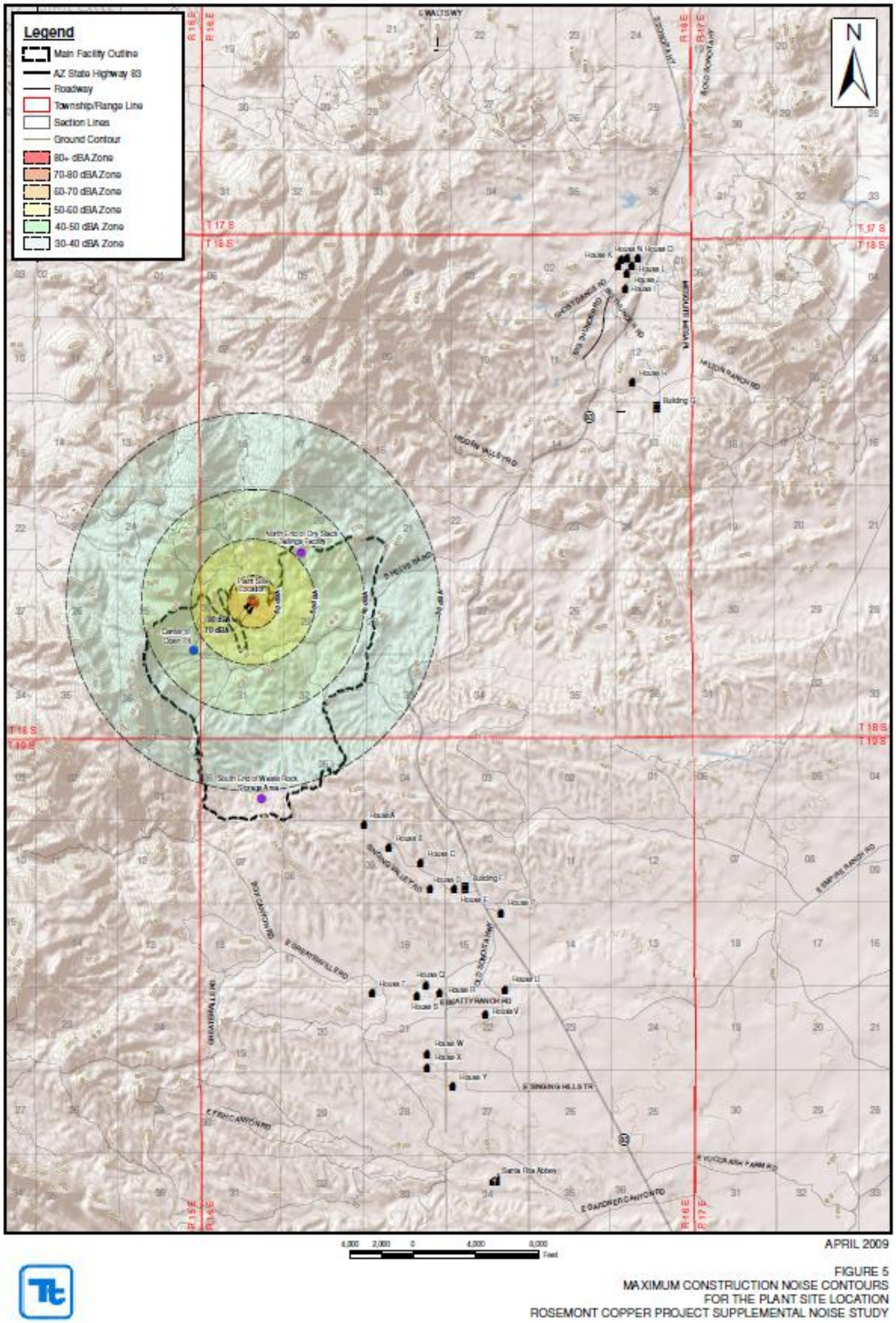


Figure J-11. Maximum noise contours for in-pit blasting (Tetra Tech 2009)

Status of the Species - Ocelot

Description, Legal Status, and Recovery Planning

The ocelot (*Leopardus pardalis*), a medium-sized spotted cat, belongs to the genus *Leopardus* which also includes the margay (*Leopardus wiedii*) and the oncilla (*Leopardus tigrinus*). The ocelot is divided into as many as 11 subspecies that ranged from the southwestern U.S. to northern Argentina (FWS 2010). Two subspecies occur in the United States: the Texas ocelot (*L. pardalis albescens*) and the Sonora ocelot (*L. p. sonoriensis*) (Hall 1981).

The ocelot was listed as endangered in 1972 under the authority of the Endangered Species Conservation Act of 1969 (FWS 1972). The 1969 Act maintained separate lists for foreign and native wildlife. The ocelot appeared on the foreign list, but due to an oversight, not on the native list. Following passage of the ESA in 1973, the ocelot was included on the January 4, 1974, list of "Endangered Foreign Wildlife" that "grandfathered" species from the lists under the 1969 Act into a new list under the ESA (FWS 1974). The entry for the ocelot included "Central and South America" under the "Where found" column in the new ESA list. Endangered status was extended to the U.S. portion of the ocelot's range with a final rule published July 21, 1982 (FWS 1982). The "Historic range" column for the ocelot's entry in the rule reads, "U.S.A. (TX, AZ) south through Central America to South America." The entry on the current list (FWS 2003) is essentially the same, and reads, "U.S.A. (TX, AZ) to Central and South America". The ocelot was upgraded to CITES Appendix I in 1986 (Nowell and Jackson 1996) and is considered endangered in Mexico (SEMARNAT 2002).

The species has a recovery priority number of 5C, meaning that it has a low potential for recovery with a relatively high degree of conflict. Recovery for the ocelot was originally addressed in *Listed Cats of Texas and Arizona Recovery Plan (with Emphasis on the Ocelot)* (FWS 1990). A draft revised recovery plan was made available for public comment in 2010 (FWS 2010), with the goal of improving the status of the species to the point that it no longer needs the protection of the ESA. The draft revised recovery plan has not been finalized as of the date of this biological opinion. The draft recovery strategy calls for 1) the assessment, protection, and restoration of sufficient habitat to support viable populations of the ocelot in the borderlands of the U.S. and Mexico; 2) the reduction of effects of human population growth and development to ocelot survival and mortality; 3) the maintenance or improvement of genetic fitness, demographic conditions, and health of the ocelot; 4) the assurance of long-term viability of ocelot conservation through partnerships, the development and application of incentives for landowners, application of existing regulations, and public education and outreach; 5) the use of adaptive management, in which recovery is monitored and recovery tasks are revised by the FWS in coordination with the Recovery Team as new information becomes available; and 6) the support of international efforts to ascertain the status and conservation of the ocelot in Sonora and south of Tamaulipas.

The major focus of the draft revised recovery plan is on two cross-border management units, the Texas/Tamaulipas Management Unit and the Arizona/Sonora Management Unit (ASMU). The boundaries of the ASMU is defined as the original range of the subspecies (*L. p. sonoriensis*) as described by Hall (1981) which generally extends from central Arizona south to central Sinaloa.

Delisting criteria for the ASMU are: 1) the ASMU population is estimated through reliable scientific monitoring to be above 2,000 animals for 10 years; 2) significant threats to this population have been identified and addressed; 3) habitat linkages to facilitate an ASMU metapopulation have been identified and are conserved for the foreseeable future.

Life History and Habitat

The ocelot is a medium-sized spotted cat weighing from 7-16 kg (15-35 lbs), with males weighing more than females (FWS 2010). The coloration of the upper parts of the body is pale gray to cinnamon. There are spots on the head, two black stripes on the cheeks, and four to five longitudinal black stripes on the neck. The body shows elongated black-edged spots arranged in chain-like bands. The rounded ears are black dorsally, with a conspicuous white spot. The underparts are whitish, spotted with black. The tail is marked with dark bars or incomplete rings (Hall 1981).

The life history of the ocelot has been summarized by Laack (1991), Laack *et al.* (1991 and 2005), Tewes and Schmidly (1987), and others. Ocelots may live greater than 10 years in the wild and can live longer (18 years plus) in captivity (Murray and Gardner 1997). Gestation lasts about 70-80 days, and breeding reaches a peak during autumn in Texas (Tewes and Schmidly 1987); however breeding peaks may vary throughout the ocelot range. Wild ocelots probably first produce young at about 18 to 30 months-of-age (Eaton 1977, Tewes and Schmidly 1987), although Laack (1991) observed first reproduction in wild female ocelots between 30 and 45 months-of-age. Average litter size is about 1 to 1.5 kittens per litter (Laack *et al.* 2005, Mora *et al.* 2000, Murray and Gardner 1997). Males are believed to contribute little to direct parental care (Tewes 1986, Laack 1991) and young may become independent at one year of age (Murray and Gardner 1997). There is little information on the interval between successive litters in the wild, but it is likely two years (Murray and Gardner 1997, FWS 2010).

Although ocelots usually disperse from the natal range, sometimes females may remain in their natal range (Laack 1991). The age at which subadult ocelots disperse from the natal range varies, but is about two years of age (Ludlow and Sunquest 1987, Laack 1991). Laack (1991) found that there was no obvious sex difference in age at dispersal and that duration of successful dispersal (time elapsed between leaving natal range and establishing an independent home range) was 7 to 9.5 months. Studies have shown that dispersal distance varies considerably, for example, in Texas, dispersal distances have been documented between 2.5 km and 42.5 km (Navarro-Lopez 1985, Tewes 1986, Laack 1991, FWS 2010). The longest documented dispersal distance (50 km/31 miles) that we are aware of was of a male ocelot in Tamaulipas, Mexico (Booth-Binczik 2007).

No studies have documented dispersal distance of ocelots in Sonora and Arizona; however, a subadult male ocelot was documented in Arizona in 2010 just west of Globe (it was killed by a car) (Holbrook *et al.* 2011). Ocelots have also been recently detected in the Whetstone (detected in 2009) (Avila-Villegas and Jessica Lamberton-Moreno 2012) and Huachuca Mountains (detections from 2011 to 2013) (email from Tim Snow, AGFD, March 13, 2013). The nearest recently (in 2011) documented female with young (one kitten) was located about 48 km (30 miles) south of the international border in the Sierra Azul of Sonora, Mexico (Avila-Villegas and Jessica Lamberton-Moreno 2012). If ocelots documented in Globe and the Huachuca and

Whetstone mountains dispersed from the nearest breeding population, assuming the nearest breeding population is the one previously mentioned, it means the ocelots moved about 220 km (135 miles) to Globe; 55 km (35 miles) to the Huachuca Mountains (email from Tim Snow, AGFD, March 18, 2013), and 110 km (70 miles) to the Whetstone Mountains (Avila-Villegas and Jessica Lamberton-Moreno 2012). Avila-Villegas and Jessica Lamberton-Moreno (2012), however, believe that travel from northern Sonora to Globe seems unlikely.

Ocelots are solitary animals that maintain home ranges (Emmons 1988, Ludlow and Sunquist 1987, Laack 1991, Crawshaw 1995). Home range for the ocelot varies throughout its range. Adult female home range sizes vary from approximately 2 km^2 to 17 km^2 (494 to 4,201 acres) while adult male home range sizes vary from approximately 5 km^2 to 38 km^2 (1,235 to 9,390 acres), both depending on the habitat type in which they are found (Tewes 1986, Ludlow and Sunquist, 1987, Crawshaw and Quigley 1989, Emmons 1988, Konecny 1989, Laack 1991, Caso 1994, Crawshaw 1995, Fernandez 2002). In the Tamaulipan thornscrub of south Texas and northeastern Mexico, mean ocelot home range sizes reported include: Laack (1991): 6.2 km^2 (1,544 acres) for males, 2.87 km^2 (709 acres) for females; Navarro-Lopez (1985): 2.5 km^2 (623 acres) for males, 2.1 km^2 (512 acres) for females; Tewes (1986): 12.3 km^2 (3,039 acres) for males and 7.0 km^2 (1,730 acres) for females; and Caso (1994): 8.1 km^2 (2,006 acres) for males, 9.6 km^2 (2,372 acres) for females. No home range studies have been done for ocelots in Arizona or northwestern Mexico. However, in western Mexico, specifically, in the tropical deciduous forest of Jalisco, average home range size using the Kernel estimator for male ocelots was 11.7 km^2 (2,891 acres) and for females was 5.8 km^2 (1,433 acres); average home range size using the 95% Minimum Convex Polygon estimator was 16.26 km^2 (4,018 acres) for males and 7.34 km^2 (1,814 acres) for females (Fernandez 2002).

Ocelots inhabit a wide variety of densely vegetated habitat types, including, but not limited to, thorn scrub, semi-arid woodland, tropical deciduous and semi-deciduous forest, subtropical forest, lowland rainforest, palm savanna, and seasonally flooded savanna woodland (Tewes 1986, Ludlow and Sunquist 1987, Crawshaw and Quigley 1989, Crawshaw 1995, Fernandez 2002). In south Texas, ocelots occur predominantly in dense thornscrub communities (Navarro-Lopez 1985, Tewes 1986, Laack 1991). Laack (1991) also documented minimal use of Johnsongrass (*Sorghum halepense*) by ocelots. Caso (1994) found ocelots used primarily forest or woody communities in Tamaulipas, Mexico, and used the open pastures much less often.

In Sonora, López González *et al.* (2003) reported 27 of 36 (75%) of verified ocelot records in Sonora were associated with tropical or subtropical habitats, namely subtropical thornscrub, tropical deciduous forest and tropical thornscrub; a few ocelots were recorded in oak woodlands, but were all males. The mean elevation of the 33 records located with precision was 700 +/- 450 meters (2,297 +/- 1,476 feet), at which altitudes subtropical thornscrub is the main habitat (López González *et al.* 2003). They report that ocelots were associated largely with the mountainous Sierra region of eastern Sonora and that records closer to the Sonoran desert biome were mainly associated with riparian areas, where the shrub cover is relatively thicker than the surrounding areas. Avila-Villegas and Jessica Lamberton-Moreno (2012) collected 68 camera photographs of ocelots in the Sierra Azul in northern Sonora, all of which were taken at elevation ranges between 1,275 and 1,625 meters (4,183 and 5,331 feet) in Madrean evergreen woodland.

Of the four ocelot recently recorded in Arizona, the one in the Whetstone Mountains was documented (via remote camera) in Madrean evergreen woodland (Avila-Villegas and Jessica Lamberton-Moreno 2012); and, based on photographs, the two in the Huachuca Mountains most likely occur in Madrean Lower Montane Pine-Oak Forest and Woodland (email from Tim Snow, AGFD, March 13, 2013). This habitat is described as from 1,710 to 2,560 meters (5,600 to 8,400 feet), containing more than 50 percent oak, and can hold dense manzanita, silk tassel, and silverleaf oak (email from Tim Snow, AGFD, March 13, 2013).

Despite the variation in habitat use, the species does not appear to be a habitat generalist. Ocelot spatial patterns are strongly linked to dense cover or vegetation, suggesting it uses a fairly narrow range of microhabitats (Emmons 1988, Horne 1998). Horne (1998), in southern Texas, was the first to statistically analyze ocelot habitat selection patterns. He found ocelots used closed (>95% canopy closure) cover types more than cover types with less-than-moderate canopy cover and avoided mixed cover type (50-75% canopy closure). Also in southern Texas, Jackson *et al.* (2005) suggested that ocelots prefer closed canopy over other land cover types, but that areas used by this species tended to consist of more patches with greater edge. No habitat use studies have been conducted in Arizona or Sonora.

Ocelots are generally active for more than half of each 24-hour period and are typically most active at night and during crepuscular periods with more limited diurnal activity (Ludlow and Sunquist 1987, Crawshaw and Quigley 1989, Fernandez 2002, Avila-Villegas and Jessica Lamberton-Moreno 2012). Ocelots are likely generally nocturnal because they follow the nocturnal habits of their primary prey, small mammals (Ludlow and Sunquist 1987, Emmons 1988, and Crawshaw and Quigley 1989).

Ocelots are solitary hunters and eat a wide variety of prey, but small mammals, especially rodents, comprise most of their diet (Emmons 1987, Ludlow and Sunquist 1987, Crawshaw 1995, De Villa Meza *et al.* 2002, Fernandez 2002). Ocelot diets, however, also include medium to large mammals, reptiles, amphibians, birds, fishes, and insects (Emmons 1987, De Villa Meza *et al.* 2002, Fernandez 2002). Based on these results some authors have suggested that ocelots are opportunistic feeders (Bisbal 1986, Emmons 1987).

Distribution and Abundance

Ocelots historically ranged from Louisiana, Arkansas, Texas, and Arizona in the U.S. southward through Mexico, Central and South America to Peru and northern Argentina (Murray and Gardner 1997). Currently, the ocelot ranges from extreme southern Texas and southern Arizona through Mexico and Central America to Ecuador and northern Argentina (Murray and Gardner 1997, FWS 2010). In Mexico, it has disappeared from much of its historic range on the west coast (Caso *et al.* 2008). There are reports of the species up to 3,000 meters (9,842 feet) (Caso *et al.* 2008).

Estimating population sizes of secretive nocturnal carnivores, especially species that inhabit dense vegetative cover, such as the ocelot, is difficult. Currently the U.S. population of the Texas ocelot subspecies has fewer than 100 individuals, found in two separated populations in southern Texas (FWS 2010). A third and larger population of the Texas/Tamaulipas ocelot subspecies occurs more than 200 km (~124 mi) south of the Texas/Mexico border in the Sierra of Tamaulipas, Mexico (Caso 1994).

In Arizona, four individuals have recently been documented, including the following: 1) one ocelot in the Whetstone Mountains in 2009; 2) one subadult male (road-killed) near Globe in 2010; 3) one male in the Huachuca Mountains in 2011; and 4) one ocelot (sex unknown) in the Huachuca Mountains in 2012 (email from Tim Snow, AGFD, March 13, 2013). Both ocelots in the Huachuca Mountains have been re-detected on multiple occasions. However, detections of ocelots in southern Arizona remain an uncommon occurrence.

In addition to the recent Arizona sightings, a number of ocelots have been documented just south of the U.S. border in Sonora, Mexico. Specifically, with the use of camera traps, six ocelots were documented between February 2007 and April 2011 in the Sierra Azul, about 30 miles southeast of Nogales, including two males, one female, one kitten, and two of undetermined sex (Avila-Villegas and Jessica Lamberton-Moreno 2012). Additionally, one ocelot was documented in 2009 in the Sierra de Los Ajos, about 30 miles south of the U.S. border near Naco, Mexico (FWS 2010).

In Sonora, López González *et al.* (2003) obtained 36 verified ocelot records, 21 of which were obtained after 1990, including 19 individual male records, 6 females, and 11 of undetermined sex. A population of 2,025 + 675 ocelots in Sonora was estimated by López González *et al.* (2003) based on the distribution of these records and the availability of potential habitat. Out of the 26 records, the northern-most record of a female was at 30°30’ latitude and only one record was of a kitten (located in the southern part of Sonora) (López González *et al.* 2003).

Although methods used to calculate densities vary among studies, some ocelot population density estimates for particular habitats include: 5.7/100 km^2 (38.6 $miles^2$) in subtropical thornscrub to tropical deciduous forest in Sonora, Mexico (Carrillo and López González 2002); 25/100 km^2 to 225/100 km^2 in the tropical deciduous forest of Jalisco (Casariego Madorell 1998; Fernandez 2002); 30 adult ocelots/100 km^2 in Bolivian dry-forests (Maffei *et al.* (2005); and 40 adult ocelots/100 km^2 in the llanos (interspersed dry tropical forest in savanna) of central Venezuela (Ludlow and Sunquist 1987).

Threats

Although the ocelot is protected over most of its range (Fuller *et al.* 1987), it is still threatened by habitat loss and fragmentation due to increased human development, agriculture, and cattle grazing; illegal killing (e.g., retaliatory killing due to depredation of poultry); and illegal trade (pet and pelt) (Fernandez 2002, FWS 2010, Caso *et al.* 2008). Widespread commercial harvests for the fur trade ceased decades ago (Caso *et al.* 2008); however, human population growth and development continue throughout the ocelot’s range. Connectivity among ocelot populations or colonization of new habitats is discouraged by the proliferation of highways and increased road mortality among dispersing ocelots. Increased illegal and law enforcement actions along the Mexico-United States border could limit ocelot movement across the border, but it is uncertain if and how much this is affecting that movement.

In Texas, collisions with motor vehicles appear to be the leading cause of known ocelot mortality and accounted for 45 percent of deaths of 80 radio-tagged ocelots between 1983 and 2002 (FWS 2010). Twenty-six of 61 ocelot deaths between 1983 and 2004 were caused by vehicle collisions in Texas (FWS 2010). Since 2007, in Arizona and Northern Sonora, there have been four documented cases of ocelots being killed by vehicles or illegally killed, including: one ocelot struck close to Globe; one ocelot struck on Mexico Highway 2, between Imuris and Cananea, Sonora; and two ocelots illegally killed in the Sierra Azul (email from Sergio Avila, Sky Island Alliance, March 15, 2013).

Planning and Conservation Efforts

The ocelot is included on CITES Appendix I and is protected across most of its range (Caso *et al.* 2008). Part of the species range includes protected areas, including some capable of maintaining long-term viable populations (Caso *et al.* 2008). While loss and fragmentation of habitat adversely affect ocelot populations, there have been notable efforts to acquire, protect, and restore habitat, and decrease mortality of the species in Texas and northeastern Mexico (see FWS 2010 for a detailed account of planning and conservation efforts made for the ocelot in Texas and northeastern Mexico).

Some planning efforts have also been made for the Sonora subspecies. For example, the recovery plan for ocelots is currently being updated and includes conservation planning efforts for ocelots in Arizona and Sonora. Among others, a specific delisting criterion includes the identification and protection of habitat linkages to facilitate a metapopulation in Sonora and Arizona. Additionally, Grigione *et al.* (2009) conducted a study to identify priority conservation areas for jaguars, ocelots, and jaguarundis in the U.S. – Mexico border region. For ocelots, it was determined that little was known in the western bioregion (Arizona-Sonora). One Cat Conservation Unit (CCU) of high priority was identified in the Sierra Madre Occidental (in Sonora) and two corridors (from the Sonora CCU to the U.S.) and one CCU (in the U.S.) were identified as needing further study.

Few conservation implementation efforts have been made specifically for the Sonora subspecies; however, conservation efforts made for jaguars undoubtedly also contribute to ocelot conservation. For example, the Northern Jaguar Project purchased a total of 18,211 hectares (45,000 acres) to create the Northern Jaguar Reserve for the protection of jaguars in Sonora. Ocelots also occur there and will benefit from this protection. Rancho El Aribabi, a privately owned ranch in northern Sonora where ocelots occur, was recently recognized by the Mexican government as a reserve. Additionally, the Northern Jaguar Project implements a felid photograph project in Sonora where private landowners are paid for photos of live felids. Although primarily designed to support the conservation of jaguars, the project also benefits ocelots. Sky Island Alliance (2013) is also conducting felid surveys and landowner outreach in northern Sonora. During this effort, they documented the most recent ocelot occurrences in the extreme northern Sonora, including a female with a kitten. Lastly, it is possible that the proposd critical habitat for jaguar will afford some protection to ocelots occurring in the U.S., though the species respective habitat preferences differ.

Environmental Baseline - Ocelot

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions that are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Action Area

The action area is defined as the area within which effects to the listed species and its critical habitat (if any is designated) are likely to occur and is not limited to the actual footprint of the proposed action. The proposed action falls within the range of the Sonora subspecies as well as within the ASMU as defined in the draft revised Ocelot Recovery Plan (FWS 2010). Although ocelots have not been documented in the Santa Rita Mountains, it is believed that they may occur there. For the purposes of the ocelot analysis, we use the Forest Service Acton Area definition (i.e., defined by hydrology).

Terrain, Vegetation Communities, and Climate in the Action Area

See the Action Area Section above for a description of terrain, vegetation communities, and climate in the action area.

Status of the Ocelot in the Action Area

Life History and Habitat

Life history of the ocelot is described above in the Status of the Species. Generally, life history elements are similar throughout their range, although some, such as diet and vegetation community use vary by region (see Status of the Species). As discussed in greater detail in the Status of the Species, no home range or habitat use studies have been conducted for the Sonora subspecies of ocelot in northwestern Mexico or Arizona, however ocelots in Sonora appear to be primarily associated with tropical or subtropical habitats, namely subtropical thornscrub, tropical deciduous forest and tropical thornscrub (López González *et al.* 2003); however, they are also associated with other vegetation types such as temperate oak woodland and pine-oak forest (López González *et al.* 2003) and Madrean evergreen woodland (Avila-Villegas and Jessica Lamberton-Moreno 2012). Based on limited records, in Arizona ocelots appear to be associated with Madrean evergreen woodland (Avila-Villegas and Jessica Lamberton-Moreno 2012) and Madrean lower montane pine-oak forest and woodland email from Tim Snow, AGFD, March 13, 2013).

Potential ocelot habitat in Arizona is yet to be quantified, but could become increasingly important to the survival of the ocelot as threats (i.e., illegal killing, land conversion, etc.) continue in Sonora. Ocelots in Arizona and Sonora represent a distributional extreme and the important genetic/adaptive resources that can characterize peripheral populations (Lomolino and Channell 1995). Similar to the jaguar, conservation of ocelots in their northern-most portion of their range may be important to the long-term survival of ocelots

Distribution, Abundance, and Population Trends

The Arizona/Sonora ocelot subspecies occurs in southern Arizona and northwestern Mexico

(Sonora and northern Sinaloa) (FWS 2010). Breeding populations occur in the States of Sonora and northern Sinaloa (FWS 2010). As stated above in the “Status of the Species”, estimating population sizes of secretive nocturnal carnivores, especially species that inhabit dense vegetative cover, such as the ocelot, is difficult. In Sonora, López González *et al.* (2003) obtained 36 verified ocelot records, 21 of which were obtained after 1990, including 19 individual male records, 6 females, and 11 of undetermined sex. A population of 2,025 + 675 ocelots in Sonora was estimated by López González *et al.* (2003) based on the distribution of these records and the availability of potential habitat. Out of the 26 records, the northern-most record of a female was at 30°30’ latitude and only one record was of a kitten (located in the southern part of Sonora) (López González *et al.* 2003). In northern Sonora, a number of ocelots have recently been documented just south of the U.S. border in Sonora, Mexico. Specifically, with the use of camera traps, six live ocelots were documented between February 2007 and April 2011 in the Sierra Azul, about 30 miles southeast of Nogales, including two males, one female, one kitten, and two of undetermined sex; three dead ocelots were documented in the same area during the same timeframe (Avila-Villegas and Jessica Lamberton-Moreno 2012). Additionally, one ocelot was documented in 2009 in the Sierra de Los Ajos, about 30 miles south of the U.S. border near Naco, Mexico (FWS 2010).

Although no field survey (i.e., camera-trap, track, or scat) efforts specifically for ocelots have been conducted in Arizona, four individuals have recently been documented, including the following: 1) one ocelot in the Whetstone Mountains in 2009; 2) one subadult male (road-killed) near Globe in 2010; 3) one male in the Huachuca Mountains in 2011; and 4) one ocelot (sex unknown) in the Huachuca Mountains in 2012 (email from Tim Snow, AGFD, March 13, 2013). Both ocelots in the Huachuca Mountains have been re-detected on multiple occasions. Detections of ocelots on southern Arizona remain uncommon.

No ocelots have been detected in the Santa Rita Mountains, site of the proposed action. However, based on habitat type (i.e., Madrean evergreen woodland) it is believed that ocelots may or could occur in these mountains (personal communication with Tim Snow, AGFD, March 18, 2013, and Sergio Avila, SIA, March 18, 2013). If ocelots occur in the Santa Rita Mountains, they are likely part of a population occurring primarily to the south. As stated above, ocelots are known to occur in the Huachuca Mountains in Arizona and the Sierra Azul in Sonora; however they have also been documented in the Whetstone Mountains and Globe (i.e., to the east and northeast of the Santa Rita Mountains, respectively). In between the Santa Ritas and the Sierra Azul lie the Patagonia Mountains. Although no ocelots have been documented in the Patagonias, this range is connected to areas south of the border, does not have an impermeable border fence, and habitat there is similar to that found in the Sierra Azul.

Threats

Threats to the Sonora subspecies of ocelot are similar to threats to the species throughout its range as described under “Status of the Species”. Recently documented cases of ocelots being killed by vehicles (Arizona and Sonora) and illegally killed (Sonora only) in the northwestern most portion of the ocelot range corroborate the hypothesis that roads/vehicles and illegal killing of ocelots are still among the primary threats to ocelot in this region. Other threats include habitat loss and fragmentation due to, among other things, urban expansion and roads. Connectivity among ocelot populations or colonization of new habitats is discouraged by the proliferation of highways.

Other threats to ocelots in this region are international border issues such as 1) infrastructure along and near the U.S. - Mexico border, including pedestrian and vehicle barriers and towers and their associated roads and lighting; and 2) illegal and U.S. Border Patrol traffic (pedestrian and vehicle). Fences designed to prevent the passage of humans (i.e., pedestrian barriers) undoubtedly also prevent passage of ocelots. Other infrastructure (e.g., vehicle barriers, towers, roads, and lighting) and human activity may limit ocelot movement across the border, but it is uncertain if and how much this is affecting that movement. Connectivity to Mexico is likely essential for maintaining ocelots in Arizona (the northern portion of the ASMU). As included in the recovery criteria for this species, delisting the species will require that habitat linkages to facilitate an ASMU metapopulation are identified and conserved for the foreseeable future.

Planning and Conservation Efforts

Significant planning and conservation efforts have been made for the ocelot in certain parts of its range, such as Texas. As described above in "Status of the Species", some planning and conservation efforts have also been made for the Sonora subspecies.

Past and Ongoing Federal Actions in the Action Area

Although a number of Federal actions have occurred in the action area, none of these actions has undergone formal consultation for effects to ocelot; therefore, no incidental take has been anticipated for ocelots in the action area.

Effects of the Proposed Action - Ocelot

"Effects of the action" refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR §402.02). Indirect effects occur later in time but are reasonably certain to occur. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR §402.02).

The proposed action may result in degradation of potential ocelot habitat and disturbance to ocelots, if they occur in the action area. Construction and operations of the mine, including the associated roads, will result in removal, destruction, and degradation of potential ocelot and ocelot prey habitat and may disturb ocelots, if they occur in the action area, causing changes in, among other things, their habitat use and movement patterns. Conservation measures included in the project description may help offset adverse effects to ocelots to some extent.

<u>Direct and Indirect Effects of Project Construction</u>

The BA defines the project area as all areas in which any ground disturbance would take place as a result of the proposed action, including the mine pit, waste rock facilities, tailings, access roads, utility corridors, and on-site facilities (i.e., the mine "footprint" or area within the security fence plus roads, corridors, and trails). The project area acreage, expected to result in direct impacts owing to project activities, is 5,393 acres (22 km^2), which includes areas within the security fence (4,228 acres), the primary access road (226 acres), the utility line corridor (867 acres), the Sycamore connector road (26 acres), decommissioned or new forest roads (54 acres), and the rerouted Arizona National Scenic Trail (19 acres) (see FEIS).

According to our calculations using ArcMap, the footprint of the security fence plus roads (primary and secondary access roads) will remove 2,506 acres (1,014 ha) of Madrean evergreen woodland and 2,273 acres (919 ha) of semidesert grassland (see FEIS). Madrean evergreen woodland is more likely to be used by ocelots than semidesert grassland; however, ocelots have been occasionally documented using grasslands in areas outside of Arizona. Therefore, it is possible that ocelots may use semidesert grassland, particularly when moving between patches of more suitable habitat. Although we do not know the home range size of ocelots in Arizona, considering ocelot home ranges in other parts of their distribution range from 2 to 38 km^2 (1,235 to 9,390 acres), using only the area of Madrean evergreen woodland that will be removed by the project, an equivalent of about 0.3 to 2.3 potential ocelot home ranges may be directly impacted (eliminated) by the project footprint assuming no overlap in home ranges. However, because ocelot home ranges overlap (Murray and Gardner 1997, Fernandez 2002, Dillon and Kelly 2008), the project footprint could impact additional ocelot home ranges. Removal of semidesert grassland may also impact ocelots, particularly their movement between patches of more suitable habitat. In addition to eliminating potential ocelot habitat, the project will also result in the direct removal of about 5,393 acres of ocelot prey habitat, possibly leading to a reduced prey base for ocelots.

Outside of the security fence, a perimeter barbed-wire fence will be constructed. The perimeter fence will encompass 6,990 acres of land (FEIS); however, except where specific features such as the primary or secondary access roads are located, the land between the perimeter fence and the security fence will not be disturbed. Together, the perimeter fence plus roads will affect 3,479 acres (1,407 ha) of Madrean evergreen woodland and 4,071 acres (1,647 ha) of semidesert grassland. Given the influence of human and vehicular activity, noise, and lighting (see discussion below for information on effects of noise, lights, and traffic on ocelots) within the perimeter fence, we anticipate that ocelots, if they occur in the area, would likely avoid most or all areas within the perimeter fence. If this is the case, then the mine will impact (using only the area of Madrean evergreen woodland that will be affected) an equivalent of about 0.4 to three potential ocelot home ranges, possibly more considering home range overlap and potential ocelot use of semidesert grassland.

Because the project footprint completely bisects a north-south oriented swath of Madrean evergreen woodland (see Figure I-1), potential ocelot movement to the northern portion of the Madrean evergreen woodland swath from the main portion of Madrean evergreen woodland in the Santa Ritas (see Figure I-4) or vice-versa may be impeded. If ocelots occurring in the main portion of Madrean evergreen woodland were completely cut-off from the northern portion, this would mean an additional ~5,000 acres of suitable potential ocelot habitat (all Madrean evergreen woodland) would become unavailable to ocelots, if they occur in the area. If ocelots currently occur to the north of the mine, after project construction, they may become isolated from ocelots to the south. It may be possible for ocelots to move around the mine; however, the semidesert grassland to the east and west of the mine does not appear to provide as much cover for ocelots as the Madrean evergreen woodland, therefore making it less likely that ocelots would use it. Additionally, because some areas to the east and west of the mine will be subjected to the effects of lighting, noise, and vibrations (see discussion below on effects of lighting, noise, and vibrations), it seems even more unlikely that ocelots, if they occur in the area, would move around the mine to reach the northern portion of the Madrean evergreen woodland swath. Habitat loss associated with the project may cause any ocelots that might occur in the area, to shift their home ranges to the south which could result in increased intra- and inter-specific competition.

Construction activities associated with all aspects of the project may disturb ocelots, if they occur in the area, and cause them to flee and/or avoid the area. Construction of the primary access road, over half of which is in Madrean evergreen woodland, is more likely to result in disturbance to ocelots than construction of and upgrades to the utility maintenance road which crosses through semidesert grassland. Disturbance to ocelots can result in behavioral changes, increased energetic expenditures, and interference with habitat use, including use of movement corridors. These could lead to decreased dispersal opportunities; changes in home range size and location; increased inter- and intra-specific competition; increased difficulty meeting energetic needs; etc. Once project construction is complete, ocelots would be excluded from the area as it will be devoid of habitat, as described above. Ocelot avoidance of the project area could cause them to travel longer distances, possibly into or through less suitable habitat. Extra travel would require ocelots to expend additional energy and increase the potential for encounters with humans, vehicles, potential predators (i.e., cougars, jaguars), and other stresses.

Disturbed ground associated with mine and road construction will be susceptible to colonization by invasive nonnative plants such as Lehmann lovegrass. Nonnative species may outcompete native species and the introduced grasses also carry fire better and burn hotter than the native species, which would degrade ocelot habitat. That said, the project proponent plans to monitor and control invasive nonnative plants throughout the project area.

Effects of Lighting, Noise, and Vibrations from Mining Operations

In addition to the direct project footprint, ocelots that might occur within the vicinity of the project footprint may also be adversely affected by light, noise, and vibrations associated with the project. Although Rosemont has developed a light pollution mitigation plan, artificial illumination will increase light levels at night, which could impact ocelots, if they occur in the area, resulting in a wide variety of effects, including, but not limited to, changes in behavior, habitat use, and dispersal and movement patterns (Beir 1995, Longcore and Rich 2004). Artificial lighting will originate from mine-site illumination and also from vehicles in the project area and beyond. Horizontal light will extend to at least 12 miles beyond the project, in some areas, and sky glow from the project is expected to be comparable, but less than, sky glow from Ajo, Arizona (a town of about 3,300 people) (WestLand 2012). The light intensity will be highest at the mine and attenuate farther from the mine. Most areas within a 12-mile radius will be blocked from line of sight horizontal light emanating from the project area; however, ocelots are mobile animals that travel over hills and ridgetops, and therefore would likely see the lighting (horizontal) during regular movement activities or during dispersal (WestLand 2012). Additionally, sky glow will likely be visible to ocelots in the vicinity of the mine at all times at night.

No data exists on the effects of artificial lighting on ocelots; however, in Peru, Emmons (1989) found that while ocelots were equally active during moonlit and dark nights they avoided open areas on moonlit nights (they likewise avoided open areas by day). They concluded that ocelots therefore generally seemed to shift their foraging to denser cover in bright light conditions. They also found that spiny rats, a major prey of ocelots, are equally active during moonlit and dark conditions; however they also changed their behavior so as to be hidden from view of trails on bright nights. They suggest that ocelots seem more likely to have their hunting impeded than enhanced by bright light conditions, which may hinder their ability to approach its prey unseen. In Southern California, radio-collared mountain lions usually avoid habitat corridors that contain artificial lights (Beier 1995). During overnight monitoring, mountain lions made consistent movements in the direction of the darkest horizon. Dispersers especially avoided night-lights in conjunction with open terrain (Beier 1995). Installation of light in cattle corrals is a well-known technique to reduce jaguar predation of cattle (because jaguars avoid lighted areas). Other studies have shown that moonlight greatly influences the activity levels of nocturnal rodents (i.e., ocelot prey) such that rodent activity may decrease and/or shift from open areas to cover as light level of moonlight increases (Grigione and Mrykalo 2004).

Although the effects of artificial lighting on ocelots is not known, given that they use denser cover during bright moon light conditions, we anticipate that they will seek areas of denser vegetation wherever horizontal light enters habitat. It is difficult to understand how sky glow may be perceived by ocelots, but because it is not shining down from above, it may not have the same effect as bright moon conditions. Never-the-less, sky glow may increase the ambient illumination in the area, which could potentially affect ocelots to some degree.

Because areas to the east, southeast, west, and northwest of the project area appear (on Google Earth) less densely vegetated than areas within the perimeter fence, ocelots may avoid or reduce their movement past or around the mine altogether. This could mean that potential east-west ocelot movement (dispersal) between the Santa Rita and Whetstone mountains could be restricted. If they do move around, as mentioned above, extra travel would require ocelots to expend additional energy and increase the potential for encounters with humans, vehicles, potential predators (i.e., cougars, jaguars), and other stresses.

Similarly, noise and vibrations from construction of the mine or blasting could disturb ocelots, if they occur in the area, possibly causing, among other things, changes in breeding behaviors, home ranges size and location, and habitat use, activity, and foraging patterns; increased stress response; and possibly damaged hearing if the noise is loud enough (NoiseQuest 2013; Pater *et al.* 2009). As with lighting, the magnitude of impacts from vibration and light are uncertain, but these impacts are expected to decrease as the distance from the mine increases. In the same or similar manner that lighting, noise, and vibrations affect ocelots, these anthropogenic disturbances may also adversely affect ocelot prey, leading to a reduced prey base for ocelots.

<u>Indirect Effects of Roads</u>

The primary access road, a new 2-lane paved road, will be constructed to provide access between SR83 and the mine. The primary access road will leave SR 83 along a straight section of the highway, just to the east of the northern portion of the perimeter fence. The majority of the primary access road skirts the northeastern portion of the perimeter fence. In addition to the primary access road, Rosemont and the Coronado National Forest will build a new access road into Sycamore Canyon. This road will also occur along the northern portion of the perimeter fence, but north of the fence. The primary access road from SR 83 to the perimeter fence will be open to the public at all times. During mine operations, the primary access road between the perimeter fence and the mine will be closed to the public; however, after mine closure, it will be open to public use. The Sycamore connector road will also be open to the public at all times. Because these roads cut across Madrean evergreen woodland and heavy vehicular use of the primary access road (which will vary from passenger vehicles to haul trucks and heavy equipment) is anticipated day and night (traffic along the new access road into Sycamore Canyon is anticipated to be limited), vehicle collisions with ocelots could occur. However, given that ocelots in Arizona are scarce and only one ocelot is known to have been struck by a vehicle in Arizona, it seems unlikely that there is great risk of vehicles striking ocelots on the primary access road. Vehicles will likely collide with potential ocelot prey; however, we do not anticipate it will have a significant impact on the ocelot prey base.

The Primary Access and Sycamore Connector roads will fragment suitable habitat between the mine footprint and areas to the north (see Figure 1 of the June 2012 BA and Figures I-1, I-2, and J-3 in this document). However, as stated above, we anticipate ocelots, if they occur in the area, would avoid most or all areas within the perimeter fence given the human influence between the project footprint and perimeter fence. The Sycamore connector road will also fragment suitable habitat outside of the perimeter fence, and provide public access to areas north of the mine. Improved accessibility in this area will likely result in increased public use in suitable ocelot habitat which may lead to somewhat increased: (1) disturbance to ocelots in the area, (2) risk of collision with ocelots, (3) habitat degradation, (4) risk of human-caused fire, (5) risk of illegal killing of ocelots, and (6) human presence in remote areas (i.e., roads may facilitate increased off-road vehicle and pedestrian traffic in the area).

The utility maintenance road (previously called the secondary access road), located within the utility corridor, crosses through semidesert grassland to the northwest of the mine. Vehicle traffic is expected to be much lighter on this road in comparison to that on the primary access road. Therefore, we anticipate the chance of vehicles colliding with ocelots is very low. The road will be closed to the public during mine construction and operation; however, after the mine is closed, portions of the road may be reopened to the public. This could result in increased public access to ocelot habitat which could lead to an increase in the six aforementioned threats. Disturbed ground will be susceptible to colonization by invasive nonnative plants such as buffelgrass and Lehmann lovegrass. Nonnative species may outcompete native species and the introduced grasses also carry fire better and burn hotter than the native species, which would degrade potential ocelot habitat.

As a result of the mine, increased traffic is anticipated on SR83 (likely primarily on the part of the road that heads from the mine to the north, located within semidesert grassland) and possibly on Box Canyon Road (part of which crosses through Madrean evergreen woodland) which may lead to an increased risk of ocelots being struck by vehicles. However, as stated above, this risk is likely fairly low. Increased vehicular traffic on these roads will likely lead to increased collisions with ocelot prey; however, we do not anticipate this will have a significant impact on the ocelot prey base.

Effects of Conservation Measures

The conservation measures that are part of the proposed action act to some extent to offset some adverse effects to ocelots. For example, purchase of land parcels, particularly Sonoita Creek Ranch (1,200 acre parcel) which contains some Madrean evergreen woodland and riparian habitat and provides habitat connectivity between the Patagonia and Santa Rita Mountains, may benefit ocelots. Additionally, the project proponent will provide $50,000 to AGFD or other suitable entity approved by the Coronado National Forest to support camera studies for predators including jaguar and ocelot. The money will be provided for additional monitoring efforts between the Santa Rita and the Whetstone Mountains and along the Santa Rita Mountains. In addition to increasing knowledge regarding the movement of wildlife in the area, information collected during this investigation may identify a suitable wildlife crossing structure location that could be constructed. That said, $50,000 is likely only enough funding to conduct carnivore monitoring in a limited geographic area for about six months which is generally not a sufficient amount of time to collect quality data on cryptic carnivore movement.

Effects to Recovery of the Ocelot in the ASMU with the Project

As stated in the "Status of the Species" delisting criteria for the ASMU are 1) the ASMU population is estimated through reliable scientific monitoring to be above 2,000 animals for 10 years; 2) significant threats to this population have been identified and addressed; and 3) habitat linkages to facilitate an ASMU metapopulation have been identified and are conserved for the foreseeable future. Although the northern part of the ASMU, where the proposed action is located, is likely important to the recovery of the ocelot in the ASMU, we do not anticipate that the proposed action will preclude recovery of the ASMU. The proposed action may directly and indirectly impact sufficient habitat to support a handful of ocelot home ranges and may also reduce connectivity with areas to the north and east. That said, because the project will affect a relatively small area of the overall ASMU, it is likely that the ASMU population goal of 2,000 ocelots could still be reached even with the impacts from the mine, particularly given that most of the ASMU occurs in Sonora. Because habitat linkages to facilitate an ASMU metapopulation have not been identified, the extent to which this project may impact those habitat linkages is not known.

Cumulative Effects - Ocelot

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

Many lands within the action area are managed by Federal agencies; thus, many activities that could potentially affect ocelots are Federal activities that are subject to section 7 consultation. The effects of these Federal activities are not considered cumulative effects. However, a portion of the action area also occurs on private lands. Residential and commercial development, road construction, farming, livestock grazing, mining, off-highway vehicle use, and other activities occur on these lands and are expected to continue into the foreseeable future. These actions, the effects of which are considered cumulative, may result in fragmentation, loss, or degradation of ocelot habitat and disturbance to ocelots. Although not documented recently in the U.S., illegal hunting of ocelots adversely affects ocelots. Illegal activities associated with cross-border smuggling and illegal immigration (e.g., human traffic, deposition of trash, creation of trails and routes, and increased fire risk from human traffic) also occur in the action area. These activities can also degrade ocelot habitat and disturb ocelots.

Conclusion - Ocelot

After reviewing the current status of the ocelot, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the ocelot. Critical habitat has not been designated for this species; thus no critical habitat will be affected by the proposed action. We base our conclusion on the following:

1. Although we anticipate the proposed action will result in the loss of potential ocelot habitat, the loss is relatively small in the context of the range of the ASMU of ocelot. Thus, the project is not expected to significantly affect the distribution, numbers, and reproduction of ocelots in the ASMU.
2. Although connectivity to ocelot habitat to the north and east may be reduced, connectivity of ocelot habitat south of the mine to Mexico will remain intact. Thus, the project is not expected to significantly affect the distribution, numbers, and reproduction of ocelots in the ASMU.
3. Conservation measures in the proposed action are anticipated to offset adverse effects of the proposed action to ocelots to some extent.

INCIDENTAL TAKE STATEMENT- OCELOT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act, prohibit take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. “Harm” is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided such taking is in compliance with this Incidental Take Statement.

Amount or Extent of Take Anticipated - Ocelot

Occupancy is difficult to document for rare and secretive animals. While there are no documented occurrences of ocelots in the Santa Rita Mountains, we conclude that, based on the consistent and increasing occurrence of ocelots in adjacent areas and the presence of appropriate habitat and habitat connectivity, ocelots are likely to occur in the project area. However, we do not anticipate the proposed action will result in incidental take of ocelots because, although we consider the action area likely to be occupied by ocelots, we do not believe it meets the standards relating to documented occupancy as defined under the Arizona Cattle Growers' Association v. U.S. Fish and Wildlife Service decision in 2001 by the 9th Circuit Appellate Court (273 F.3d 1229). If, however, ocelots are definitively documented in the action area in the future, reinitiation of consultation would be prudent to reexamine incidental take.

Status of the Species - Pima Pineapple Cactus

The Pima Pineapple cactus was listed as an endangered species without critical habitat on September 23, 1993 (58 FR 49875). Factors that contributed to the listing include habitat loss and degradation, habitat modification and fragmentation, limited geographical distribution and species rareness, illegal collection, and difficulties in protecting areas large enough to maintain functioning populations. In 2005, a 5-year review was initiated for the Pima Pineapple cactus (70 FR 5460). This review was completed in 2007 and recommended no change to the cactus's classification as an endangered species (U.S. Fish and Wildlife Service 2007).

Recent investigations of taxonomy and geographical distribution focused in part on assessing the validity of the taxon (see Baker 2004, Baker 2005, and Schmalzel *et al.* 2004). Although there is evidence for a general pattern of clinal variation across the range of the species (Schmalzel *et al.* 2004), this does not preclude the recognition of taxonomic varieties within *C. sheeri* (= *C. robustispina*). Baker (2005) found that there are distinct geographical gaps between the distribution of this subspecies and the other subspecies, which occur in eastern Arizona, New Mexico, and Texas, and that the subspecies are morphologically coherent within their respective taxa (Baker 2004). His geographical and morphological work supports the idea that the sub-specific groups within *C. robustispina* are indeed discrete, and merit separate taxonomic status as subspecies (U.S. Fish and Wildlife Service 2007).

We have determined that Pima Pineapple cactus that are too isolated from each other may not be effectively pollinated. For example, the major pollinator of Pima Pineapple cactus is thought to be *Diadasia rinconis*, a ground-nesting, solitary, native bee. McDonald (2005) found that Pima Pineapple cactus plants need to be within approximately 600 m (1,969 ft) of each other in order to facilitate effective pollination. Based on this information and other information related to similar cacti and pollinators, we have determined that Pima Pineapple cactus plants that are located at distances greater than 900 meters from one another become isolated with regard to meeting their life history requirements. The species is an obligate outcrosser (not self-pollinating), so it is important for plants to be within a certain distance to exchange pollen with each other. Also, the study found that pollination was more effective when other species of native cacti are near areas that support Pima Pineapple cactus. The native bees pollinate a variety of cacti species and the sole presence of Pima Pineapple cactus may not be enough to attract pollinators.

The Pima Pineapple cactus occurs south of Tucson, in Pima and Santa Cruz counties, Arizona, as well as in adjacent northern Sonora, Mexico. In Arizona, it is distributed at very low densities throughout both the Altar and Santa Cruz valleys, and in low-lying areas connecting the two valleys. This cactus generally grows on slopes of less than 10 percent and along the tops (upland areas) of alluvial bajadas. The plant is found at elevations between 2,360 feet (ft) and 4,700 ft

(Phillips *et al.* 1981, Benson 1982, Ecosphere Environmental Services Inc. 1992), in vegetation characterized as either or a combination of Arizona upland of the Sonoran desertscrub community and semi-desert grasslands (Brown 1982, Johnson 2004). Paredes-Aguilar *et al.* (2000) reports the subspecies from oak woodlands in Sonora. Several attempts have been made to delineate habitat within the range of Pima Pineapple cactus (McPherson 2002, RECON Environmental Inc. 2006, U.S. Fish and Wildlife Service unpublished analysis) with limited success. As such, we are still unable to determine exact ecological characters to help us predict locations of Pima Pineapple cactus or precisely delineate Pima Pineapple cactus habitat (U.S. Fish and Wildlife Service 2007), except perhaps in localized areas (U.S. Fish and Wildlife Service 2005).

As a consequence of its general habitat requirements, considerable habitat for this species appears to exist in Pima and Santa Cruz counties, much of which is unoccupied. Pima Pineapple cactus occurs at low densities, widely scattered, sometimes in clumps, across the valley bottoms and bajadas. The species can be difficult to detect, especially in dense grass cover. For this reason, systematic surveys are expensive and have not been conducted extensively throughout the range of the Pima Pineapple cactus. As a result, location information has been gathered opportunistically, either through small systematic surveys, usually associated with specific development projects, or larger surveys that are typically only conducted in areas that seem highly suited for the species. Furthermore, our knowledge of the distribution and status of this species is gathered primarily through the section 7 process; and we only see projects that require a Federal permit or have Federal funding. There are many projects that occur within the range of Pima Pineapple cactus that do not undergo section 7 consultation, and we have no information regarding the status or loss of plants or habitat associated with those projects. For these reasons, it is difficult to address abundance and population trends for this species.

The AGFD maintains the Heritage Data Management System (HDMS), a database identifying elements of concern in Arizona and consolidating information about their distribution and status throughout the state. This database has 5,553 Pima Pineapple cactus records, 5,449 Pima Pineapple cactus of which have coordinates. Some of the records are quite old, and we have not confirmed whether the plants are still alive. We also cannot determine which plants may be the result of multiple surveys in a given area. Of the known individuals (5,553), approximately 1,340 Pima Pineapple cactus plants are documented in the database as extirpated as of 2003. There have been additional losses since 2003, but that information is still being compiled in the database. The database is dynamic, based on periodic entry of new information, as time and staffing allows.
As such, the numbers used from one biological opinion to the next may vary and should be viewed as a snapshot in time at any given moment. We have not tracked loss of habitat because a limited number of biological assessments actually quantify habitat for Pima Pineapple cactus.

We do know the number and fate of Pima Pineapple cactus that have been detected during surveys for projects that have undergone section 7 consultation. Through 2010, section 7 consultations on development projects (e.g., residential and commercial development, mining, infrastructure improvement) considered 2,680 Pima Pineapple cactus plants found on approximately 15,192 acres within the range of the Pima Pineapple cactus. Of the total number of plants, 1,985 Pima Pineapple cactus (74 percent) were destroyed, removed, or transplanted as a result of development, mining, and infrastructure projects. In terms of Pima Pineapple cactus habitat, some of the 15,192 acres likely did not provide Pima Pineapple cactus habitat, but that amount is difficult to quantify because Pima Pineapple cactus habitat was not consistently delineated in every consultation. Of the 15,192 acres, however, we are aware that 14,545 acres (96 percent) have been either permanently or temporarily impacted. Some of these acres may still provide natural open space, but we have not been informed of any measures (e.g., conservation easements) that have been completed to ensure these areas will remain open. Through section 7 consultation on non-development-related projects (e.g., fire management plans, grazing, buffelgrass control), we are aware of an additional 781 plants within an unknown number of acres; we do not know the number of acres because these types of projects are often surveyed for Pima Pineapple cactus inconsistently, if at all. Across the entire Pima Pineapple cactus range, it is difficult to quantify the total number of Pima Pineapple cactus lost and the rate and amount of habitat loss for three reasons: 1) we review only a small portion of projects within the range of Pima Pineapple cactus (only those that have Federal involvement and are subject to section 7 consultation), 2) development that takes place without any jurisdictional oversight is not tracked within Pima and Santa Cruz counties, and 3) many areas within the range of the Pima Pineapple cactus have not been surveyed; therefore, we do not know how many plants exist or how much habitat is presently available.

Some additional information related to the survival of Pima Pineapple cactus comes from six demographic plots that were established in 2002 in the Altar Valley. The results from the first year (2002-2003) indicate that the populations were stable; out of a total of over 300 Pima Pineapple cactus measured, only 10 died, and two Pima Pineapple cactus seedlings were found (Routson *et al*. 2004). The plots were not monitored in 2004, but were visited again starting in May 2005. In the two years between September 2003 and September 2005, 35 individuals, or 13.4 percent, of the original population had died and no new seedlings were found (Baker 2006). Baker (2006) suggests that recruitment likely occurs in punctuated events in response to quality and timing of precipitation, and possibly temperature, but there is little evidence until such events occur. He goes on to say that further observations need to be made to determine the rate at which the population is declining, because, based on an overall rate of die-off of 13.4 percent every two years, few individuals will be alive at this site after 15 years. As this monitoring program continues, critical questions regarding the life cycle of this species will be answered.

Threats to Pima Pineapple cactus continue to include habitat loss and fragmentation, competition with non-native species, and inadequate regulatory mechanisms to protect this species. We believe residential and commercial development, and its infrastructure, is by far the greatest threat to Pima Pineapple cactus and its habitat. However, we have only a limited ability to track the cumulative amount of development within the range of Pima Pineapple cactus. What is known with certainty is that development pressure continues in Pima and Santa Cruz counties.

Invasive grass species may be a threat to the habitat of Pima Pineapple cactus. Habitat in the southern portion of the Altar Valley is now dominated by Lehmann lovegrass (*Eragrostis lehmanniana*). According to Gori and Enquist (2003), Boer lovegrass (*Eragrostis chloromelas*) and Lehmann lovegrass are now common and dominant on 1,470,000 acres in southeastern Arizona. They believe that these two grass species will continue to invade native grasslands to the north and east, as well as south into Mexico. These grasses have a completely different fire regime than the native grasses, tending to form dense stands that promote higher intensity fires more frequently. Disturbance (like fire) tends to promote the spread of these non-natives (Ruyle *et al.* 1988, Anable *et al.* 1992). Roller and Halvorson (1997) hypothesized that fire-induced mortality of Pima Pineapple cactus increases with Lehmann lovegrass density. Buffelgrass (*Pennisetum ciliare*) has become locally dominant in vacant areas in the City of Tucson and along roadsides, notably in the rights-of-way along Interstate 10 and State Route 86. Some portions of Pima Pineapple cactus habitat along these major roadways are already being converted to dense stands of buffelgrass, which can lead to recurring grassland fires and the destruction of native desert vegetation (Buffelgrass Working Group 2007).

The effects of climate change (i.e., decreased precipitation and water resources) are a threat to the long-term survival and distribution of native plant species, including the Pima Pineapple cactus. For example, temperatures rose in the twentieth century and warming is predicted to continue over the twenty-first century. Although climate models are less certain about predicted trends in precipitation, the southwestern United States is expected to become warmer and drier. In addition, precipitation is expected to decrease in the southwestern United States, and many semi-arid regions will suffer a decrease in water resources from climate change as a result of less annual mean precipitation and reduced length of snow season and snow depth. Approximately half of the precipitation within the range of the Pima Pineapple cactus typically falls in the summer months; however, the impacts of climate change on summer precipitation are not well understood. Drought conditions in the southwestern United States have increased over time and may have contributed to loss of Pima Pineapple cactus populations through heat stress, drought stress, and related insect attack, as well as a reduction in germination and seedling success since the species was originally listed in 1993, and possibly historically. Climate change trends are likely to continue, and the impacts on species will likely be complicated by interactions with other factors (e.g., interactions with non-native species and other habitat-disturbing activities).

The Arizona Native Plant Law can delay vegetation clearing on private property for the salvage of specific plant species within a 30-day period. Although the Arizona Native Plant Law prohibits the taking of this species on State and private lands without a permit for educational or research purposes, it does not provide for protection of plants *in situ* through restrictions on development activities. Even if Pima Pineapple cactus are salvaged from a site, transplanted individuals only contribute to a population if they survive and are close enough (within 900 m [(2,970 ft]) to other Pima Pineapple cactus to be part of a breeding population from the perspective of pollinator travel distances and the likelihood of effective pollination. Transplanted Pima Pineapple cactus have variable survival rates, with moderate to low levels of survival documented. Past efforts to transplant individual Pima Pineapple cactus to other locations have had limited success. For example, on two separate projects in Green Valley, the mortality rate for transplanted Pima Pineapple cactus after two years was 24 percent and 66 percent, respectively (SWCA, Inc. 2001, WestLand 2004). One project southwest of Corona de Tucson involved transplanting Pima Pineapple cactus into areas containing *in situ* plants. Over the course of three years, 48 percent of the transplanted individuals and 24 percent of the *in situ* individuals died (WestLand 2008). There is also the unquantifiable loss of the existing Pima Pineapple cactus seed bank associated with the loss of suitable habitat. Furthermore, once individuals are transplanted from a site, Pima Pineapple cactus is considered to be extirpated from that site, as those individuals functioning in that habitat are moved elsewhere.

Pima County regulates the loss of native plant material associated with ground-disturbing activities through their Native Plant Protection Ordinance (NPPO) (Pima County 1998). The

NPPO requires inventory of the site and protection and mitigation of certain plant species slated for destruction by the following method: the designation of a minimum of 30 percent of on-site, permanently protected open space with preservation in place or transplanting of certain native plant species from the site. There are various tables that determine the mitigation ratio for different native plant species (e.g. saguaros, ironwood trees, Pima Pineapple cactus) with the result that mitigation may occur at a 1:1 or 2:1 replacement ratio. Mitigation requirements are met through the development of preservation plans. The inadvertent consequence of this ordinance is that it has created a “market” for Pima Pineapple cactus. Any developer who cannot avoid this species or move it to another protected area must replace it. Most local nurseries do not grow Pima Pineapple cactus (and cannot grow them legally unless seed was collected before the listing). As a result, environmental consultants are collecting Pima Pineapple cactus seed from existing sites (which can be done with a permit from the Arizona Department of Agriculture and the permission of the private landowner), germinating seed, and placing Pima Pineapple cactus plants grown from seed back on these sites. There have been no long-term studies of transplant projects, thus the conservation benefit of these actions is unknown. Moreover, growing and planting Pima Pineapple cactus does not address the loss of Pima Pineapple cactus habitat that necessitated the action of transplanting cacti in the first place.

Other specific threats that have been previously documented (U.S. Fish and Wildlife Service 1993), such as overgrazing, illegal collection, prescribed fire, and mining, have not yet been analyzed to determine the extent of effects to this species. However, partial information exists. Overgrazing by livestock, illegal collection, and fire-related interactions involving exotic Lehmann lovegrass and buffelgrass may negatively affect Pima Pineapple cactus populations. Mining has resulted in the loss of hundreds, if not thousands, of acres of potential habitat throughout the range of the plant.

The protection of Pima Pineapple cactus habitat and individuals is complicated by the varying land ownership within the range of this species in Arizona. An estimated 10 percent of the potential habitat for Pima Pineapple cactus is held in Federal ownership. The remaining 90 percent is on Tribal, State, and private lands. Most of the federally-owned land is either at the edge of the plant’s range or in scattered parcels. The largest contiguous parcel of federally-owned habitat is the Buenos Aires National Wildlife Refuge, located at the southwestern edge of the plant’s range at higher elevations and with lower plant densities. No significant populations of Pima Pineapple cactus are known from Sonora or elsewhere in Mexico (Baker 2005).

There have been some notable conservation developments for this species. As of 2010, there are two conservation banks for Pima Pineapple cactus, one on a private ranch in the Altar Valley (Palo Alto Ranch Conservation Bank) and another owned by Pima County that includes areas in both the Altar Valley and south of Green Valley. In the Palo Alto Ranch Conservation Bank, 131.6 acres have been conserved to date. In Pima County’s Bank, a total of 530 acres are under a conservation easement at this time (the County offsets its own projects within this bank). Additionally, three large blocks of land totaling another 1,078 acres have been set aside or are under conservation easements through previous section 7 consultations (see consultations 02-21-99-F-273, 02-21-01-F-101, and 02-21-03-F-0406). While not formal conservation banks, these areas, currently totaling 1,739.6 acres, are set aside and managed specifically for Pima Pineapple cactus as large blocks of land, and likely contribute to recovery of the taxon for this reason; therefore, we consider these acres conserved. Another 647 acres of land have been set aside as natural open space within the developments reviewed through section 7 consultation between 1995 and 2010. However, these are often small areas within residential backyards (not in a common area) that are difficult to manage and usually isolated within the larger development, and often include areas that do not provide Pima Pineapple cactus habitat (e.g., washes). Some conservation may occur onsite because of these open space designations, but long-term data on conservation within developed areas are lacking; the value of these areas to Pima Pineapple cactus recovery over the long-term is likely not great.

In summary, Pima Pineapple cactus conservation efforts are currently hampered by a lack of information on the species. Specifically, we have not been able to determine exact ecological characters to help us predict locations of Pima Pineapple cactus or precisely delineate its habitat, and considerable area within the Pima Pineapple cactus range has not been surveyed. Further, there are still significant gaps in our knowledge of the life history of Pima Pineapple cactus; for instance, we have yet to observe a good year for seed germination. From researcher observations and motion sensing cameras, we have learned that ants, Harris' antelope squirrels, and jackrabbits act as seed dispersal agents. Demographic plots have been only recently established, and information is just now beginning to be reported with regard to describing population dynamics for Pima Pineapple cactus in the Altar Valley.

Development and associated loss of habitat remain important and continuing threats to this taxon. However, the expanding threat of non-native grasses and resulting altered fire regimes are a serious concern for the long-term viability of the species, as is ongoing drought. The full impact of drought and climate change on Pima Pineapple cactus has yet to be studied, but it is likely that, if recruitment occurs in punctuated events based on precipitation and temperature (Baker 2006), Pima Pineapple cactus will be negatively affected by these forces. Already we have seen a nearly 25% loss of individuals across six study sites in the Altar Valley between 2010 and 2011; these deaths were attributed largely to drought and associated predation by native insects and rodents (Baker 2011). Conservation efforts that focus on habitat acquisition and protection, like those proposed by Pima County and the City of Tucson, are important steps in securing the long-term viability of this taxon. Regulatory mechanisms, such as the native plant protection ordinances, provide conservation direction for Pima Pineapple cactus habitat protection within subdivisions, and may serve to reduce Pima Pineapple cactus habitat fragmentation within areas of projected urban growth.

Environmental Baseline - Pima Pineapple Cactus

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Description of the Action Area

For the Rosemont Mine project, we define the action area for Pima Pineapple cactus as the area that will be impacted for the utility corridor (TEP line and the water pipeline). Pima Pineapple cactus are not known or expected to occur within the footprint of the mine and associated structures and facilities occurring at higher elevation within the Santa Rita Mountains. Therefore, the action area for Pima Pineapple cactus includes only the lower elevation portions of the proposed utility corridor up to 4,000 feet elevation (see Figure PPC-1). Within the action area, approximately 24.4 acres of anticipated disturbance will occur within Pima Pineapple cactus habitat along the proposed utility corridor, in addition to any disturbance that may occur on the Helvetia Ranch North conservation lands associated with the development of water features as a conservation measure for other species covered under this BO such as the Chiricahua leopard frog, jaguar, or ocelot (see Conservation Measures D, G, H, and I of the Second Supplemental BA).

The development and identification of alternative routes for the transmission line was based on electrical system requirements and an environmental and public planning process conducted by TEP from the summer of 2008 through the spring of 2010. Environmental studies included a review of land use issues, as well as studies of visual, biological, and cultural resources. Consideration was given to each route's compatibility with established criteria for a Certificate of Environmental Compatibility (CEC) and consideration in the final route selection process by the Arizona Power Plant and Line Siting Committee and the Arizona Corporation Commission (ACC).

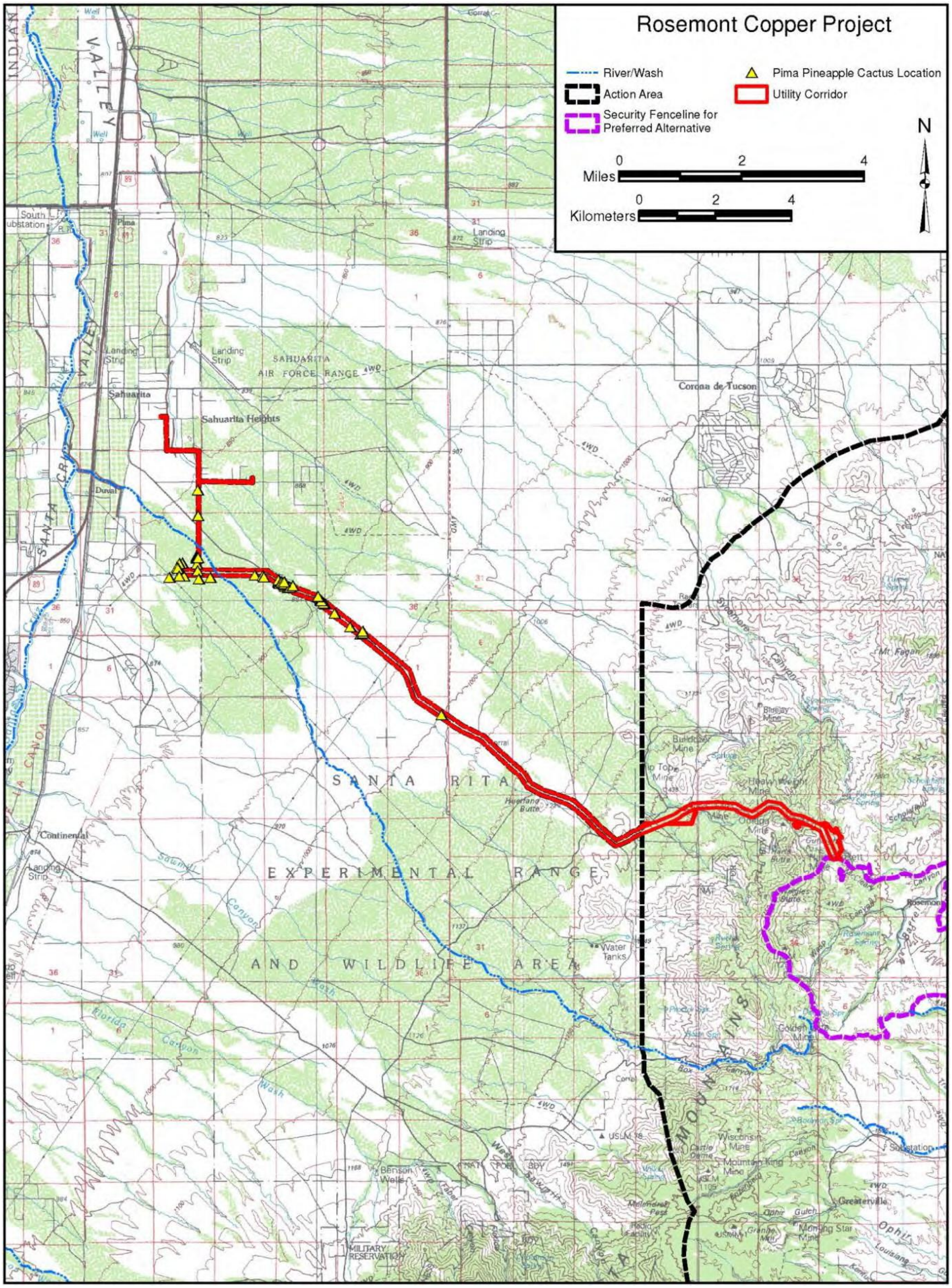


Figure PPC-1: Location of the Utility Corridor and Pima pineapple cacti for the Rosemont Mine project.

Power would be provided from a link attached to existing transmission lines on the South Substation loop. All of the transmission lines alternatives include aboveground 138-kilovolt transmission lines and an associated 14-foot-wide unpaved maintenance road. This set of routing alternatives recommended to be carried forward will be presented to the Arizona Corporation Commission Line Siting Committee. TEP identified a preferred route and four alternatives for consideration; however, only the preferred route is considered this BO. The TEP preferred route runs west of the Santa Rita Mountains ridgeline. The preferred route generally parallels the existing South Santa Rita Road before entering private property held by Rosemont (see Figure PPC-1). The alignment then enters the Rosemont claim block and crosses the ridgeline at Lopez Pass. The ACC has selected the preferred route and a CEC was issued on June 12, 2012.

With regard to the proposed water pipeline, the proposed Rosemont Mine project will use approximately 5,000 acre-feet per year of fresh water, for a total use over the mine life of approximately 100,000 acre-feet. The water will be pumped from four to six wells located on land owned or leased by Rosemont near the community of Sahuarita in the Santa Cruz Valley at a maximum rate of 5,000 gallons per minute (total pumpage), and the pipeline will require booster stations to maintain water flow in the line. The water pipeline alignment will follow the TEP Preferred Alternative Transmission Line (see Figures I-1, PPC-1, and J-3).

The pipeline will be constructed with a minimum soil cover of 36 inches within ASLD easements and up to 24 inches on Rosemont's property, where available and practical, depending on slope, topography, and the availability of material. At wash crossings, the pipeline will be constructed below the calculated scour depth of the wash, and grade control structures will be provided at the largest washes to provide additional protection. Construction of the pipeline will include an unpaved permanent maintenance road and up to five reservoirs and pump stations. The reservoirs and pump stations will be built outside potential jurisdictional WUS.

The action area occurs is northwest of the Santa Rita Mountains extending to the Town of Sahuarita. Topography consists of sloping terrain bisected by washes, with an estimated elevation range from approximately 2,750 to 4,000 feet. The biotic communities present are the Arizona Upland Subdivision of the Sonoran Desert and Semi-desert Grassland (Brown 1994). Typical vegetation within the project area includes creosote bush (*Larrea tridentata*), velvet mesquite (*Prosopis velutina*), catclaw acacia (*Acacia greggii*), barrel cactus (*Ferocactus wislizenii*), and saguaro (*Carnegiea gigantea*).

Land uses within the action area include the residential areas of the Town of Sahuarita, mining activities in the northwest corner of the Santa Rita Mountains, and livestock grazing lands. Much of the action area is included within the Santa Rita Experimental Range. This area of approximately 50,000 acres consists primarily of State Trust lands, and is controlled by the University of Arizona and used to conduct rangeland management research and monitoring.

Status of the Species within the Action Area

<u>Recent Surveys</u>

In 2008, species-specific surveys for Pima Pineapple cactus were conducted along a preliminary water pipeline corridor route (WestLand 2009a), which has since been dropped because it was decided that the water pipeline alignment should follow the TEP power line and utility maintenance road corridor. Hence, in 2009, a new preferred corridor route was selected, and additional surveys were conducted (WestLand 2009b, 2010b) (Figure PPC-1). The preferred 2009 corridor route extends from just east of the town of Sahuarita to the east side of Lopez Pass in the Santa Rita Mountains.

The width of the area surveyed by WestLand ranged from 150 feet to approximately 650 feet (the width of proposed surface disturbance within the survey corridor is expected to be approximately 50 feet). Approximately 18.5 miles of the preferred corridor route were surveyed in 2009; the easternmost 3.2 miles was not surveyed because it was determined that the area has no potential for Pima Pineapple cactus occurrence because of the presence of steep slopes, sandy washes, and bedrock.

The survey followed guidelines provided by USFWS in the document titled Pima Pineapple cactus 3 Tier Survey Methods (Roller 1996). Surveyors walked parallel transects spaced approximately 15 feet apart in order to achieve 100% coverage of the survey area. The survey area was covered in a single pass. Coordinates for all Pima Pineapple cactus found during the survey were entered into a handheld Trimble global positioning system (GPS) unit. Pima Pineapple cactus were tagged with a unique number, and information was collected on the number of stems and general health of each plant.

Forty-seven living Pima Pineapple cactus have been found within the preferred TEP and water pipeline corridor (see Figure PPC-1) (WestLand 2009a, 2009b, 2010b). Given that the width of proposed surface disturbance within the survey corridor is 50 feet, it is likely that several of these cacti would be avoided during construction of the proposed action. The total impact area (i.e., potentially suitable Pima Pineapple cactus habitat along the selected alternative route) is estimated to be approximately 24.4 acres (8.4 permanent, 16.0 temporary).

Effects of the Proposed Action - Pima Pineapple Cactus

The use of the proposed utility corridor to provide power and water for the Rosemont Mine project would result in direct effects to Pima Pineapple cactus owing to the placement of electrical and water transmission lines and associated access roads. Approximately 47 live Pima Pineapple cactus and 24.4 acres of Pima Pineapple cactus habitat would be impacted. Areas of permanent disturbance would remove portions of the seed bank, and areas of temporary disturbance could alter the seed bank. Disturbance of soils would change water infiltration, compact soil, and change local site conditions. Recently disturbed areas have an increased potential to be invaded by noxious weeds (e.g., Lehmann lovegrass), which can negatively affect Pima Pineapple cactus. Pima Pineapple cactus can be found in areas of recent disturbance, as competition with other plants for nutrients and light are reduced. Although some areas of temporary disturbance may recover, it may take many years before full recovery is achieved. Vasek *et al.* (1975) found that desert vegetation is fragile and easily destroyed, but does have a long-term potential (probably measured in centuries) to recover from substantial disturbance such as that associated with the construction of a utility corridor.

Any individual Pima Pineapple cactus growing in the action area outside the mine footprint may experience indirect effects, such as fugitive dust. Effects from dust are likely to occur along the utility corridor as a result of traffic along the associated roadway. Existing traffic occurs in the area of the utility corridor, but the Rosemont mine project will result in a limited increase in traffic in the area of Santa Rita Road as a result of inspections and maintenance along the utility corridor. Physical effects of windborne fugitive dust on plants may include blockage and damage to stomata and shading and abrasion of the plant surface, which could result in reduced photosynthetic activity (Goodquarry 2011) and possibly reproductive success. These effects may also impact pollinators of Pima Pineapple cactus.

The proposed action will result in the direct removal of 47 Pima Pineapple cactus and approximately 24.4 acres of Pima Pineapple cactus habitat within the action area. Within the context of Pima Pineapple cactus individuals and surveyed area we have reviewed through section 7 consultation on development projects, this project adds 47 individuals and 24.4 acres of Pima Pineapple cactus habitat to the known baselines. Within the range of the Pima Pineapple cactus in Arizona, this brings baseline numbers up to 2,764 Pima Pineapple cactus individuals, of which, 2,051 will have been destroyed, removed, or transplanted, and 15,275 acres surveyed, of which 14,612 will have been permanently or temporarily impacted by development projects. What this means in the context of the entire range of the Pima Pineapple cactus is difficult to determine for the reasons discussed above.

To offset the indirect effects to Pima Pineapple cactus and Pima Pineapple cactus habitat from invasive plant species, Rosemont has developed an *Invasive Species Management Plan*. This plan includes measures such as using weed-free seed and hay in reclamation and compliance actions, avoiding the use of invasive ornamental plants in landscaping and reclamation activities, and cleaning heavy equipment prior to use on the project to remove dirt, plant parts, and other materials that could carry invasive plant seeds. As part of the Invasive Species Management Plan, Rosemont will conduct monitoring of the project area once per year to determine the occurrence of invasive plant species. The goal of monitoring is to detect newly introduced invasive species and eliminate them before they infest the area and spread to other locations. The *Invasive Species Management Plan* is incorporated herein by reference.

To offset the direct impacts to Pima Pineapple cactus and its habitat, Rosemont proposes to record a restrictive covenant on parcels of land that support Pima Pineapple cactus. The lands are located within the Helvetia Ranch North Parcels (see Figure PPC-2). The proposed conservation lands are currently occupied by Pima Pineapple cactus and support appropriate Pima Pineapple cactus habitat. Prior to initiation of construction on the utility corridor, the restrictive covenant will be recorded for the 940 acres that make up these ranch parcels.

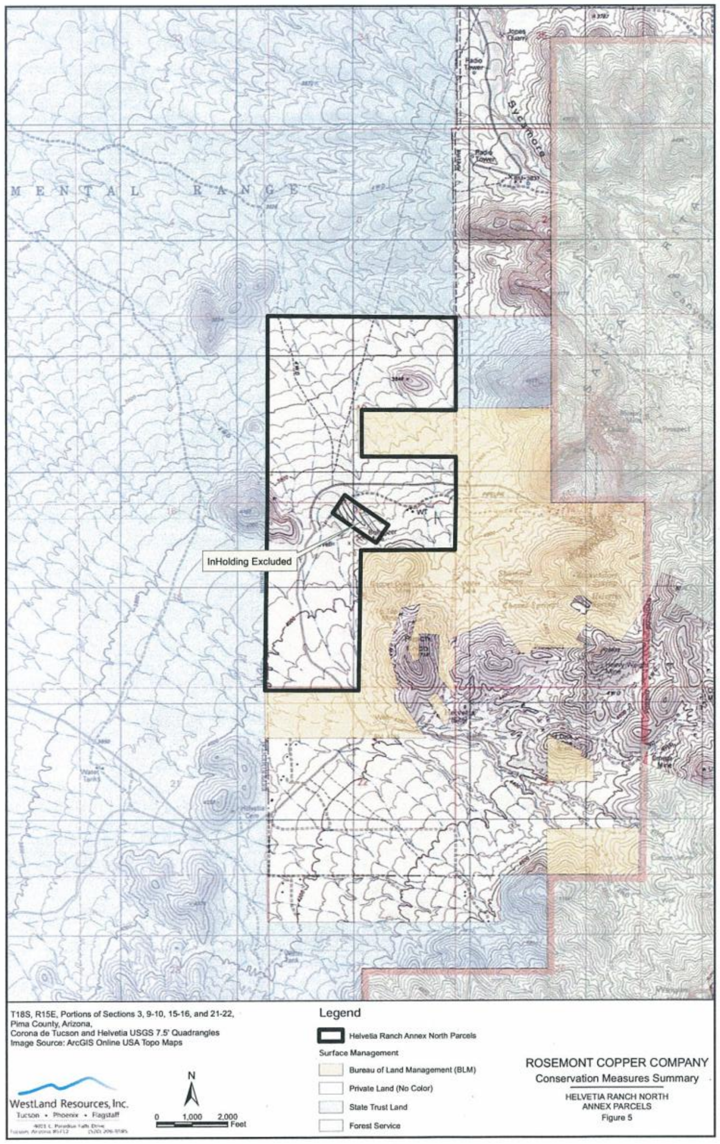


Figure PPC-2: Helvetia Ranch North Pima Pineapple cactus Conservation Parcels

In summary, the proposed action will result in the direct loss of 47 Pima Pineapple cactus and 24.4 acres of Pima Pineapple cactus habitat. This represents a loss of less than two percent of the known individuals and surveyed area we have reviewed through section 7 consultations. Rosemont proposes to offset this loss by setting aside 940 acres within the action area, 705 acres of which contain soils and other habitat conditions suitable Pima Pineapple cactus habitat and which is currently supports Pima Pineapple cactus. The project, while contributing to further fragmentation of Pima Pineapple cactus habitat, also contributes to the survival and recovery of Pima Pineapple cactus because it will establish protection from certain threats for Pima Pineapple cactus on the Helvetia Ranch parcels.

Cumulative Effects - Pima Pineapple Cactus

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Federal land managers, the Coronado National Forest and Bureau of Land Management, manage approximately 45% of the lands affected by the Rosemont Mine project, and administer projects and permits on those lands. However, within the action area for the Pima Pineapple cactus, lands are primarily non-Federal, so there are many activities that could potentially affect Pima Pineapple cactus that are not Federal activities and thus not subject to additional Section 7 consultation under the ESA.

Activities that could result in cumulative effects to Pima Pineapple cactus include continued road maintenance, grazing activities, the spread of invasive species, and recreation in the action area, current and future development, other nearby mining projects, and unregulated activities on non-federal lands, such as trespass livestock and inappropriate use of OHVs. Adjacent open space, such as that found within the Santa Rita Experimental Range and other State Trust lands often provides recreational areas for nearby residents, and the use of these lands for recreation, off-road vehicle use, and illegal dumping of trash can ultimately lead to habitat degradation and possible loss of Pima Pineapple cactus. Additional cumulative effects on Pima Pineapple cactus include cross-border activities such as human traffic; deposition of trash; new trails from human traffic; increased fire risk from human traffic; and water depletion and contamination. From all of these activities, there is an increased risk of non-native invasive plant invasion, leading to both competition for limited resources and increased fire occurrence and intensity, all of which threaten Pima Pineapple cactus conservation and survival.

As discussed above, threats to Pima Pineapple cactus continue to include habitat loss and fragmentation both for the plant and its pollinators, competition with non-native species, and inadequate regulatory mechanisms to protect this species. We conclude that residential and commercial development, and its infrastructure, is a significant threat to Pima Pineapple cactus and its habitat, and that drought, nonnative plant invasion, and predation are also severe threats. The cumulative effects mentioned above all contribute to these ongoing threats to Pima Pineapple cactus in the action area. The conservation of the Pima Pineapple cactus population in the southern portions of Tucson, extending into the Green Valley area, is tenuous given the extent of these threats and the likelihood that these threats will continue into the foreseeable future. Consideration of the conservation needs of Pima Pineapple cactus is included in the proposed habitat conservation plans being developed by the City of Tucson and Pima County, and implementation of these habitat conservation plans may help to reduce the extent of cumulative impact of non-Federal actions in the vicinity of the action area for Pima Pineapple cactus related to the Rosemont Mine project.

Conclusion - Pima Pineapple Cactus

After reviewing the current status of Pima Pineapple cactus, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the Rosemont Mine project is not likely to jeopardize the continued existence of the

Pima Pineapple cactus. No critical habitat has been designated for this species; therefore, none will be affected. Our rationale for this conclusion is as follows:

1. The loss of 47 Pima Pineapple cactus and 24.4 acres of Pima Pineapple cactus habitat represents less than two percent of the Pima Pineapple cactus individuals (the majority of which were destroyed) and area surveyed for which we have conducted section 7 consultations. Additional Pima Pineapple cactus and habitat occur throughout the range of the taxon, but we do not have the information to determine the percentage of the overall range which these 47 Pima Pineapple cactus and 24.4 acres represent. However, based on the sites we have evaluated and for which we have information, the number of Pima Pineapple cactus and acres of Pima Pineapple cactus habitat impacted related to this project are relatively small and, additively, contribute a relatively small number of plants and acres to the effects we have evaluated. However, we lack sufficient information to determine what this means with regard to the contribution of the effects of this project towards reaching the threshold at which the continued existence of Pima Pineapple cactus is jeopardized.
2. Rosemont is proposing measures to reduce direct impacts to Pima Pineapple cactus during the construction of the utility corridor.
3. To offset effects from the Rosemont Mine project, Rosemont will protect approximately 700 acres of occupied Pima Pineapple cactus habitat on the Helvetia Ranch North parcels by recording a restrictive covenant on the parcels which will protect Pima Pineapple cactus from certain activities outlined as threats to Pima Pineapple cactus in our discussion above. This action will also address to some extent the ongoing cumulative effects to Pima Pineapple cactus habitat in the vicinity of the action area by removing the potential for future development of these lands in the future.
4. The relatively small magnitude of effects described under Conclusion 1 and the conservation measures described under Conclusion 3, above, indicate that the proposed action is unlikely to diminish the potential to achieve recovery of the Pima pineapple cactus.

INCIDENTAL TAKE STATEMENT - PIMA PINEAPPLE CACTUS

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

Conservation Recommendations - Pima Pineapple Cactus

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the FS participate in efforts to identify and conserve Pima Pineapple cactus throughout its range, including participation in forums that address the control of invasive, exotic plants (e.g. buffelgrass and Lehmann lovegrass).

2. We recommend that FS support research and monitoring proposals that will contribute to an increased understanding of important conservation efforts related to Pima Pineapple cactus such as the effectiveness of translocating Pima Pineapple cactus, appropriate management of conservation lands and conservation banks to promote recovery of Pima Pineapple cactus, and effects of climate change and fire on Pima Pineapple cactus.

3. We recommend the FS work with Rosemont to implement measures on the Helvetia Ranch North parcels, including appropriate monitoring of Pima Pineapple cactus and Pima Pineapple cactus habitat, so that the conservation approach on these parcels is consistent with other conservation lands, including Conservation Banks, established for the conservation of Pima Pineapple cactus. These measures should include the following in order to ensure the conservation of Pima Pineapple cactus in perpetuity:

   (a.) The conservation lands should be surveyed with 100% survey coverage using an approved Pima Pineapple cactus survey protocol. All Pima Pineapple cactus that are detected during the survey effort should be mapped, GPS coordinates recorded, and information regarding the condition and status of each cactus should be collected. This information should be provided to FWS.

   (b.) A management plan addressing actions needed for long-term conservation of the conservation lands, and all Pima Pineapple cactus within the conservation lands, should be developed and implemented in perpetuity. The management plan should address issues such as fencing and fence maintenance, invasive species management, fire management, approved and prohibited land uses, maintaining appropriate buffers from surrounding land uses, etc. The management plan should also address monitoring, which should include monitoring every three years to document the status of known cacti, as well as the presence of any new cacti. Annual reports on the status of the conservation lands should be submitted to the FWS.

   (c.) Adequate funding should be provided to implement the management plan and required monitoring.

In order that we are kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

Status of the Species – Chiricahua Leopard Frog

The Chiricahua leopard frog was listed as a threatened species without critical habitat in a Federal Register notice dated June 13, 2002. Included was a special rule to exempt operation and maintenance of livestock tanks on non-Federal lands from the section 9 take prohibitions of the Act. Final designation of critical habitat was made on March 20, 2012 (77 FR 16324) and included 39 sites in Arizona and New Mexico.

The frog is distinguished from other members of the *Lithobates pipiens* complex by a combination of characters, including a distinctive pattern on the rear of the thigh consisting of small, raised, cream-colored spots or tubercles on a dark background; dorsolateral folds that are interrupted and deflected medially; stocky body proportions; relatively rough skin on the back and sides; and often green coloration on the head and back (Platz and Mecham 1979). The species also has a distinctive call consisting of a relatively long snore of 1 to 2 seconds in duration (Platz and Mecham 1979, Davidson 1996). Snout-vent lengths of adults range from approximately 2.1 to 5.4 inches (Platz and Mecham 1979, Stebbins 2003). The Ramsey Canyon leopard frog (*Lithobates* "*subaquavocalis*"), found on the eastern slopes of the Huachuca Mountains, Cochise County, Arizona, has recently been subsumed into *Lithobates chiricahuensis* (Crother 2008) and recognized by the FWS as part of the listed entity (U.S. Fish and Wildlife Service [USFWS] 2009).

The range of the Chiricahua leopard frog includes central and southeastern Arizona; west-central and southwestern New Mexico; and, in Mexico, northeastern Sonora, the Sierra Madre Occidental of northwestern and west-central Chihuahua, and possibly as far south as northern Durango (Platz and Mecham 1984, Degenhardt *et al.* 1996, Lemos-Espinal and Smith 2007, Rorabaugh 2008). Reports of the species from the State of Aguascalientes (Diaz and Diaz 1997) are questionable. The distribution of the species in Mexico is unclear due to limited survey work and the presence of closely related taxa (especially *Lithobates lemosespinali*) in the southern part of the range of the Chiricahua leopard frog. Historically, the frog was an inhabitant of a wide variety of aquatic habitats, including cienegas, pools, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,281 to 8,890 feet. However, the species is now limited primarily to headwater streams, springs and cienegas, and cattle tanks into which nonnative predators (e.g. sportfishes, American bullfrogs, crayfish, and tiger salamanders) have not yet invaded or where their numbers are low (USFWS 2007). The large valley-bottom cienegas, rivers, and lakes where the species occurred historically are populated with nonnative predators at densities with which the species cannot coexist.

The primary threats to this species are predation by nonnative organisms and die offs caused by a fungal skin disease – chytridiomycosis (caused by the skin fungus, *Batrachochytrium dendrobatidis* (*Bd*)). Additional threats include drought, floods, degradation and loss of habitat as a result of water diversions and groundwater pumping, poor livestock management, altered fire regimes due to fire suppression and livestock grazing, mining, development, and other human activities; disruption of metapopulation dynamics, increased chance of extirpation or extinction resulting from small numbers of populations and individuals, and environmental contamination (USFWS 2007). Loss of Chiricahua leopard frog populations is part of a pattern of global amphibian decline, suggesting other regional or global causes of decline may be important as well (Carey *et al.* 2001). Witte *et al.* (2008) analyzed risk factors associated with disappearances of ranid frogs in Arizona and found that population loss was more common at higher elevations and in areas where other ranid population disappearances occurred. Disappearances were also more likely where introduced crayfish occur, but were less likely in areas close to a source population of frogs.

Based on 2009 data, the species is still extant in the major drainage basins in Arizona and New

Mexico where it occurred historically; with the exception of the Little Colorado River drainage in Arizona and possibly the Yaqui drainage in New Mexico. It has not been found recently in many rivers within those major drainage basins, valleys, and mountains ranges, including the following in Arizona: White River, West Clear Creek, Tonto Creek, Verde River mainstem, San Francisco River, San Carlos River, upper San Pedro River mainstem, Santa Cruz River mainstem, Aravaipa Creek, Babocomari River mainstem, and Sonoita Creek mainstem. In southeastern Arizona, no recent records (1995 to the present) exist for the Pinaleño Mountains or Sulphur Springs Valley. Once thought to be extirpated from the Chiricahua Mountains, the species now occurs in Cave Canyon, in the vicinity of the Southwestern Research Station operated by the Smithsonian Institution. The species is now absent from all but one of the southeastern Arizona valley bottom cienega complexes. In many of these regions Chiricahua leopard frog were not found for a decade or more despite repeated surveys.

As of 2009, there were 84 sites in Arizona at which Chiricahua leopard frog occur or are likely to occur in the wild, with an additional four captive or partially captive refugia sites. At least 33 of the wild sites support breeding. In New Mexico, 15-23 breeding sites were known in 2008; the frogs occur at additional dispersal sites. The species has been extirpated from about 80 percent of its historical localities in Arizona and New Mexico. Nineteen and eight localities are known from Sonora and Chihuahua, respectively. The species' current status in Mexico is poorly understood; however, it has been found in recent years in western Chihuahua. Some threats, such as introduced nonnative predators and the threat of catastrophic wildfire, appear to be less important south of the border, particularly in the mountains where Chiricahua leopard frog have been found (Gingrich 2003, Rosen and Melendez 2006, Rorabaugh 2008).

The chytridiomycete skin fungus, *Batrachochytrium dendrobatidis* (*Bd*), the organism that causes chytridiomycosis, is responsible for global declines of frogs, toads, and salamanders (Berger *et al.* 1998, Longcore *et al.* 1999, Speare and Berger 2000, Hale 2001). Decline or extinction of about 200 amphibian species worldwide has been linked to the disease (Skerratt *et al.* 2007). In Arizona, *Bd* infections have been reported from numerous populations of Chiricahua leopard frog in southeastern Arizona and one population on the Tonto National Forest, as well as populations of several other frogs and toads in Arizona (Morell 1999, Davidson *et al.* 2000, Sredl and Caldwell 2000, Hale 2001, Bradley *et al.* 2002, USFWS 2007). In New Mexico, chytridiomycosis appears to be widespread in populations in west-central New Mexico, where it often leads to population extirpation. A threats assessment conducted for the species during the development of the recovery plan identified *Bd* as the most important threat to the frog in recovery units 7 and 8 in New Mexico. In recovery unit 6, which includes much of the mountainous region of west-central New Mexico, *Bd* and nonnative predators were together identified as the most important threats. Die-offs from disease typically occur during the cooler months from October-February (USFWS 2007).

The role of the *Bd* fungus in the population dynamics of the Chiricahua leopard frog is as yet undefined. Some populations are driven to extinction soon after the animals become symptomatic; however, other Chiricahua leopard frog populations can exist with the pathogen for years (USFWS 2007). For instance, the frog has coexisted with *Bd* in Sycamore Canyon, Santa Cruz County, Arizona since at least 1972. That is the earliest record for *Bd* in the western United States, which roughly corresponds to the first observed mass die-offs of ranid frogs in Arizona. Even in cases where populations exist with the disease, it is an additional stressor, resulting in periodic die-offs that increase the likelihood of extirpation and extinction.

Epizootiological data from Central America and Australia (high mortality rates, wave-like spread of declines, wide host range) suggest introduction of the disease into previously uninfected populations and the disease subsequently becoming enzootic in some areas. Alternatively, the fungus may be a widespread organism that has emerged as a pathogen because of either higher virulence or an increased host susceptibility caused by other factors such as environmental changes (Berger *et al.* 1998), including changes in climate or microclimate, contaminant loads, increased UV-B radiation, or other factors that cause stress (Pounds and Crump 1994; Carey *et al.* 1999, 2001; Daszak 2000). Morehouse *et al.* (2003) found low genetic variability among 35 *Bd* strains from North America, Africa, and Australia, suggesting that the first hypothesis – that it is a recently emerged pathogen that has dispersed widely – is the correct hypothesis.

The infection intensity or lethal threshold of *Bd* is perhaps more important to control than the prevalence of infection (the proportion of infected hosts). Efforts to limit multiple exposures to the pathogen can prevent the host population from reaching the lethal threshold of zoospores per frog. In a nine to13 year study by Vredenberg *et al.* (2010), a *Bd* infection took three years to spread until nearly all the 88 yellow-legged frog populations at a lake were infected. A lethal threshold of about 10,000 zoospores of the fungus per frog caused the collapse of these amphibian populations with Bd. Within a population, as the infection prevalence reached 100%, the infection intensity on individual frogs increased in parallel. Frog mass mortality began only when infection intensity reached a critical threshold and repeatedly led to extinction of populations. Our results indicate that the high growth rate and virulence of *Bd* allow the near-simultaneous infection and buildup of high infection intensities in all host individuals; subsequent host population crashes therefore occur before *Bd* is limited by density-dependent factors. Preventing infection intensities in host populations from reaching this threshold could provide an effective strategy to avoid the extinction of susceptible amphibian species in the wild. Because of a threshold of zoospores per frog must be reached before it results in mortality, there is a time lag between exposure to the pathogen and mortality. This time lag allows for the spread of the pathogen throughout the amphibian population before the population crashes. Unlike other pathogens that disappear as their hosts decline in numbers, this pathogen can cause the extirpation of its host population (Blaustein and Johnson 2010).

Because of this threshold, there is a time lag between exposure and mortality, so the pathogen can spread through much of the amphibian population before disease-driven reductions in host density negatively affect the transmission of *Bd*. Consequently, the pathogen can cause the loss and extinction of its host population, unlike the many other pathogens that disappear as their hosts decline in numbers (Blaustein and Johnson 2010).

Retrospective analysis revealed presence of chytridiomycosis in wild African clawed frogs (*Xenopus laevis*) dating to 1938 (Weldon *et al.* 2004). African clawed frogs were exported to many areas of the globe from Africa for use in human pregnancy testing beginning in the 1930s. Some of the test frogs escaped or were released and established populations in California, Arizona, and other areas. Although other explanations for the origin of the disease are viable, Weldon *et al.* (2004) suggest that Africa is where the disease originated and that international trade in African clawed frogs was the means of disease dissemination.

If the disease was introduced to the Southwest via escaped or released clawed frogs, it may have spread across the landscape by human introductions or natural movements of secondarily-infected American bullfrogs, tiger salamanders, or leopard frogs. If this is the case, its rapid establishment and spread could be attributable to humans. *Bd* does not have an airborne spore, so it must spread via other means. Amphibians in the international pet trade (Europe and USA), outdoor pond supplies (USA), zoo trade (Europe and USA), laboratory supply houses (USA), and species recently introduced (*Rhinella marinus* in Australia and American bullfrog in the USA and Uruguay) have been found infected with *Bd*, suggesting human-induced spread of the disease (Daszak 2000, Mazzoni *et al.* 2003).

Free-ranging healthy bullfrogs with low-level *Bd* infections have been found in southern Arizona (Bradley *et al.* 2002). Tiger salamanders and bullfrogs can carry the disease without exhibiting clinically significant or lethal infections. When these animals move, or are moved by people, among aquatic sites, *Bd* may be carried with them (Collins *et al.* 2003, Picco and Collins 2008). Other native or nonnative frogs may serve as disease vectors or reservoirs of infection, as well (Bradley *et al.* 2002). Green and Dodd (2007) found *Bd* in bullfrogs at a fish hatchery in Georgia and suggested the disease could be moved with stocks of fish. Since that study, *Bd* was confirmed from a bullfrog captured at the Bubbling Ponds Hatchery in Arizona (V. Boyarski, pers. comm.). *Bd* could also be spread by tourists or fieldworkers sampling aquatic habitats (Halliday 1998). The fungus can exist in water or mud and thus could be spread by wet or muddy boots, vehicles, cattle, fishing gear, and other animals moving among aquatic sites, or during scientific sampling of fish, amphibians, or other aquatic organisms. The AESO and AGFD are employing preventative measures to ensure the disease is not spread by aquatic sampling.

Numerous studies indicate that declines and extirpations of Chiricahua leopard frog are at least in part caused by predation and possibly competition by nonnative organisms, including fishes in the family Centrarchidae (*Micropterus* spp., *Lepomis* spp.), bullfrogs, tiger salamanders (*Ambystoma mavortium mavortium*), crayfish (*Orconectes virilis* and possibly others), and several other species of fishes (Clarkson and Rorabaugh 1989; Sredl and Howland 1994; Fernandez and Bagnara 1995; Rosen *et al.* 1996, 1994; Snyder *et al.* 1996; Fernandez and Rosen 1996, 1998). For instance, in the Chiricahua region of southeastern Arizona, Rosen *et al.* (1996) found that almost all perennial waters investigated that lacked introduced predatory vertebrates supported Chiricahua leopard frogs. All waters except three that supported introduced vertebrate predators lacked Chiricahua leopard frogs. Sredl and Howland (1994) noted that Chiricahua leopard frogs were nearly always absent from sites supporting bullfrogs and nonnative predatory fish. Rosen *et al.* (1996) suggested further study was needed to evaluate the effects of mosquitofish, trout, and catfish on frog presence.

The effect of mosquitofish on Chiricahua leopard frog populations could be influenced by factors such as abundant escape cover, high adult frog survivorship, and high reproductive output in terms of numbers of frog egg masses produced. Examination of studies with other ranid frog species illustrates the likely effects of trout on Chiricahua leopard frog. The relationship between trout and amphibian decline has best been documented with the Mountain yellow-legged frog (*Rana muscosa*) in high lakes of the Sierra Nevada, California. Several authors have concluded that predation by introduced trout and charr (*Salveninus* spp.) into these previously fishless lakes have eliminated many populations of this species (Bradford 1989, Bradford *et al.*

1993, Knapp and Mathews 2000, Vredenburg *et al.* 2005). One of the threats that lead to the listing of the southern California populations of the Mountain yellow-legged frog was predation by introduced trout. However, other factors, including chytridiomycosis and pesticides, are possible contributors to the decline of the species as well (Fellers *et al.* 2001, 2004; Vredenburg *et al.* 2005). Predation by trout has also been also implicated as a factor in decline or population loss in the Cascades frog (*Rana cascadae*, Fellers *et al.* 2007) and Columbia spotted frog (*Rana luteiventris*, Reaser and Pilliod 2005).

Disruption of metapopulation dynamics is likely an important factor in regional loss of populations (Sredl and Howland 1994, Sredl *et al.* 1997). Chiricahua leopard frog populations are often small and habitats are dynamic, resulting in a relatively low probability of long-term population persistence. Historically, populations were more numerous and closer together. If populations became extirpated due to drought, disease, or other causes, these sites could be re-colonized via immigration from nearby populations. However, as numbers of populations declined, populations became more isolated and were less likely to be re-colonized if extirpation occurred. Also, most of the larger source populations along major rivers and in cienega complexes have disappeared.

Wildfires have affected Chiricahua leopard frog habitat. On May 29, 2011, Arizona's largest wildfire in recorded history started, known as the Wallow Fire. The Wallow Fire consumed 538, 049 acres of montane conifer forest on the Apache-Sitgreaves National Forest and likely adversely affected proposed critical habitat in Unit 27, Campbell Blue and Coleman Creeks, although as of October 2010, little information is available on the post-fire status of potential Chiricahua leopard frog habitat within the fire footprint. Since many tanks and springs that are important for recovery of the species in this area occur in meadows, sediment flows may not affect them as they would habitat within canyon bottoms.

Waters at the Beatty's Guest Ranch in the Huachuca Mountains, until recently, supported one of the most robust and dense populations of Chiricahua leopard frogs. On June 12, 2011, the Monument Fire started 4-miles east of Hereford, Arizona; ultimately consuming 30,526 acres and significantly affecting a portion of the Huachuca Mountains, including Miller Canyon and the Beatty Guest Ranch. Subsequent monsoon precipitation in the region liberated significant amounts of top soil and sediment which scoured the canyon bottom and filled-in the majority of ponds and suitable habitat for the frog in lower Miller Canyon on the Ranch. The remaining population at the Ranch represents a small fraction of its former number.

The Greaterville Fire started on May 2, 2011, and may have affected dispersal habitat along the eastern bajada of the Santa Rita Mountains (proposed critical habitat Units 7 and 8), but that fire was less severe, comparatively small-sized, and of shorter duration.

Fire frequency and intensity in Southwestern forests are much altered from historical conditions (Dahms and Geils 1997). Before 1900, surface fires generally occurred at least once per decade in montane forests with a pine component. Beginning about 1870-1900, these frequent ground fires ceased to occur due to intensive livestock grazing that removed fine fuels, followed by effective fire suppression in the mid to late 20th century (Swetnam and Baisan 1996). Absence of ground fires allowed a buildup of woody fuels that precipitated infrequent but intense crown fires (Swetnam and Baisan 1996, Danzer *et al.* 1997). Absence of vegetation and forest litter following intense crown fires exposes soils to surface and rill erosion during storms, often causing high peak flows, sedimentation, and erosion in downstream drainages (DeBano and Neary 1996). These post-fire events have likely resulted in scouring or sedimentation of frog habitats (Wallace 2003).

An understanding of the dispersal abilities of Chiricahua leopard frogs is the key to determining the likelihood that suitable habitats will be colonized from a nearby extant population of frogs. As a group, leopard frogs are surprisingly good at dispersal. In Michigan, young northern leopard frogs (*Lithobates pipiens*) commonly move up to 0.5 mile from their place of metamorphosis, and three young males established residency up to 8.4 miles from their place of metamorphosis (Dole 1971). Both adults and juveniles wander widely during wet weather (Dole 1971). In the Cypress Hills, southern Alberta, young-of-the year northern leopard frogs successfully dispersed to downstream ponds 3.4 miles from the source pond, upstream 0.6 mile, and overland 0.6 mile. At Cypress Hills, a young-of-the-year northern leopard frog moved 5 miles in one year (Seburn *et al.* 1997). The Rio Grande leopard frog (*Lithobates berlandieri*) in southwestern Arizona has been observed to disperse at least one mile from any known water source during the summer rainy season (Rorabaugh 2005). After the first rains in the Yucatan Peninsula, leopard frogs have been collected a few miles from water (Campbell 1998). In New Mexico, Jennings (1987) noted collections of Rio Grande leopard frogs from intermittent water sources and suggested these were frogs that had dispersed from permanent water during wet periods.

Dispersal of leopard frogs away from water in the arid Southwest may occur less commonly than in mesic environments in Alberta, Michigan, or the Yucatan Peninsula during the wet season. However, there is evidence of substantial movements even in Arizona. Movement may occur via locomotion of frogs or passive movement of tadpoles along stream courses. The maximum distance moved by a radio-telemetered Chiricahua leopard frog in New Mexico was 2.2 miles in one direction (R. Jennings, Western New Mexico University, C. Painter, NMDGF, pers. comm. 2004). In 1974, Frost and Bagnara (1977) noted passive or active movement of Chiricahua and Plains (*Lithobates blairi*) leopard frogs for 5 miles or more along East Turkey Creek in the Chiricahua Mountains. In August, 1996, Rosen and Schwalbe (1998) found up to 25 young adult and subadult Chiricahua leopard frog at a roadside puddle in the San Bernardino Valley, Arizona. They believed that the only possible origin of these frogs was a stock tank located 3.4 miles away. Rosen *et al.* (1996) found small numbers of Chiricahua leopard frog at two locations in Arizona that supported large populations of nonnative predators. The authors suggested these frogs could not have originated at these locations because successful reproduction would have been precluded by predation. They found that the likely source of these animals were populations 1.2-4.3 miles distant. In September 2009, 15-20 Chiricahua leopard frog were found at Peña Blanca Lake west of Nogales. The nearest likely source population is Summit Tank, a straight line distance of 3.1 miles overland and approximately 4.1 miles along intermittent drainages.

Movements away from water do not appear to be random. Streams are important dispersal corridors for young northern leopard frogs (Seburn *et al.* 1997). Displaced northern leopard frogs will home, and apparently use olfactory and auditory cues, and possibly celestial orientation, as guides (Dole 1968, 1972). Rainfall or humidity may be an important factor in dispersal because odors carry well in moist air, making it easier for frogs to find other wetland sites (Sinsch 1991). Based on these studies, the Chiricahua leopard frog recovery plan (USFWS 2007) provides a general rule on dispersal capabilities. Chiricahua leopard frogs are assumed to be able to disperse one mile overland, three miles along ephemeral drainages, and five miles along perennial water courses.

A recovery plan has been completed (USFWS 2007), the goal of which is to improve the status of the species to the point that it no longer needs the protection of the Endangered Species Act. The recovery strategy calls for reducing threats to existing populations; maintaining, restoring, and creating habitat that will be managed in the long term; translocation of frogs to establish, reestablish, or augment populations; building support for the recovery effort through outreach and education; monitoring; conducting research needed to provide effective conservation and recovery; and application of research and monitoring through adaptive management. Recovery actions are recommended in each of eight recovery units throughout the range of the species. Management areas are also identified within recovery units where the potential for successful recovery actions is greatest.

Additional information about the Chiricahua leopard frog can be found in Platz and Mecham (1984, 1979), Sredl and Howland (1994), Jennings (1995), Rosen *et al.* (1996, 1994), Degenhardt *et al.* (1996), Sredl *et al.* (1997), Painter (2000), Sredl and Jennings (2005), and USFWS (2007).

Critical Habitat

The 2012 final rule includes 39 critical habitat units across the range of the species in Arizona and New Mexico. Based on the above needs and our current knowledge of the life history, biology, and ecology of the species, and the habitat requirements for sustaining the essential life-history functions of the species, we have determined the physical or biological features (the general habitat features upon which a species depends), as described by the primary constituent elements (or PCEs)(the more specific habitat parameters defining the physical and biological features), essential to the conservation of the Chiricahua leopard frog are:

1. Aquatic breeding habitat and immediately adjacent uplands exhibiting the following characteristics:

    a. Standing bodies of fresh water (with salinities less than 5 parts per thousand, pH greater than or equal to 5.6, and pollutants absent or minimally present), including natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, off-channel pools, and other ephemeral or permanent water bodies that typically hold water or rarely dry for more than a month. During periods of drought, or less than average rainfall, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they would still be considered essential breeding habitat in non-drought years.
    b. Emergent and or submerged vegetation, root masses, undercut banks, fractured rock substrates, or some combination thereof, but emergent vegetation does not completely cover the surface of water bodies.
    c. Nonnative predators (e.g., crayfish, bullfrogs, nonnative fish) absent or occurring at levels that do not preclude presence of the Chiricahua leopard frog.

d. Absence of chytridiomycosis, or if present, then environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs.
e. Upland habitats that provide opportunities for foraging and basking that are immediately adjacent to or surrounding breeding aquatic and riparian habitat.

2. Dispersal and nonbreeding habitat, consisting of areas with ephemeral (present for only a short time), intermittent, or perennial water that are generally not suitable for breeding, and associated upland or riparian habitat that provides corridors (overland movement or along wetted drainages) for frogs among breeding sites in a metapopulation with the following characteristics:

a. Are not more than 1.0 mile (1.6 kilometers) overland, 3.0 miles (4.8 kilometers) along ephemeral or intermittent drainages, 5.0 miles (8.0 kilometers) along perennial drainages, or some combination thereof not to exceed 5.0 miles (8.0 kilometers).
b In overland and nonwetted corridors, provide some vegetation cover or structural features (e.g., boulders, rocks, organic debris such as downed trees or logs, small mammal burrows, or leaf litter) for shelter, forage, and protection from predators; in wetted corridors, provide some ephemeral, intermittent, or perennial aquatic habitat.
c. Are free of barriers that block movement by Chiricahua leopard frogs, including, but not limited to, urban, industrial, or agricultural development; reservoirs that are 50 acres (20 hectares) or more in size and contain nonnative predatory fish, bullfrogs, or crayfish; highways that do not include frog fencing and culverts; and walls, major dams, or other structures that physically block movement.

The critical habitat units affected by the proposed action include:

<u>Eastern Slope of the Santa Rita Mountains Unit</u>

This unit includes 172 ac (70 ha) of lands in the Greaterville area of the Santa Rita Mountains that are managed by the Coronado National Forest, as well as 14 ac (6 ha) of private lands in this area. Included in this unit are two metal troughs in Louisiana Gulch, Greaterville Tank, Los Posos Gulch Tank, and the Granite Mountain Tank complex. The Granite Mountain Tank complex includes two impoundments and a well. We have determined this unit to be essential to the conservation of the species because it represents several known occupied areas that support or likely support breeding activity for the Chiricahua leopard frog in the Santa Rita Mountains. A number of other sites in this area have been found to support dispersing Chiricahua leopard frogs. Designated critical habitat also includes intervening drainages as follows: (1) From Los Posos Gulch upstream to a saddle, then downslope in an unnamed drainage to the confluence with another unnamed drainage, then upstream and south in that drainage to a saddle, and downslope through an unnamed drainage to its confluence with Ophir Gulch, then in Ophir Gulch to upper Granite Mountain Tank, to include an ephemeral tank near upper Granite Mountain Tank and a well; (2) from Greaterville Tank downstream in an unnamed drainage to Ophir Gulch; and (3) Louisiana Gulch from the metal tanks upstream to the headwaters of Louisiana Gulch then across a saddle and downslope through an unnamed drainage to its confluence with Ophir Gulch. Additionally, this unit has both PCEs 1 and 2.

Las Cienegas National Conservation Area Unit

This unit is in Pima County, Arizona, and includes 1,364 ac (552 ha) of Bureau of Land Management lands and 186 ac (75 ha) of Arizona State Land Department lands, including an approximate 4.33-mi (6.98-km) reach of Empire Gulch and 1.91 mi (3.08 km) of Cienega Creek, including the Cinco Ponds. This unit currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. This reach includes: (1) Empire Gulch from a pipeline road crossing above the breeding site downstream to Cienega Creek; and (2) Cienega Creek from the Empire Gulch confluence upstream to the approximate end of the wetted reach and where the creek bends hard to the east, to include Cinco Ponds. This unit is currently managed an isolated metapopulation.

Environmental Baseline - Chiricahua Leopard Frog

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Status of the Chiricahua Leopard Frog in the Action Area

Recovery Unit 2 (Santa Rita-Huachuca-Ajos Bavispe, Arizona and Mexico)

There are eight recovery units identified in the Chiricahua leopard frog recovery plan (USFWS 2007). The action area pertaining to the Chiricahua leopard frog under this consultation includes portions of Recovery Unit 2 (RU2), which incorporates several metapopulations (or management areas) and critical habitat units. Specifically, we consider the action area to include the Santa Rita, Empire Cienega, and Red Rock-Sonoita Creek Management Areas which include the Eastern Slope of the Santa Rita Mountains, and Las Cienegas National Conservation Area critical habitat units. These areas are discussed in greater detail below, following general discussion of RU2.

RU2 is generally located in portions of Cochise, Santa Cruz, and Pima counties, Arizona and adjacent portions of northern Sonora. This RU includes the upper reaches and headwaters of the San Pedro and Santa Cruz rivers, as well as the headwaters of the Rios Sonora, Magdalena, and Bavispe. Elevations vary from 9,466 feet on Miller Peak in the Huachuca Mountains to less than 4,000 feet at the western base of the Sierra de Pinitos and on Sonoita Creek downstream of Patagonia. Vegetation communities include semi-desert grasslands at the lower elevations, climbing through oak and pine-oak woodlands to stands of mixed conifer forests. The latter are restricted to the higher elevations of the Santa Rita and Huachuca Mountains in Arizona, and to the Sierra de los Ajos, Sierra Cananea, Sierra Azul, and the southern portions of the Sierra Pinitos in Sonora (Brown and Lowe 1980).

In RU2, Chiricahua leopard frogs are known historically from montane canyons below about

6,230 feet and in valleys above about 4,000 feet. Historically they inhabited canyons such as Scotia Canyon in the Huachuca Mountains and Big Casa Blanca Canyon in the Santa Rita Mountains; valley bottom cienegas, such as Sheehy Spring and the Empire Cienega in the upper Santa Cruz River drainage; as well as major rivers, such as the San Pedro and Santa Cruz. Platz and Mecham (1979) list only a single locality in Sonora from RU2: on the Rio Santa Cruz 4 miles south of the international boundary. However, the frog has been reported from the Ajos – Bavispe region (The Nature Conservancy undated), including Canon Evens in the Sierra los Ajos (Hale pers. comm. 2004); leopard frogs (possibly Chiricahua leopard frogs) reportedly occur at the Los Fresnos Cienega and the Rancho Las Palmitas in the upper San Pedro River drainage (IMADES 2003); and likely also occur or occurred in other mountain ranges and valleys elsewhere in the Sonoran portion of RU2. Chiricahua leopard frogs are still well-represented in RU2, including populations on the eastern slope of the Santa Rita Mountains, Patagonia Mountains, Canelo Hills, Empire Cienega/Cienega Creek, Monkey Springs, Ajos-Bavispe area/upper San Pedro River basin, and San Rafael Valley.

The management areas (MAs) within RU2, affected by the proposed action include:

Santa Rita MA–Includes Box Canyon Wash-Upper Santa Cruz River hydrologic unit, Cienega Creek hydrologic unit, and Sonoita Creek hydrologic unit. The major threat in this MA is scarcity of water, particularly during long periods of drought. Also, fire in the watershed could result in scouring and sedimentation in the pools important as habitat for the frog. The breeding habitat at Louisiana Gulch, although limited to two 6.0-ft (1.8-m) diameter steel tanks, is dependable because it is fed by a well. The other tanks are filled by runoff and susceptible to drying during drought. Improvements have been made to important breeding habitat to improve their resiliency in holding water. West Tank, a tank formerly threatened by seasonal drying near Greaterville Tank, had piping installed in June 2011, which is fed by a nearby well and now supports a robust breeding population of Chiricahua leopard frogs. Greaterville Tank was dredged and lined in June 2012, which greatly improved its ability to maintain water during periods of short- to medium-term drought. Chytridiomycosis and nonnative predators are potential threats, but neither is considered a current threat in this MA.

Table CLF-1: Chiricahua leopard frog survey data for the Santa Rita Management Area from 2010-2012

Site Name	Descriptor	2010	2011	2012	Notes
Cave Creek	Sawmill Canyon Confluence	ND	D	D	Adults, Juveniles
Anaconda Spring	Temporal Gulch	NS	ND	ND	
Fish Canyon	Fish Well	ND	NS	NS	
Fish Canyon Tank	None	ND	NS	NS	
El Pilar Tank	Trib of Adobe Canyon	NS	ND	ND	
Big Casa Blanca Canyon	“Bathtubs” Area	ND	ND	ND	
Big Casa Blanca Canyon	“Long Pool/Ledge Pool” Area	ND	ND	ND	
Big Casa Blanca Canyon	“String of Pools” Area	ND	NS	ND	
Unnamed Tank	N of Fish Canyon	NS	ND	NS	
Unnamed Tank	SW of Fish Canyon	ND	NS	NS	
Unnamed Tank	Los Posos Gulch	ND	NS	ND	

Table CLF-1: Chiricahua leopard frog survey data for the Santa Rita Management Area from 2010-2012

Site Name	Descriptor	2010	2011	2012	Notes
Unnamed Tank	Little Fish Canyon	ND	ND	NS	
Unnamed Tank	S of Enzenberg Canyon	ND	D	D	Adults, Juveniles
Unnamed Tank	NE of California Gulch	ND	NS	NS	
Unnamed Tank	N of Thurber Ranch	ND	NS	ND	
Unnamed Tank	Ophir Gulch	D	D	ND	Adults, Juveniles
Unnamed Tank	California Gulch	D	D	D	Adults, Juveniles
Unmarked Tank	Armada Mine – Temporal Gulch	NS	NS	ND	
Unmarked Tank	1.2 mi from Crazy Lazy P Tank	NS	ND	D	Juveniles
Unmarked Tank	Just S of Hog Canyon on Mesa	NS	NS	ND	
Unnamed Tank	SE of Adobe Tank	ND	NS	NS	
Unnamed Tank	SE of Barrel Tank	ND	ND	ND	
Unnamed Tank	W of Trail Canyon	ND	ND	ND	
Unnamed Tank	S of Oak Tree Canyon	ND	NS	NS	
Unnamed Tank	Unnamed Trib of Empire Gulch	ND	NS	NS	
Unmarked Tank	Louisiana Gulch	ND	NS	NS	
Unnamed Tank	Los Posos Gulch	ND	NS	NS	
Unnamed Tank	Enzenberg Canyon	ND	NS	NS	
Unnamed Tank	Unnamed Trib of Gardner Canyon	ND	NS	NS	
Jones Canyon	Temporal Gulch	NS	NS	ND	
Adobe Canyon	End of FS 234	ND	ND	ND	
Bathtub Tank	Adobe Canyon	NS	NS	ND	
Temporal Gulch	From 4,450 to 6,450 ft elevation	NS	NS	ND	
Box Canyon	NW of Greaterville	ND	D	D	Adults, Juveniles
Highway Tank	State Hwy 83 and Oak Creek Canyon	ND	ND	ND	
Oak Tree Canyon Tank*	Oak Tree Canyon	ND	ND	ND	
Greaterville Tank*	NW of Greaterville	D	D	D	Adults, Juveniles
Granite Mountain Tank*	Ophir Gulch	D	D	D	Adults, Juveniles, Larvae
Upper Walker Tank	Walker Basin	NS	NS	ND	
Unnamed Drinkers	Corral in Louisiana Gulch	D	D	NS	Adults, Juveniles, Larvae
Unmarked Plastic Drinker/Spring	Ophir Gulch	ND	NS	NS	
Unmarked Drinker	Sucker Gulch	ND	NS	NS	
Unnamed Drinker	Sucker Gulch				
Unnamed Drinker	Ophir Gulch	ND	NS	NS	
Walker Canyon	Walker Basin	NS	NS	ND	
Louisiana Gulch	N of Sucker Gulch	NS	NS	D	Adults, Larvae
Bowman Tank*	Empire Gulch	ND	D	D	Adults, Juveniles
Bowman Spring	Mill Canyon	ND	NS	ND	
Lower Granite Mountain	Ophir Gulch	ND	ND	ND	

Table CLF-1: Chiricahua leopard frog survey data for the Santa Rita Management Area from 2010-2012

Site Name	Descriptor	2010	2011	2012	Notes
Tank*					
Unmarked Well	W of Greaterville along Ophir Gulch	D	D	D	Adults
Gardner Canyon	Cave Creek-Gardner Canyon Confluence	NS	D	D	Adults, Juveniles, Larvae, Egg Masses; Robust Breeding Population
Gardner Canyon	E of Tunnel Spring, W of Cave Creek Confluence	NS	D	ND	Adults, Juveniles, Egg Masses; Robust Breeding Population
West Tank*	California Gulch	D	D	D	Adults, Juveniles, Larvae; Robust Breeding Population
Fish Tank*	Hog Canyon	NS	D	D	Adults
Sweetwater Dam*	SW of Sweetwater Spring	ND	ND	ND	
Crazy Lazy P Tank*	NW of Douglas Ranch	ND	D	D	Adults, Juveniles
Mesa Tanks	Between Hog and Adobe Canyons	NS	NS	ND	
Milo Tank*	Nothern Trib of Hog Canyon	NS	ND	ND	
Upper Enzenberg Tank*	Enzenberg Canyon	D[+]	ND	ND	[+] Ranid sp., Adult
Perfect Tank*	Unnamed Trib of Sawmill Canyon	ND	ND	NS	
Barrel Tank	E of Oak Tree Canyon	ND	ND	ND	
Cemetery Tank*	Ophir Gulch	ND	NS	NS	
Fish Dam*	Fish Canyon	ND	NS	NS	
Granite Mountain Drinker*	Sucker Gulch	ND	NS	NS	
Gunsite Tank*	W of McLeary Canyon	ND	ND	ND	
McLeary Tank*	McLeary Canyon	ND	ND	ND	
North Basin Tank	E of Barrel Canyon	ND	ND	ND	
Rosemont Crest Tank*	E of Gunsite Pass	ND	ND	ND	
Roadside Tank*	Gardner Canyon	ND	NS	NS	
South Upper Tank*	W of Wasp Canyon	ND	ND	ND	
Oak Tree Windmill*	Oak Canyon	ND	ND	ND	
Substation Tank*	Empire Gulch	ND	NS	NS	

Notes: "NS" means "not surveyed," "D" means species was "detected," and "ND" means the species was "not detected." "Unmarked" means the site was not marked on the corresponding USGS 7.5 minute quadrangle. "Unnamed" means the site was marked on the corresponding USGS 7.5 minute quadrangle but was not named. An asterisk denotes that the site was either unmarked or unnamed and was ascribed a name for identification purposes in the Arizona Game and Fish Department Ranid Frog Database. Survey data from sites on private lands are not included. Data provided by the Arizona Game and Fish Department, Nongame Branch, Ranid Frogs Project and WestLand Resources, Inc.

Empire Cienega MA–Includes the Cienega Creek hydrologic unit. Approximately 60 metamorphosed Chiricahua leopard frogs and 400 tadpoles were released to Las Cienegas Natural Conservation Area during the fall of 2011. Special management is required in this area to improve habitat, control disease, and remove nonnative species. A collaborative, three-year, multi-partner recovery program for the Chiricahua leopard frog and other native aquatic species known as the FROG Project was completed in 2012 at Las Cienegas which included habitat improvements, nonnative management, and headstarting Chiricahua leopard frogs. Significant progress was been made to eliminate bullfrogs from the area, but bullfrogs are still present regionally and represent a potential, on-going threat. Chiricahua leopard frogs suffer from chytridiomycosis in this area; however, the Chiricahua leopard frogs are persisting with the disease. Crayfish occur within a few miles and pose a significant threat if they reach Cienega Creek or Empire Gulch.

Table CLF-2: Chiricahua leopard frog survey data for the Empire Cienega Management Area from 2010-2012.

Site Name	Descriptor	2010	2011	2012	Notes
Mattie Canyon	Empire Cienega	ND	ND	NS	
Road Canyon Tank	Empire Cienega	ND	ND	D	Juveniles
Unnamed Spring	NE of Empire Ranch	NS	D	D	Adults, Larvae, Egg Masses
Gardner Canyon	E of Cottonwood Windmill	NS	NS	ND	
Cienega Creek	The Narrows	NS	ND	NS	
Cienega Creek	E of Empire Gulch	ND	ND	ND	Bullfrogs detected 2010-2012
Cienega Creek	SW of Cienega Ranch	NS	ND	NS	
Cienega Creek	Headwaters	ND	NS	NS	
Cinco Ponds*	E of Cienega Creek	NS	ND	ND	Bullfrogs detected 2011 and 2012
Empire Gulch	Cienega Creek	ND	NS	NS	
East Dam	S of Barrel Canyon	ND	NS	NS	
Adobe Tank	E of State Hwy 83	ND	NS	NS	
Clyne Pond*	Mud Spring Canyon	ND	ND	ND	Bullfrogs detected 2010
Clyne Spring*	Mud Spring Canyon	NS	ND	NS	
Boulder Tank	Hilton Wash	ND	NS	NS	
Oil Well Tank	Empire Cienega	ND	ND	NS	
Beck Tank*	W of Cienega Creek	ND	NS	NS	
Bellota Tank*	S of Los Posos Gulch	ND	NS	NS	
Big Pond*	N of Fortynine Wash	ND	NS	NS	
Blacktail Tank	W of Davidson Canyon	ND	NS	NS	
Cemetery Tank	W of Davidson Canyon	ND	NS	NS	
Cottonwood Tank*	Gardner Canyon	ND	NS	NS	
Dry Tank*	S of Smith Canyon	ND	NS	NS	
Fish Tank*	Davidson Canyon	ND	NS	NS	
Water Tank	E of Cienega Creek	ND	NS	NS	
Hummel Tank*	Cienega Creek	ND	NS	NS	
Landing Strip Tank*	N of Fortynine Wash	ND	NS	NS	
Johnson Reservoir*	W of Cienega Creek	ND	NS	NS	
East Johnson Reservoir*	Trib of Cienega Creek	ND	NS	NS	
Mulberry Tank	Mulberry Canyon	ND	NS	NS	
Enzenberg North Well	N of North Canyon	ND	NS	NS	
Rattlesnake Tank*	N of Cienega Creek	ND	NS	NS	

Reeves Tank*	E of Cienega Creek	ND	NS	NS	
Regge Tank*	S of Gardner Canyon	ND	NS	NS	
Unnamed Tank	SW of Blacktail Tank	ND	NS	NS	
Unnamed Tank	W of Davidson Canyon	ND	NS	NS	
Unnamed Tank	Unnamed trib of Cienega Creek	ND	NS	NS	
Smith Tank*	Smith Canyon	ND	NS	NS	
Twin Tanks	E of Davidson Canyon	ND	NS	NS	
Springwater Marsh*	Empire Gulch	ND	NS	NS	
Wind Tank	S of Hilton Wash	ND	NS	NS	
Unmarked Drinker	N of Smith Canyon	ND	NS	NS	
Unmarked Tank	Stoddard Ranch	ND	NS	NS	
Unmarked Tank	Cienega Creek	ND	NS	NS	

Notes: “NS” means “not surveyed,” “D” means species was “detected,” and “ND” means the species was “not detected.” “Unmarked” means the site was not marked on the corresponding USGS 7.5 minute quadrangle. “Unnamed” means the site was marked on the corresponding USGS 7.5 minute quadrangle but was not named. An asterisk denotes that the site was either unmarked or unnamed and was ascribed a name for identification purposes in the AGFD Ranid Frog Database. Survey data from sites on private lands are not included. Data provided by the AGFD, Nongame Branch, Ranid Frogs Project.

Red Rock-Sonoita Creek MA–Includes the Sonoita Creek hydrologic unit. Red Rock Canyon maintains a largely native biotic community with four species of native fish, Sonoran tiger salamanders, and northern Mexican gartersnakes but bullfrogs and nonnative, soft-rayed fish species are also known to occur within the Red Rock subbasin. Sonoita Creek maintains a persistent population of bullfrogs, crayfish and nonnative, spiny-rayed fish that likely trace their origin to downstream Patagonia Lake which is fed by Sonoita Creek. We are not currently aware of any occupied sites in this MA.

Table CLF-3: Chiricahua leopard frog survey data for the Red Rock-Sonoita Creek Management Area from 2010-2012.

Site Name	Descriptor	2010	2011	2012	Notes
Unnamed Tank	Gringo Gulch	NS	ND	NS	Bullfrogs detected 2010
Dark Tank*	Dark Canyon	ND	NS	NS	

Notes: “NS” means “not surveyed,” “D” means species was “detected,” and “ND” means the species was “not detected.” “Unnamed” means the site was marked on the corresponding USGS 7.5 minute quadrangle but was not named. An asterisk denotes that the site was either unmarked or unnamed and was ascribed a name for identification purposes in the AGFD Ranid Frog Database. Survey data from sites on private lands are not included. Data provided by the AGFD, Nongame Branch, Ranid Frogs Project.

In total and within the Santa Rita (n=17) and Empire Cienega (n=2) MAs, we are aware of 19 sites where Chiricahua leopard frogs have been documented in one or more life stages. West Tank and Gardner Canyon are considered the strongest breeding populations but reproduction has been observed in several other locations from 2010-2013 (see Tables CLF-1, 2, and 3, above). Recent efforts to improve the water storage capacity and duration of Greaterville Tank are expected to create a third robust breeding population in that area.

Effects of the Proposed Action - Chiricahua Leopard Frog

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, which will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

The project description provided on pages 9-17 of the June, 2012, Biological Assessment for this project describes mining operations, ancillary operations, and reclamation and closure operations that will result in the direct disturbance of 5,393 acres of Federal, State, and private lands. This description will not be reiterated here, but independent facets of the proposed action that may affect the Chiricahua leopard frog or its critical habitat are identified and discussed below. We differentiate effects of the proposed action as those associated with the physical construction, operation, and closure of the mine and those associated with conservation measures included in the proposed action.

<u>Adverse Effects Associated with Mine Construction and Operation</u>

Adverse effects to Chiricahua leopard frogs are reasonably certain to occur over the life of the proposed action (up to 30 years), but are most likely to be heavily weighted towards the beginning phase of project implementation. Specifically, the majority of adverse effects are likely to result from the 18-month initial period of construction which will include the use of heavy earth-moving equipment to clear vegetation, build roads, construct infrastructure, manipulate area drainage patterns, build power lines and their access roads; seconded by sustained effects of harassment from lighting and noise associated with operations and discussed below. These activities will span all seasons of the calendar year and therefore overlap with periods recognized for Chiricahua leopard frog surface activity (March – October) and dispersal (July - September; monsoon). Individual frogs dispersing to or from known occupied sites nearby may be injured or killed by heavy equipment or their behavior may be modified by the effects of avoidance behaviors from construction activities in a manner that may result in decreased survivorship or fitness of individuals. Lower Stock Tank, the only tank within the active footprint of mine operations will be removed, but the tank will undergo pre-construction surveys which will greatly limit the number of individual frogs adversely affected by its removal.

As a result of on-going mine operations which include vehicle use, blasting, drilling, lighting, and the processing and management of ore and waste materials, Chiricahua leopard frogs that find their way into the active mining area or cross roads associated with mining activity and may be harassed, injured, or killed. Chiricahua leopard frogs that are nearby but not within the active mining area may be harassed by noise and light pollution associated with blasting, operation of heavy machinery and equipment, and the lighting needs associated with the proposed action. Frogs of many species (including those on the genus *Lithobates*) are known may be attracted to light sources (Longcore and Rich 2004) which may create an attractive nuisance at the active mining area, but most observations of this lighting-behavior phenomena are with light sources several times smaller than that considered for a massive project on a local landscape level. Longcore and Rich (2004) reported conclusions by Rand *et al.* (1997) and Buchanan (pers.

comm.) that artificial night lighting may interfere with amphibian breeding activities such as mate selection, inhibit or interfere with movement to and from breeding sites by stimulating phototactic behavior, or may cease breeding behaviors entirely. Increased nocturnal lighting can also increase the predation risk of frogs as found by Rand *et al.* (1997). The rate of attenuation with distance from these types of lighting effects on frogs is uncertain but logic suggests that effects are attenuated with increasing distance from the lighting source. Loud noises associated with blasting and heavy equipment operation may also affect nearby Chiricahua leopard frogs by interfering with male calling ability and therefore breeding success, both independently and in chorus with other males, as suggested by research on the European treefrog (*Hyla arborea*) by Lengagne (2008). Finally, Chiricahua leopard frogs that disperse into the active mining area may be injured or killed by exposure to toxic chemicals associated with ore processing and wastewater storage in open ponds or pits, or associated with contaminated leach piles.

As a result of groundwater drawdown after the life of the mine, the amount or volume of water within regional perennial pools could decrease, which could result in indirect effects on Chiricahua leopard frogs through long-term habitat alteration, which could cause die-back in aquatic and some riparian vegetation. Chiricahua leopard frogs have been documented within the action area in four locations that are fed by groundwater and where groundwater drawdown is possible after closure of the mine: Empire Gulch, Box Canyon–Dam Structure, Well in Ophir Gulch, and South Sycamore Canyon.

Groundwater flow models were designed to simulate conditions prior to pit development, during pit dewatering, and for a 1,000-year post-closure period of groundwater level recovery and potential pit lake development (Montgomery and Associates 2010; Tetra Tech 2010c), and it was determined that groundwater level drawdown could result in the dewatering of key breeding sites and other streams, seeps, and springs that support, or that may support, breeding frogs. These indirect impacts are anticipated to be negligible and immeasurable until at least 50 years after project closure in Empire Gulch and Cienega Creek. After mining activity ceases, however, there are indirect effects anticipated based on long-term projections of the hydrology models. Uncertainties in the variables used to build the models, however, could be manifested as greater reductions of groundwater and greater impact to surface water levels (e.g., lower water level, more extensive dry reaches) and riparian vegetation than modeled. The timing and amount of groundwater drawdown at Box Canyon–Dam Structure, Ophir Gulch Well, and South Sycamore Canyon have not been specifically reported. These impacts could be critical during periods of low flow (May and June) because even small flow reductions could cause some portions of Cienega Creek, or other aquatic areas, to stop flowing. These modeled decreases in groundwater (less than 1 foot) would occur over a long period of time but could cause changes in riparian vegetation extent or health; the reduction in stream flow could impact this frog species, which needs standing or flowing water. Indirect effects of groundwater drawdown on Chiricahua leopard frogs breeding and foraging within these areas could result in reduction of substrate for eggs, substrate for organisms fed on by tadpoles and adult frogs, escape cover for tadpoles and adults, and moist microhabitats for frogs, hence reducing the success of eggs, altering growth rates of tadpoles, reducing food for tadpoles and adults, and increasing the exposure of tadpoles and adults to vertebrate predation and desiccation (Southwest Endangered Species Act Team 2008). The term "possible" means there is definitely enough drawdown to impact a spring, but the water source of the spring is unknown. If the spring arises from the regional aquifer, then it would be impacted; however, if it is a localized spring that is not connected to the regional aquifer, then it may not be impacted at all.

Impacts to water quality and/or disruption of surface water flow resulting from the capture of runoff in the pit are only expected to occur along the Barrel Canyon drainage through Davidson Canyon to its confluence with Cienega Creek. The Chiricahua leopard frog is not known to currently occur in any of these reaches; however, lower Davidson Canyon Creek may provide suitable habitat for this species during high-water events, when Chiricahua leopard frogs are able to move upstream to temporary pools downstream of the head cut barrier to movement.

The same types of effects described above can also affect Chiricahua Leopard Frog prey species as a result of the proposed project activities, hence altering their predator-prey relationships and resulting in additional effects to Chiricahua Leopard Frogs. Additionally, because the mine pit lake water quality could exceed wildlife standards for three contaminants that are known to bioaccumulate (i.e., cadmium, mercury, and selenium), effects on this species could occur from eating aquatic invertebrates originating from the mine pit lake. The results of geochemical modeling for the mine pit lake indicate that various contaminant levels that would result from these mining processes may exceed aquifer or surface water quality standards for wildlife. Cadmium is highly toxic to wildlife, is carcinogenic and teratogenic, and can have sublethal and lethal effects at low environmental concentrations (EPA 2011). It affects respiratory functions, enzyme levels, muscle contractions, growth reduction, and reproduction. Cadmium is known to bioaccumulate in the food chain. A portion of mercury released into the environment is transformed by abiotic and biotic chemical reactions to organic derivatives, such as methylmercury, which bioaccumulates in individual organisms, biomagnifies in aquatic food chains, and is the most toxic form of mercury to which wildlife are exposed (EPA 1997). Risks from selenium are primarily associated with aquatic species. Selenium is a bioaccumulative pollutant, and aquatic life is exposed to selenium primarily through diet (EPA 2004). Risks stem from aquatic life eating food that is contaminated with selenium, rather than from direct exposure to selenium in the water.

Within the portions of the action area that include designated critical habitat for the Chiricahua leopard frog, it is possible that the proposed project could indirectly impact some of the PCEs of critical habitat for this species within those areas. Chiricahua leopard frogs are known to occur at seven locations within proposed critical habitat within the action area. There are two known Chiricahua leopard frog locations in designated critical habitat that are supported by groundwater: Ophir Gulch Well and Empire Gulch Springs. Groundwater drawdown at Empire Gulch is modeled to be measurable beginning 50 years after mine closure; the timing or amount of groundwater drawdown at Ophir Gulch Well has not been modeled. Other locations in Cienega Creek in designated critical habitat that are supported by groundwater are modeled to experience groundwater drawdown, and impacts are modeled to be negligible and immeasurable in Cienega Creek until at least 50 years after mine closure. Impacts to an ephemeral system, such as Cienega Creek, could be much greater during critical periods of low flow and during critical times of the year (May and June), and even small flow reductions could cause some portions of Cienega Creek, or other aquatic areas, to stop flowing. These modeled decreases in groundwater (less than 1 foot) would occur over a long period of time but could cause changes in riparian vegetation extent or health, and the reduction in stream flow could impact designated critical habitat for this aquatic frog species, which needs standing or flowing water.

Cover vegetation at the edge of stock tanks in designated critical habitat, especially the areas of designated critical habitat near the proposed project area, could be negatively impacted by windborne fugitive dust coating leaves, resulting in reduced photosynthetic activity. Physical effects of dust on plants may include blockage and damage to stomata, shading, abrasion of leaf surface or cuticle, and cumulative effects (e.g., drought stress on already stressed species) (Goodquarry 2011). Reduced emergent vegetation cover or substrates could result in reduced of substrate for eggs, substrate for organisms fed upon by tadpoles and adult frogs, escape cover for tadpoles and adults, and moist microhabitats for frogs, hence reducing the success of eggs, altering growth rates of tadpoles, reducing food for tadpoles and adults, and increasing the exposure of tadpoles and adults to vertebrate predation and desiccation (Southwest Endangered Species Act Team 2008). It is possible that the proposed mine and associated disturbances could also result in increases in populations of nonnative species and could create conditions suitable for the presence of *Bd*. *Bd* has been documented from Las Cienegas NCA (USFWS 2012b) but not confirmed from the Santa Rita Mountains; however, there is speculation that *Bd* may have been present in Tarahumara Frogs (*Lithobates tarahumarae*) in the Santa Rita Mountains in the past (Hale *et al.* 2005; Rorabaugh *et al.* 2005).

<u>Effects from Conservation Measures</u>

Numerous conservation measures are included in the proposed action; some that benefit the Chiricahua leopard frog directly and others, indirectly. Although most of these actions should be considered beneficial to the Chiricahua leopard frog in both the short- and long-term, brief but adverse effects are also associated with implementation of these activities. In some instances, conservation measures could pose more harm than good to the Chiricahua leopard frog and are therefore being replaced or modified by terms and conditions described below. Following, we discuss the effects associated with the proposed conservation measures.

Sonoita Creek Ranch – The general scope and purpose of proposed management on the Sonoita Creek Ranch is commensurate with ongoing recovery strategies outlined in the Chiricahua leopard frog Recovery Plan (USFWS 2007); that is to say, management to benefit native aquatic species. We concur with the AGFD's recommendation in their letter dated February 14, 2013, that these two large ponds will be better managed for native vertebrates if they were reconstructed as a conglomeration of smaller bodies of water, after the removal of existing nonnative species. The construction of barrier fencing to restrict movement of bullfrogs was not included as part of this specific conservation measure. Without the construction of barrier fencing around these constructed water features, regional bullfrog populations are likely to infiltrate these ponds and render them useless for Chiricahua leopard frog conservation. Barrier fencing will allow these water features to act as self-sustaining source populations of Chiricahua leopard frogs by providing individuals, larvae, and egg masses for introductions elsewhere in the three affected frog management areas. It is likely that some level of larval Chiricahua leopard frog predation can be expected by interactions with Gila chub in ponds where both species are present. In general terms, conservation activities associated with introducing Chiricahua leopard frogs into these waters for conservation purposes will result in harassment of individuals and on rare occasion, injury or death of individuals from activities associated with capture, storage, transportation, and release of frogs in all life stages. These potential adverse effects are far outweighed by the benefits gained in recovery of the species. This conservation measure in its original form has been affectively modified by terms and condition 3.1 below to provide greater conservation value for Chiricahua leopard frogs.

Chiricahua Leopard Frog-Specific Measures – Anticipated effects to Chiricahua leopard frogs from general survey, capture, and relocation of frogs outlined in the Conservation Measures above may include harassment of individuals and on rare occasion, injury or death of individuals from activities associated with capture, storage, transportation, and release of frogs in all life stages. These potential adverse effects are far outweighed by the benefits gained in recovery of the species.

In addition to the known anticipated effects to Chiricahua leopard frogs from general survey, capture, and relocation of frogs discussed previously that we understand will precede any physical tank renovation work at a given site, we expect that a small percentage of adults and potentially numerous tadpoles may be injured or killed as a result of project implementation. These effects are in addition to harassment of frogs in any life stage present in selected sites from the capture, detainment, and potential relocation of resident frogs. It should be noted that improvements to a given tanks' ability to hold water for longer periods does not ultimately preserve the tanks suitability for occupation under medium- to long-term drought stress. Only installing an artificial water supply (such as a solar groundwater well) can warrant such a guarantee. Therefore, we have amended this conservation measure by adding the requirement in term and condition 3.2 that a guaranteed water supply shall be installed at each of the seven tanks being improved to secure against their drying during periods of prolonged drought conditions. Lastly, for maximum recovery benefit, the location and selection of tanks for improvement should be a collaborative decision with the Chiricahua leopard frog local recovery group consisting of the Coronado National Forest, the AGFD, direct stakeholders, and ourselves (local recovery group) as landscape and resource variables and regional threats are expected to change over time and it may be necessary to focus such efforts at other sites within the affected management areas.

Anticipated effects to Chiricahua leopard frogs from general survey, capture, and relocation of frogs that are associated with the creation of additional water features to support Chiricahua leopard frogs may include harassment of individuals and on rare occasion, injury or death of individuals from activities associated with capture, storage, transportation, and release of frogs in all life stages to these new sites. Under the same premise as discussed immediately above, the location and selection of sites for creation should be a collaborative decision with the local recovery group for maximum conservation benefit.

Because effective nonnative species management is directly linked to surveys and monitoring, we expect resident Chiricahua leopard frogs in all life stages to be harmed or harassed as discussed previously where they occur in sites selected. We expect nonnative species management to occur in all three affected Chiricahua leopard frog Management Areas in Recovery Unit 2 (Santa Rita MA, Empire Cienega MA, and Redrock-Sonoita Creek MA) as appropriate.

Stormwater ponds were originally intended to be managed for Chiricahua leopard frogs as a conservation measure. The creation of stormwater ponds for the purpose of capturing precipitation runoff from the active mining area for subsequent evaporation may attract

Chiricahua leopard frogs and can become an attractive nuisance for regional metapopulations. We do not see conservation value in attracting frogs closer to the active mining area because we conclude that this will indirectly increase the number of frogs adversely affected by mining operations over the life of the proposed action; indirectly acting as a regional population sink versus a population source. Therefore, we are replacing the concept of using these stormwater ponds as Chiricahua leopard frog habitat with term and conditions 2.1 and 2.2 which call for actions be taken to minimize the threat posed by these ponds to Chiricahua leopard frogs.

Because we understood that the presence of water on the landscape is an attractive and necessary element to the Chiricahua leopard frogs' natural history, it is likely that over the life of the proposed action, an unknown number of dispersing adults may move into exposed process water where they are likely to be injured or killed from toxic exposure. Barriers will minimize and likely remove this threat.

Cumulative Effects - Chiricahua Leopard Frog

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Exceptions include continued road maintenance, grazing activities, and recreation in the action area, current and future development, other nearby mining projects, and unregulated activities on non-federal lands, such as trespass livestock, inappropriate use of off-highway vehicles (OHVs), and illegal introduction of nonnative aquatic species (e.g., bullfrogs, crayfish, and salamanders), which can cumulatively adversely affect the Chiricahua leopard frog and its designated critical habitat. Additional cumulative effects on Chiricahua leopard frogs include ongoing activities in the watersheds in which the species occurs such as livestock grazing and associated activities outside federal allotments, irrigated agriculture, groundwater pumping, stream diversion, bank stabilization, channelization, recreation without a federal nexus, and cross-border activities that include the following: human traffic; deposition of trash; new trails from human traffic; soil compaction and erosion; increased fire risk from human traffic; and water depletion and contamination. These impacts are somewhat attenuated by the relatively minor amount of non-Federal lands in the action area.

Conclusion - Chiricahua Leopard Frog

After reviewing the current status of the Chiricahua leopard frog, the environmental baseline for the action area, the effects of the proposed Rosemont Mine Project, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Chiricahua leopard frog nor adversely modify its designated critical habitat. We make this finding for the following reasons:

1. The majority of the project activity likely associated with adverse effects from mine construction and operation is located on the northern-most edge of the recovery focus for the Santa Rita Management Area, and therefore, core metapopulation areas that have

been the focus of recent recovery actions are spatially distant from the active mining area. This mitigates the likelihood for dispersing frogs to be present in the active mining area.

2. Conservation benefits from the suite of proposed conservation measures, if properly implemented, are expected to outweigh the adverse effects of mine construction and operation, through the creation and improvement of habitat and management of nonnative species, provided that predominate forces such as potential drought from regional climate change have been adequately forecasted over the life of the project. The most significant threats to Chiricahua leopard frogs in this area are drought (Santa Rita MA, Empire Cienega MA, and Redrock-Sonoita Creek MA), nonnative species (Redrock-Sonoita Creek MA), and Bd (Empire Cienega MA). Collectively, with the exception of the threat of Bd, the proposed conservation measures, with minor modifications, are likely to help secure the regional status of Chiricahua leopard frogs and enhance the achievement of recovery goals in this area.

The conclusions of this biological opinion are based on full implementation of the project as described in the "Description of the Proposed Action" section of this document, including any Conservation Measures that were incorporated into the project design.

INCIDENTAL TAKE STATEMENT - CHIRICAHUA LEOPARD FROG

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USFS so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The USFS has a continuing duty to regulate the activity covered by this incidental take statement. If the USFS (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USFS must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement. [50 CFR 402.14(i)(3)].

Amount or Extent of Take - Chiricahua Leopard Frog

We anticipate that take of Chiricahua leopard frogs in the form of harm and harassment will occur at up to 6 known sites where the species is currently or formerly known, as a result of groundwater drawdown as reported in the Biological Assessment: Lower Stock Tank, Empire Gulch, Box Canyon Dam, Ophir Gulch Well, South Sycamore Canyon, Cienega Creek.

We anticipate take of up to 25 Chiricahua leopard frogs in the form of harm or harassment from adverse effects associated with the mine construction and continued operations at the active mine site and access roads. This number is our conservative estimate of the total number of frogs that could be taken within the active mining footprint and associated road use over the life of the permit. Currently there is no occupied Chiricahua leopard frog within the footprint of the proposed mine. Rosemont will survey for Chiricahua leopard frogs prior to construction which will reduce the potential for take. The proposed project area is generally located in the northernmost periphery of the core metapopulation area along the eastern bajada of the Santa Ritas. If Rosemont will take measures to avoid attracting frogs to the mine and monitor sites within overland dispersal distance during the monsoon for potential translocations, we conclude that a limited number of frogs are likely to be directly affected by operations. These factors were considered in our estimate of take.

We are unable to anticipate the amount of take associated with indirect effects of potential contamination of prey species (insects) in the region because the data required to ascertain that figure are unavailable and not reasonably collected. However, we do not consider this form of take to be significant because insects that are heavily impacted by contamination are not likely to move appreciable distances and comprise a meaningful proportion of the average frogs' diet.

We anticipate a proportion of Chiricahua leopard frogs will be taken through the implementation of conservation measures, most likely from activities associated with capture, detainment, disease treatments, transportation, and release of frogs in all life stages. It is impractical to quantify actual numbers of individuals taken under these mechanisms and we are not going to limit this form of take because potential, short-term adverse effects are far less significant than the conservation value gained in recovery of the species in the area and because the net number of individuals potentially harmed is far exceeded by the number of individuals which are benefited or created by the implementation of these activities.

Effect of the Take - Chiricahua Leopard Frog

In this biological opinion, we determine that this level of anticipated take is not likely to result in jeopardy to the species or result in adverse modification of its designated critical habitat for the reasons stated in the Conclusions section.

Reasonable and Prudent Measures - Chiricahua Leopard Frog

Reasonable and prudent measures and terms and conditions should minimize the effects of take, and provide monitoring and reporting requirements [50 CFR 402.14(i)(3)].

<u>Chiricahua Leopard Frog</u>

The following reasonable and prudent measures are necessary and appropriate to minimize take of Chiricahua leopard frogs:

1. The Coronado National Forest shall ensure that incidental take resulting from the proposed action is monitored and report to our office the findings of that monitoring with regard to nonnative species and adaptive management actions.

2. The Coronado National Forest shall ensure that necessary precautions are taken to minimize the potential for Chiricahua leopard frogs to become attracted to water features near the active mining area.

3. The Coronado National Forest shall ensure that long-term, secure breeding populations of Chiricahua leopard frogs are created to act as source populations for use in future introductions of frogs into sites within the three affected Management Areas.

Terms and Conditions - Chiricahua Leopard Frog

In order to be exempt from the prohibitions of section 9 of the Act, the USFS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

<u>Chiricahua Leopard Frog</u>

1.1 The Coronado National Forest shall ensure the action area is monitored to ascertain take of individuals and report to our office (written correspondence, e-mail, or phone call), information regarding:

a. The observed occurrence or the discovery of nonnative species to provide for collaborative emergency planning and corrective action (within three days of the observation).

b. The results of any monitoring efforts conducted and a summary of any situations (and their corrective actions), that occurred during project implementation. The report shall also make recommendations for modifying or refining potential, future conservation measures for implementation of similar projects which are likely to adversely affect Chiricahua leopard frogs (within 90 days of the conclusion of the proposed action).

2.1 The Coronado National Forest shall ensure that suitable habitat within one mile of the active operations area is monitored twice monthly from July 1 through September 30 while the mine is in operation. If Chiricahua leopard frogs are detected within a mile of the active operations area, they will be relocated to suitable habitat within the management area under close coordination with the local recovery group.

2.2 The Coronado National Forest shall ensure every precaution is taken to avoid creating habitat in the active operations area that could become an attractive nuisance for frogs to enter the active operations area, specifically focusing on the propensity of stormwater ponds to act as potentially suitable habitat. Alternatives to traditional stormwater pond construction, operation, etc. shall be explored to minimize water holding duration to the maximum extent practicable without compromising the primary function of the ponds.

3.1 The Coronado National Forest shall ensure the creation of small waters on the Sonoita Creek Ranch property to be managed as potential source populations of Chiricahua leopard frogs for future releases in the affected management areas. This will include renovation to remove harmful nonnative predators such as bullfrogs, crayfish, nonnative spiny-rayed fish and the construction and maintenance of frog barrier fencing to prevent bullfrogs from recolonizing these waters. Fencing gauge shall be chosen that will not entrap other small terrestrial vertebrates such as snakes, lizards, etc., such as 0.25" mesh size or smaller. Barrier fencing will be located in a manner to allow adequate terrestrial space for foraging or terrestrial habitat enhancements. Should future, unrelated conservation activities render Sonoita Creek free of bullfrogs, the barrier fencing could be removed to allow natural immigration and emigration from the site. Management of Chiricahua leopard frogs at this site shall be coordinated through the local recovery group.

3.2 The Coronado National Forest shall ensure the location of the seven tanks specifically dedicated for Chiricahua leopard frog conservation will be a collaborative decision among the local recovery group as landscape and resource variables and regional threats are expected to change over time and it may be necessary to focus such efforts in other focal areas within the affected management areas. These sites may or may not include particular sites referenced in the conservation measures of the Biological Assessment and may or may not be located on grazing allotments managed by Rosemont. They will however, be located within one or more of the affected Chiricahua leopard frog recovery management areas. To protect against the threat of prolonged drought, each of the seven tanks that will be improved for permeability and retention shall also have an artificial water source provided, such as a solar groundwater well, to ensure permanency of water at improved sites. Any water features that are created in addition to these seven sites that may affect the status of Chiricahua leopard frogs in the action area will be chosen in consultation with the local recovery group to facilitate avoiding incidental adverse effects or creating conservation opportunities.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. The Coronado Nation Forest must immediately provide an explanation of the causes of the taking and review with our office the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations - Chiricahua Leopard Frog

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the Coronado National Forest implement Forest-specific actions within the Chiricahua Leopard Frog Recovery Plan (U.S. Fish and Wildlife Service 2007).
2. We recommend the Coronado National Forest work with us and the AGFD to continue to control nonnative aquatic organisms on the Forest, particularly bullfrogs, nonnative fish, and crayfish. We therefore encourage the Coronado National Forest to consider installing drains at each of the seven tanks that will be improved or created for use by Chiricahua leopard frogs described in term and condition 3.2. Drains can significantly assist resource managers in the management of harmful nonnative species such as bullfrogs in the event they colonize any one or more of the improved or created tanks.
3. We recommend that the Coronado National Forest continue to identify factors that limit the recovery potential of Chiricahua leopard frogs on lands under their jurisdiction and work to correct them.

In order for us to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

Effects Aquatic Ecosystems

This section includes an analysis of the effects of the proposed action on fluvial aquatic ecosystems. The Gila chub and Gila topminnow occur in streams that are affected by the proposed action. The Huachuca water umbel is a semi-aquatic plant that occurs in and immediately adjacent to streams. The analyses contained herein will be incorporated via reference into the respective species' analyses. These analyses also, in part, inform the respective action area descriptions for the affected species.

The proposed action includes the excavation of an open pit to an elevation of approximately 3,050 feet, a level that will intersect regional groundwater and/or water-conducting subsurface fracture networks (USFS 2011). Subsurface water will therefore "daylight" and fill the excavated area. The need to dewater the pit during active mining operations and the post-mining existence of a lake from which water will evaporate mean that the pit will function as a well from which regional groundwater is removed from storage in the regional aquifer and, eventually, captured from discharges to springs, streams, and evapotranspiration (ET, the uptake of groundwater by vegetation) (Leake *et al*. 2008).

The effects of groundwater withdrawal on surface waters of interest may be evaluated with a model calibrated to local conditions. Groundwater models were prepared by Montgomery and Associates (2010) and Tetra Tech (2010), the results of which were incorporated into the Draft

EIS. The BA and supplemental documents include analyses of effects to surface waters based on the outcomes of the Montgomery and Associates (2010) and Tetra Tech (2010) models, as well as an independent model prepared by Myers (2010). The validity of these models was later evaluated by SRK Consulting at the request of the Forest Service (SRK 2012).

Our review of DEIS comments submitted to the Coronado NF by the U.S. Geological Survey (USGS) (Port 2012), Pima County (Pima County 2012), and Sonoran Institute (Propst 2012), indicated that there were substantial uncertainties regarding the magnitude and timing of groundwater drawdowns, particularly as those drawdowns relate to potential reductions in discharges to springs and streams. These uncertainties were explored at length, culminating in an October 18, 2012, meeting between the Forest Service, consulting hydrologists, the USGS, the BLM, the USEPA, and the FWS. The technical discussions concluded with general consensus as to the validity of the models applied to evaluate the effects of the proposed action (FS 2012a).

Given the general agreement regarding the validity and utility of the Montgomery and Associates (2010), Tetra Tech (2010), and Myers (2010) models, SWCA prepared a definitive impact analysis for seeps, springs, and riparian ecosystems for the Coronado NF and presented it to us on November 16, 2012 (SWCA 2012). The Coronado NF subsequently adopted the SWCA analysis in the second Supplemental BA (FS 2013a). These analyses are incorporated herein via reference.

We note that the models were based on the assumption that the local groundwater system exists as a relatively uniform, porous media, albeit one with low hydraulic conductivity (the ease by which water can move through the material) and low specific storage (which refers to the amount of water an aquifer can release from storage during changes in hydraulic head). There is a possibility that some portion of the regional groundwater is conducted through subterranean fractures and/or faults in the lithology in the project area, though we note that karst (limestone prone to formation of dissolution channels capable of relatively rapid groundwater movement) is unlikely to be present in or near the to-be-excavated area (USFS 2013b, SRK 2012). Knight (1996) described evidence of groundwater flow through fractures. If such a flow system is an appreciable component of the hydrogeology at and near the mine pit, or if mining results in loss of subterranean buoyant forces, new fractures could form. These scenarios would represent a system in which the impacts of the proposed action cannot be fully modeled with the existing, porous media-based modeling tools.

Furthermore, it is not definitively known if or to what extent spring and stream baseflows are the result of discharges from: (1) the regional aquifer, which is affected by the proposed action; (2) a geologically-isolated groundwater system, isolated from the effects of the action; or (3) a combination of these two sources. Also note that our use of the term baseflow refers only to the water discharged from the regional or local aquifer to a spring, stream or waterbody, or to riparian vegetation (in the form of evapotranspiration).

Lastly, we are aware of the cautionary narrative in Leake (2011), which stated that capture of groundwater destined for discharge to streams or riparian ET does not depend on rates and directions of groundwater flow. Leake (2011) further stated that: (1) capture can occur in stream reaches both up- and downgradient of pumping locations [see also Cosgrove and Johnson

(2005)]; (2) capture is not limited to the fraction of base flow that originates in the pumped area, even in streams with base flow derived from groundwater discharge; (3) capture still occurs even if a groundwater divide exists between the pumping location and the river or stream; (4) non-pumping transient events, such as episodic recharge from connected streams, do not affect capture; and (5) the geochemical signature of surface water, if different from the groundwater signature, is not necessarily an indication that pumping from a particular location does not affect that surface water. These precepts, in part, form the basis for our precautionary approach regarding the interception of mountain front recharge (see Gardner Canyon, Empire Gulch, Barrel Canyon, and Davidson Canyon Wash analyses).

The natural hydrologic system to which the models have been applied also exhibits a relatively large degree of variation under current conditions. This natural variation is unaffected by the proposed action but does experience impacts from existing water withdrawals. The hydrologic summary compiled by SWCA and transmitted by the Forest Service (SWCA 2012), includes the following statements regarding fluctuations in depth to groundwater in the area of interest:

- In a well in lower Davidson Canyon, groundwater levels have been observed to fluctuate by more than 10 feet in a single year.
- Two stock wells along Empire Gulch have been monitored by the Arizona Department of Water Resources for three to four decades, and the results show that water levels have varied between 4 to 4.5 feet.
- Similar stock wells along Cienega Creek show variation between 3 and 4 feet.
- Two wells immediately adjacent to lower Cienega Creek were monitored between 2007 and 2009 by the Pima Association of Governments and exhibited a fluctuation in water level of up to 5 feet seasonally.
- Montgomery and Associates (2010) conducted a similar analysis on a much greater number of wells located throughout the basin (not just near streams) and found that the average short-term fluctuation in groundwater levels was 7.1 feet and that the long-term fluctuation in groundwater levels was 19.7 feet.

It is important to note that groundwater drawdowns resulting from implementation of the proposed action will be in addition to the natural variation noted above, and would be additive to any negative baseline effects (or offset by positive effects) already extant (or reasonably certain to occur), as well as the effects of cumulative (future, non-Federal, and within the action area) actions. Please see the climate change discussion appearing in the Gila chub Status of the Species section and to the same species' Cumulative Effects analysis for additional information.

Despite the inherent uncertainties in the hydrologic system and the groundwater modeling data derived from analyses of that system, we are aware of no other model results or empirical data that would more accurately inform our analyses. The existing groundwater models therefore represent the best available information with which we can analyze the groundwater-related effects of the proposed action.

The action area is drained by ephemeral, intermittent, and perennial watercourses that flow primarily in a northeasterly direction from high-elevation ridges on the eastern flank of the Santa

Rita Mountains through foothills toward larger drainages located at lower elevations on the basin floor. Ephemeral refers to streams or portions of a stream that flow briefly in direct response to precipitation, and whose channel is at all times above the groundwater reservoir. Intermittent refers to a stream where portions flow continuously only at certain times of the year, for example when it receives water from a spring, groundwater source, or from a surface source such as melting snow (i.e., seasonal). At low flow, an intermittent stream may exhibit dry reaches alternating with flowing reaches. Perrenial refers to a stream or portion of a stream that flows year-round and is considered a permanent stream, and for which base flow is maintained by groundwater discharge to the streambed. Discharge to the streambed from groundwater would be due to the groundwater elevation adjacent to the stream typically being higher than the elevation of the streambed, though artesian conditions can also support perennial streams.

Four major drainages occur in the primary area of disturbance: Wasp, McCleary, Scholefield, and Barrel Canyons. Scholefield, Wasp, and McCleary Canyons drain to Barrel Canyon, which then joins Davidson Canyon approximately 4 miles east of the project area. Davidson Canyon wash flows northwesterly between the Empire and Santa Rita Mountains into Cienega Creek, which eventually enters Pantano Wash outside of the action area. The distance from the confluence of Barrel and Davidson Canyons to the outlet of Davidson Canyon at Cienega Creek is approximately 14 miles. Drainage from these systems eventually reaches the Santa Cruz River north of Tucson.

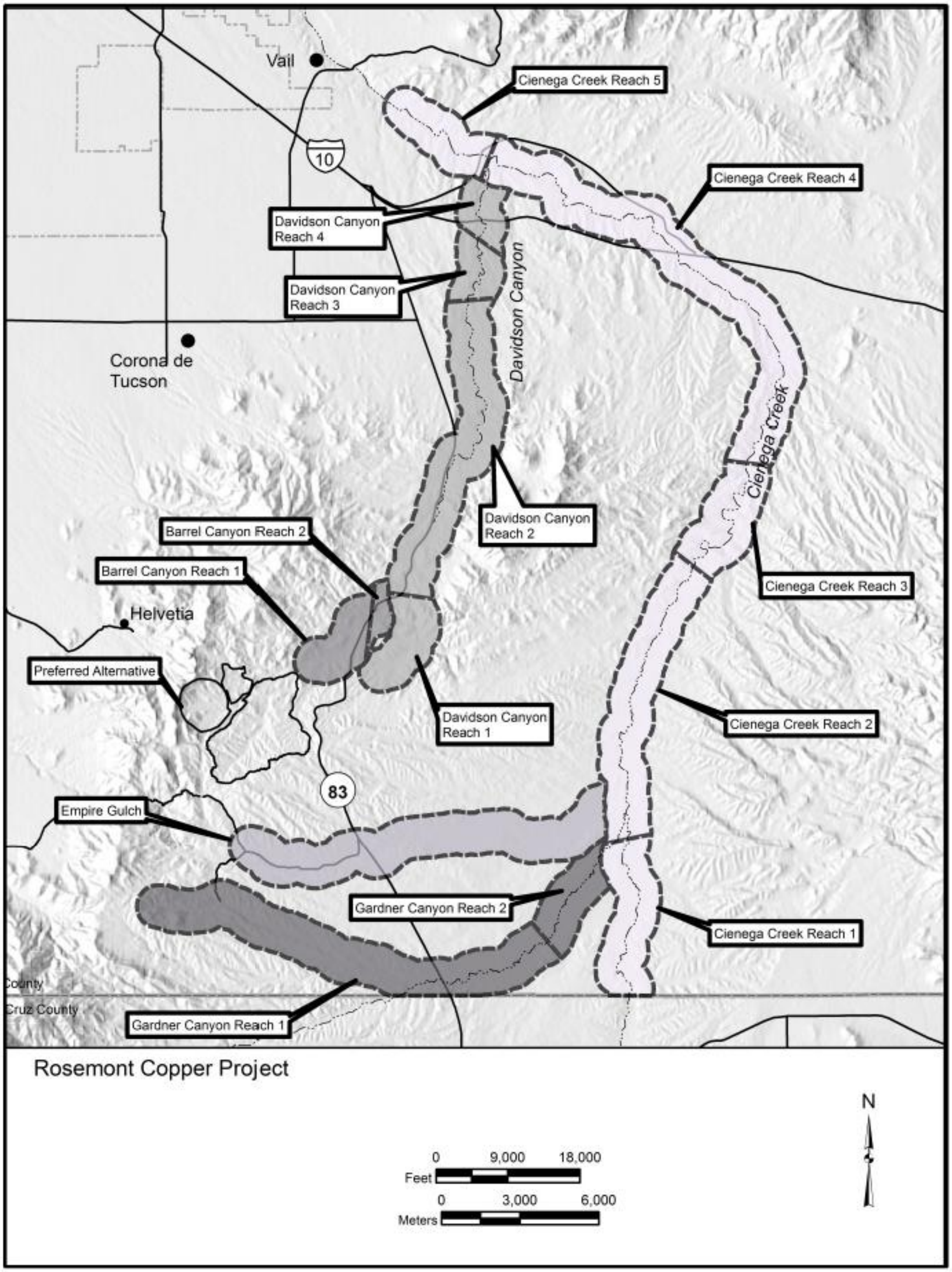


Figure A-1: Surface hydrology of the actions area (SWCA 2012)

Table A-1: Narrative descriptions of stream reaches adapted from SWCA (2012)

Reach	Location	Flow Regime
Cienega Creek 1	From headwaters to confluence with Gardner Canyon	Ephemeral
Cienega Creek 2	From confluence of Gardner Canyon to the Narrows	Spatially intermittent; some perennial reaches; contains U.S. Geological Survey gage no. 09484550
Cienega Creek 3	The Narrows	Spatially intermittent; some perennial reaches
Cienega Creek 4	From the Narrows to confluence with Davidson Canyon	Spatially intermittent; some perennial reaches; contains U.S. Geological Survey gage no. 09484560
Cienega Creek 5	From confluence with Davidson Canyon to Pantano Dam	Spatially intermittent; some perennial reaches
Gardner Canyon 1	Upper Gardner Canyon	Ephemeral
Gardner Canyon 2	Lower Gardner Canyon	Ephemeral
Empire Gulch	From headwaters to confluence with Cienega Creek	Spatially intermittent; some perennial reaches
Davidson Canyon 1	From headwaters to confluence with Barrel Canyon	Ephemeral
Davidson Canyon 2	From Barrel Canyon to Davidson Spring	Ephemeral
Davidson Canyon 3	From Davidson Spring to Reach 2 Spring	Ephemeral
Davidson Canyon 4	From Reach 2 Spring to confluence with Cienega Creek	Has been intermittent or perennial in the past; recently has been intermittent; contains U.S. Geological Survey gage no. 09484590
Barrel Canyon 1	From mine site to State Route 83	Ephemeral; contains U.S. Geological Survey gage no. 09484580
Barrel Canyon 2	From State Route 83 to confluence with Davidson Canyon	Ephemeral

Watershed Overview

The action area encompasses a large proportion of the greater Cienega Creek watershed. The Whetstone and Mustang Mountains form the eastern watershed boundary, the Canelo Hills form the southern boundary, and the eastern and northern Santa Rita and eastern face of the Empire mountains bound the western portion of the Cienega Creek watershed. Gardner Canyon and Empire Gulch are the largest tributaries to the upper reaches of Cienega Creek, and enter the stream south of the Empire Mountains. Mattie Canyon originates in the Whetstone Mountains and enters Cienega Creek downstream of the Empire Gulch confluence. Downstream from these three tributaries, Cienega Creek enters the narrows, a confined, bedrock-dominated reach in which alluvial and other sources of shallow groundwater are forced to the surface to contribute to discharges in the stream. Barrel Canyon and Davidson Canyon Wash arise in the Santa Rita Mountains and flow south along the western flanks of the Empire Mountains to join Cienega Creek well downstream of the narrows, south of Interstate 10.

The proposed mine will be situated within a portion of the watershed of Cienega Creek. Barrel Canyon watershed is the largest of the four major drainages that occur in the primary area of disturbance. Two sub-watersheds, Upper and Lower Barrel, total more than 2,300 acres and combine to make Barrel Canyon proper. Barrel Canyon is the largest of the watersheds affected by surface disturbance, extending almost 4 miles from its headwaters to its confluence with East Canyon; the average sandy-bottom channel width for washes in Barrel Canyon is estimated to be 51 feet. For comparison purposes, average wash widths in Wasp, McCleary, and Scholefield Canyons are approximately 38, 29, and 27 feet, respectively.

Somewhat smaller portions of additional watersheds occur within the perimeter fence. These watersheds include Oak Tree Canyon, Empire Gulch, and East Canyon. East, and Oak Tree Canyons are located east of the mine and drain east to join Cienega Creek. Empire Gulch is located southeast of the mine and also drains east to join Cienega Creek. Much of the land between the perimeter and security fences will remain undisturbed, though the primary access road, rerouted portion of the Arizona Trail, decommissioning of Forest Service Roads and secondary access road and utility ROW construction will result in effects to the Barrel canyon, East Canon, McCleary Canyon, and Wasp Canyon watersheds.

Groundwater and Surface Water Effects

The Montgomery and Associates (2010) and Tetra Tech (2010) models have variously predicted drawdowns greater than 100 feet in the immediate vicinity of the site; drawdowns of lesser magnitude are modeled to occur to the north along Davidson Canyon, to the east toward Cienega Creek, and to the south toward Empire Gulch. Specific drawdown estimates vary between models. The ability for groundwater models to accurately predict the propagation of drawdown away from the pit is limited due to the asymptotic nature (mathematical leveling-off) of the response to groundwater withdrawals at large distances and times (SRK 2012). The difficulty in employing groundwater models to predict changes over large temporal and spatial scales (here, at up to 1,000 years and over 10 miles) is further increased if the groundwater system of interest exists within geologic formations of low permeability, as exists in the hard rock-dominated lithology at and near the mine site (SRK 2012, FS 2011). For these reasons, SRK (2012) estimated that the Montgomery and Associates (2010) and Tetra Tech (2010) models can reliably predict groundwater drawdowns of 5 feet or greater; changes of less magnitude have lower confidence (SRK 2012). It is unclear to us how modeled drawdowns of greater than five feet, but with increments of less than that amount, are inherently more reliable than incremental changes that do not meet the 5-foot threshold. We will therefore analyze the effects of all modeled drawdowns, regardless of their magnitude.

Of the groundwater drawdowns predicted by Myers (2010), Montgomery and Associates (2010), and Tetra Tech (2010), the latter appear to be the most severe (see Table A-5). We feel that emphasizing the results of the Tetra Tech (2010) model will represent the most conservative (i.e. worst-case scenario) case for an effects analysis.

The proposed action’s effects to surface flows and groundwater occur in the southern and western portions of the greater Cienega Creek watershed. As stated previously, Gardner Canyon and Empire Gulch are tributaries to the upstream reaches of Cienega Creek. Barrel Canyon is a tributary to Davidson Canyon Wash which, in turn, is also a tributary to Cienega Creek. The effects to Barrel Canyon, Davidson Canyon Wash, Gardner Canyon, Empire Gulch and the upstream reaches of Cienega Creek represent incremental, additive effects to the lowermost reaches of Cienega Creek.

The stream-by-stream and reach-by-reach analyses that follow are arranged such that the uppermost portions of the watershed (Gardner Canyon, Empire Gulch, and upper Cienega Creek) appear first. The analyses then shift to Barrel Canyon and Davidson Canyon Wash, to which the former is the main, affected tributary. The individual analyses conclude with Lower Cienega Creek.

Gardner Canyon

Gardner Canyon is anticipated to experience regional aquifer drawdowns of < 0.1 foot from the cessation of mining until 50 years later (Tetra Tech 2012) (see Gardner/Cienega Confluence data in Table A-5). At 150 years after mining, the effect to Gardner Canyon increases to 0.2 foot and reaches 0.5 foot at 1,000 years.

We are concerned with the interception of mountain front recharge by the mine pit. Mountain front recharge is water that originates as precipitation and which enters the regional aquifer via infiltration in uplands and channels. Huth (1996, as cited in Knight 1997) found that approximately 70 percent of the annual recharge in Cienega Creek originates from the Santa Rita Mountains, with the majority of that subsurface flow travelling down the Gardner Canyon corridor. The mine pit appears to be quite distant from Gardner Canyon, but we note that Figure 44 in SWCA (2012) (Figure A-2 in this document) shows the Tetra Tech (2010) 1,000-year, 5-foot drawdown contour reaching at least a portion of what is likely the Gardner Canyon recharge zone.

The Coronado National Forest reviewed a preliminary, administrative draft version of this section (USFS 2013), wherein comments regarding alterations in recharge were provided. Tetra Tech (2010) predicts an increase in recharge because of the draining down of water from the tailings, and because of the flow-through drains would result in infiltration instead of runoff. This draining down may be appreciable; the proposed action will import over 5,000 acre-feet of water for application within the site (USFS 2013). Montgomery and Associates (2010) predicted a slight decrease in recharge post-closure (USFS 2013).

For the purposes of NEPA analysis, the Coronado National Forest has assumed that the water that gets intercepted by the pit either as rainfall or runoff is a loss to mountain front recharge (USFS 2013). All other water not intercepted by the pit may become mountain front recharge either by infiltrating into fractures within the mine site and/or infiltrating into alluvial channels. The review comments indicated that there will be an estimated loss of approximately 35 to 127 acre-feet of recharge.

Given that there is no evidence of separate shallow and deep groundwater systems (Leake pers. comm. 2012), the interception of an estimated 35 to 127 acre-feet mountain front recharge by the drawdown associated with the pit represents a further reduction in the recharge that sustains sub- and surface flows in Gardner Canyon and the upper reaches of Cienega Creek.

Empire Gulch

The proposed action will affect the subsurface and, eventually, the surface hydrology of Empire Gulch at the Upper Empire Gulch Springs site (see Upper Empire Gulch Springs data in Table A-5). Tetra Tech (2010) modeled the effects at this site to range from 0.1 foot of groundwater drawdown upon cessation of mining to 0.2 foot at 20 years, 0.5 foot at 50 years, 2.5 feet at 150 years, and 6 feet at 1,000 years.

Empire Gulch is a spring-fed system (Bodner and Simms 2008) and is thus vulnerable to alterations in the groundwater conditions that sustain the spring discharges. The appreciable groundwater drawdowns discussed above will likely diminish surface flows in the stream.

Also, while Huth (1996; a pers. comm. cited in Knight 1997) stated that approximately 70 percent of the annual recharge in Cienega Creek originates from the Santa Rita Mountains and flows down the Gardner Canyon corridor, it is reasonable to presume some smaller fraction of the Santa Rita Mountain front recharge travels down the Empire Gulch flow path. We again refer to Figure 44 in SWCA (2012) (Figure A-2 in tis document), which shows the Tetra Tech (2010) 1,000-year, 5-foot drawdown contour reaching well across the channel of Empire Gulch and thus, portion of the likely Empire Gulch recharge zone and/or the path taken by the recharge.

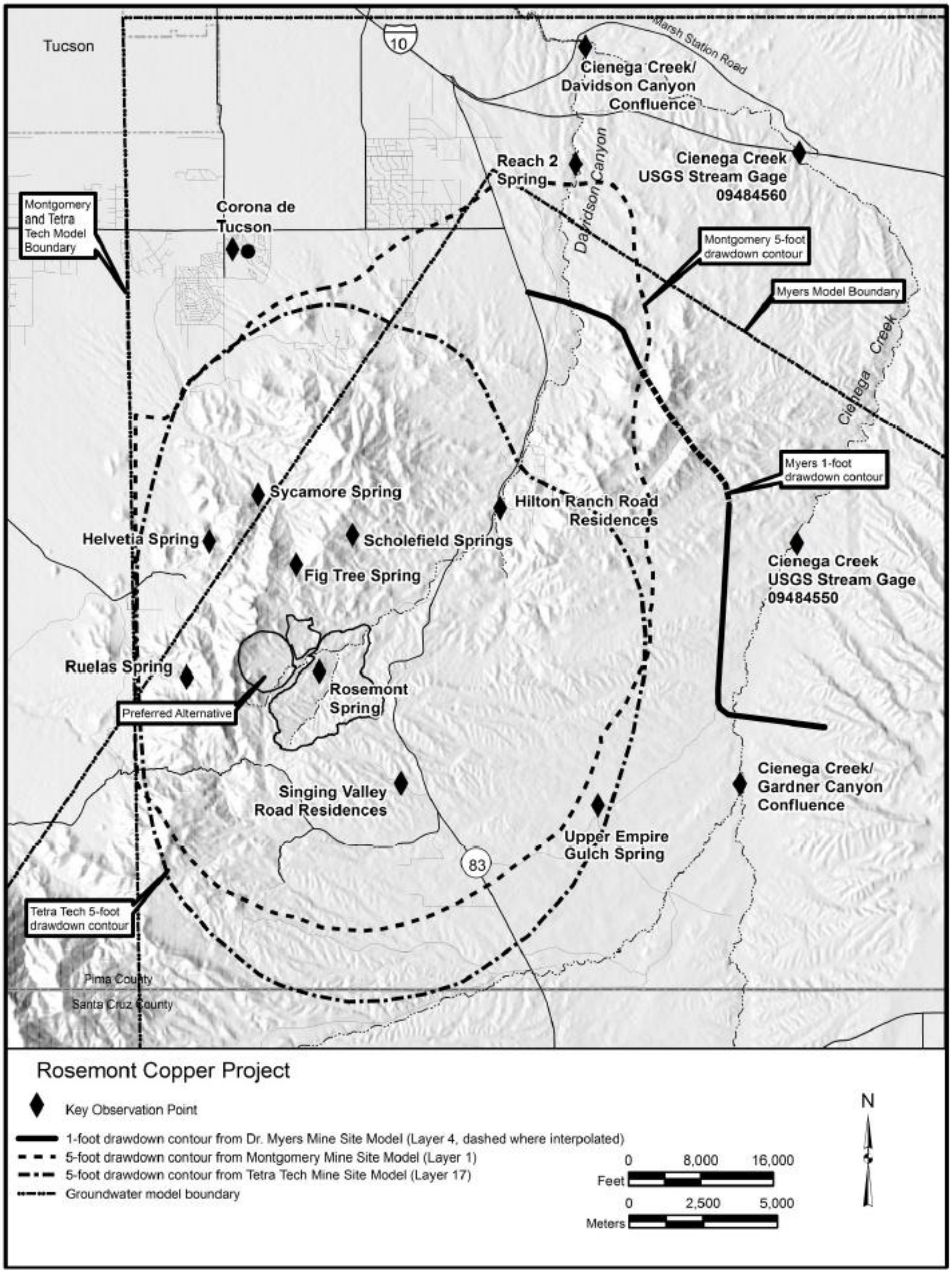


Figure A-2: Modeled groundwater drawdown contours

Upper Cienega Creek

Upper Cienega Creek is that portion of the stream in Reaches 1, 2, and 3 (the latter includes the narrows) (see Figure A-1). Gardner Canyon and Empire Gulch, along with Mattie Canyon are the major tributaries in this reach.

The USGS Cienega Creek stream gage (0948550) is situated near the narrows in the upstream portion of Reach 3 (see Figure A-1). Regional groundwater drawdowns at this site describe the effects to upper Cienega Creek. Tetra Tech (2010) modeled drawdowns of <0.1 foot from the end of mining and at 20, 50, and 150 years later. Drawdowns reach 0.25 feet and 0.5 feet at 150 and 1,000 years, respectively. We remain concerned with diminished recharge within the watershed at this site; our concerns are described in the Gardner Canyon and Empire Gulch analyses, above.

Table 7 in Montgomery (2010) is a summary of various hydrologic and environmental effects resulting from the modeled drawdowns. Table A-2, below, excerpts the hydrologic effects analysis for upper Cienega Creek, including the narrows. The effects don't manifest until 1,000 years after the cessation of mining, but they become appreciable at that time.

Table A-2: Summary of Effects to Upper Cienega Creek, including the Narrows

Years after mining	Drawdown at perennial reach (feet)	Decrease in stream length (miles)	Decrease in baseflow (cfs)	Decrease in ET (afa)
0	0	0	0	0
20	0	0	0	0
150	0	0	0	0
1,000	0.01	0.16	0.02	51

Barrel Canyon

Barrel Canyon is proximal to the mine site. The primary effect of the proposed action on this stream is the reduced runoff that will result from the placement of mine tailings in its upper watershed and the retention of stormwater within the mine site, as opposed to the aquifer drawdowns that will occur deep beneath the stream bed (the ephemeral channel in this area does not receive discharge from the regional aquifer). SWCA (2012) included an estimate that ephemeral surface runoff in Barrel Canyon, under post-closure conditions, will be reduced approximately 17.2 percent. Greater effects – up to a 30 to 40 percent reduction in runoff- will occur during the first 10 years of mine construction (SWCA 2012), before concurrent reclamation activities that allow more water to move downstream are implemented. This would not include the interception of mountain front recharge and the likely associated incremental increases in modeled groundwater drawdown values, as discussed in the Empire Gulch and Gardner Canyon analyses, above.

The Coronado National Forest's review of the preliminary, administrative draft version of this section (USFS 2013) indicated that the placement of tailings in Barrel Canyon may have differing effects to mountain front recharge. As designed, the tailings lack flow-through drains, which would decreases potential for recharge within the mine site boundary. The Barrel alternative also lacks post-closure storage of water on site, which also decreases the potential for recharge within the mine site boundary. On the other hand, the Barrel alternative also moves more water downstream into ephemeral channels, within which mountain front recharge may be increased.

Davidson Canyon Wash

The uppermost reaches of Davidson Canyon Wash (Reaches 1 and 2) (see Figure A-1) are situated relatively close to the proposed mine pit and are situated in an area that will experience severe drawdowns (10 to 100 feet) in the regional aquifer; however, the primary water source in this area is precipitation runoff rather than regional aquifer discharge. These local sources of runoff will be unaffected and thus, the groundwater hydrology of Reaches 1 and 2 are not anticipated to be affected; Tetra Tech (2010) predicted drawdowns of <0.1 foot from the cessation of mining to 1,000 years.

Reaches 3 and 4 of Davidson Canyon Wash (see Figure A-1) may also be relatively unaffected by groundwater drawdowns. Tetra Tech predicted groundwater drawdowns in Davidson Canyon Wash at the downstream end of Reach 4 (see the Davidson/Cienega Confluence data in Table A-5) of <0.1 foot from 0 to 150 years after mining and 0.1 foot at 1,000 years. These results assume a complete hydrologic connection between the regional aquifer and surface flows in the stream exists. However, persistent surface flows in Davidson Canyon Wash, receive contributions from discharges at Reach 2 Spring and Escondido Spring (see Figure A-1). Tetra Tech (2010b) conducted an analysis, and based on geologic evidence, isotopic signatures in the springs, and the lack of consistent streamflow concluded that these springs likely derive their water from precipitation runoff-driven, ephemeral storm flows stored in the shallow alluvial stream sediments, which are then forced to the surface by bedrock constrictions in the stream channel. SRK conducted additional analyses (2012) and concluded that while some of the available evidence was anecdotal and less than certain, the available information also suggested that there is no connection between the Davidson Canyon springs and the regional aquifer. If surface flows in Davidson Canyon Wash are indeed derived from sources completely separate from the regional aquifer, then drawdowns caused by the proposed action could be of an even lower magnitude than those noted above.

Davidson Canyon Wash will, however, experience appreciable effects to its annual yield and peak flows. The stream's upper watershed will be subject to altered surface water runoff patterns due to the aforementioned placement of tailings and stormwater retention in the Davidson Canyon Wash tributary Barrel Canyon and retention of stormwater within the mine site. SWCA (2012), referencing Tetra Tech (2012) states that surface water runoff modeling on Barrel Canyon at Highway 83 indicated a post-closure runoff decrease (in acre-feet per annum) of approximately 17.2 percent under the proposed action. SWCA further extrapolates that this would equate to a 4.3 percent reduction of runoff (in acre-feet per annum) 12 miles downstream in the lower reaches of Davidson Canyon Wash. Modeled peak flow reductions (in cubic feet per second) are 22 percent at the Highway 83 Bridge, whichextrapolates to 5.6 percent in Davidson Canyon Wash. Ephemeral channels (such as the upper and middle reaches of Davidson Canyon Wash (Reaches 1 and 2) can be characterized by stream flow losses (SWCA 2012), but the fate of surface waters that infiltrate into channel sediments varies. Some of the infiltrated runoff will be discharged to riparian vegetation via evapotranspiration, but some may remain in the sediment as subflow.

We are also concerned with the interception of mountain front recharge and the likely associated incremental increases in modeled groundwater drawdown values, as discussed in the Empire Gulch, Gardner Canyon, and Barrel Canyon analyses, above.

The lowermost reaches of Davidson Canyon Wash (Reaches 2, 3, and 4; see Figure A-1) will experience decreases in runoff volume. SWCA (2012) extrapolated the modeled 4.3 percent reduction in runoff to Cienega Creek reaches 3 and 4 and anticipated that it would have minimal effects to surface flows and riparian vegetation (as had been noted for reaches 1 and 2, above).

Lower Cienega Creek

Lower Cienega Creek extends from the narrows (Reach 3) to the Del Lago Diversion Dam, at which point the stream is referred to as Pantano Wash. Reach 4 is between the narrows and the Davidson Canyon Wash confluence while Reach 5 is downstream of the confluence (see Figure A-1). Tetra Tech (2010) modeled groundwater drawdowns of <0.1 foot at the USGS stream gage in Reach 5 for all time steps from the cessation of mining to 1,000 years; this is to be expected at such a relatively large distance from the mine pit.

SWCA (2012), using data from the groundwater models and Pima County (Pima Association of Governments 2003b) has estimated that the anticipated reductions in Davidson Canyon Wash surface flow (and thus, subflow) are therefore anticipated, via extrapolation, to result in a 4.3 percent reduction in Cienega Creek subflow (SWCA 2012). This measurable reduction in subflow, in combination with other surface flow (both in yield and peak flow magnitude) reductions upstream (see Gardner Canyon, Empre Gulch, and Cienega Creek sections, above), the influence of climate change on baseline conditions over time, and the effects of cumulative actions, is likely to have detrimental effects to aquatic ecosystems in lowermost Cienega Creek.

As discussed above, Table 7 in Montgomery (2010) summarizes various hydrologic and environmental effects resulting from groundwater drawdowns. Table A-3, below, excerpts the Table 7 hydrologic effects analysis for Davidson Canyon Wash and lower Cienega Creek. Effects begin to appear 20 years after the conclusion of mining and become appreciable at 1,000 years. We note that Montgomery (2010) has predicted groundwater drawdowns of 0.31 foot at 20 years and 0.98 foot at 1,000 years, whereas Tetra Tech (2010) modeled drawdowns no greater than 0.1 foot at the same time steps.

Table A-3: Summary of Effects to Davidson Canyon Wash and Lower Cienega Creek

Years after mining	Drawdown at perennial reach (feet)	Decrease in stream length (miles)	Decrease in baseflow (cfs)	Decrease in ET (afa)
0	0	0	0	0
20	0.01	0	0.01	0
150	0.31	0	0.02	8
1,000	0.98	0.29	0.04	22

Summary of Effects to Aquatic Ecosystems

The analyses, above, describe incremental changes to the groundwater and surface water systems that sustain a series of streams and their associated aquatic and riparian ecosystems. Given that the affected ground and surface watersheds contribute to flows in the most downstream reach on the mainstem Cienega Creek, the effects of flow reductions are in addition to one another and in addition to any similar effects that result from baseline conditions (primarily ongoing drought and the future impacts of climate change) and the effects of future, non-Federal cumulative actions in the area (primarily, groundwater withdrawal not associated with the proposed action). Table A-4, below, summarizes the proposed action's effects to streams.

Table A-4: Summary of effects to streams

Stream	Drawdown (feet) (Tetra Tech 2010)		Primary Effects
	150 years	1,000 years	
Gardner Canyon	0.2	0.5	Modest drawdown, potential for interception of mountain front recharge
Empire Gulch	2.5	6.0	Appreciable drawdown, reduced flows and stream length, potential for interception of mountain front recharge
Upper Cienega Creek	0.25	0.5	Modest drawdown, reduced flows and stream length
Barrel Canyon	Isolated from regional aquifer		Reduced runoff from placement of tailings in channel, potential for interception of mountain front recharge
Davidson Canyon Wash			Reduced flows due to tributary impacts in Barrel canyon, above; potential for interception of mountain front recharge
Lower Cienega Creek	<0.1	<0.1	Minimal drawdown, but reduced flows and stream length possible

Table A-5: Modeled groundwater drawdowns at key locations (adapted from SWCA 2012).

End of active mining			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	<0.1	0
Upper Empire Gulch Springs	<0.1	0.1	0
Cienega near stream gage 09484550 (perennial reach)	<0.1	<0.1	0
Davidson/Cienega Confluence	<0.1	<0.1	Outside of model domain
Cienega near stream gage 09484560 (intermittent reach)	<0.1	<0.1	0
20 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	<0.1	0
Upper Empire Gulch Springs	<0.1	0.2	0
Cienega near stream gage 09484550 (perennial reach)	<0.1	<0.1	0
Davidson/Cienega Confluence	<0.1	<0.1	Outside of model domain
Cienega near stream gage 09484560 (intermittent reach)	<0.1	<0.1	0
50 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	<0.1	0
Upper Empire Gulch Springs	<0.1	0.5	0.2
Cienega near stream gage 09484550 (perennial reach)	<0.1	<0.1	0
Davidson/Cienega Confluence	<0.1	<0.1	Outside of model domain
Cienega near stream gage 09484560 (intermittent reach)	<0.1	<0.1	0
150 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	0.2	0.1
Upper Empire Gulch Springs	0.3	2.5	0.3
Cienega near stream gage 09484550 (perennial reach)	<0.1	0.25	0
Davidson/Cienega Confluence	<0.1	<0.1	Outside of model domain
Cienega near stream gage 09484560 (intermittent reach)	<0.1	<0.1	0
1,000 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	0.5	2.2
Upper Empire Gulch Springs	3.3	6	4.3
Cienega near stream gage 09484550 (perennial reach)	<0.1	0.5	0.2
Davidson/Cienega Confluence	<0.1	0.1	Outside of model domain
Cienega near stream gage 09484560 (intermittent reach)	<0.1	<0.1	0.3

Status of the Species – Gila Chub

Gila chub (*Gila intermedia*) was listed as endangered with critical habitat on November 11, 2005 (70 FR 51985). The final rule cites collection records, historical habitat data, the 1996 AGFD Gila chub status review (Weedman *et al.* 1996), and USFWS information documenting currently occupied habitat to conclude that Gila chub has been eliminated from 85 to 90 percent of formerly occupied habitat. It was also estimated that 90 percent of the currently occupied habitat is degraded due to the presence of nonnative species and land management actions. Due to fragmented and often small population sizes, extant populations are susceptible to environmental conditions such as drought, flood events, and wildfire. Primary threats to Gila chub such as predation by and competition with nonnative organisms and secondary threats identified as habitat alteration, destruction, and fragmentation are all factors identified in the final rule that contribute to the consideration that Gila chub is likely to become extinct throughout all or a significant portion of its range (70 FR 66664).

<u>Background</u>

Gila chub is a member of the roundtail chub (*Gila robusta*) complex that also includes headwater chub (*G. nigra*). The roundtail chub complex has had a turbulent and controversial taxonomic history that includes an assortment of classification schemes. Much of the debate has centered on whether the complex represents a number of nominal species or subspecies of *Gila robusta*. A nomenclatorial synonymy for Gila chub can be found in Minckley (1973).

Gila chub has long been recognized as distinct. Miller (1945), following the arrangement of Jordan and Evermann (1896), supported full generic rank for the genus *Gila* (Baird and Girard) with a "*Gila robusta* complex" that included Gila chub. Miller (1946) considered Gila chub to be an "ecological subspecies" of *G. robusta* (i.e., *G. r. intermedia*) characteristic of the small tributaries they inhabit. Rinne (1969, 1976), using univariate analyses of morphological and meristic characters, argued for recognition of both *G. robusta* and *G. intermedia* as distinct species and against the ecological subspecies concept. This approach was supported by some (e.g. Minckley 1973), but it was not until further evidence was generated by DeMarais (1986, 1995) that the specific status for *G. intermedia* was generally accepted. DeMarais (1995) supported continued recognition of *G. intermedia* based on the following arguments: 1) phenotypic extremes between *G. intermedia* and *G. robusta* are widely divergent and each possesses many morphologically uniform populations; (2) the geographic distributions of both species is an overlapping mosaic, therefore not satisfying traditional geographic criteria; and (3) contiguous populations of *G. intermedia* and *G. robusta* show no evidence of genetic exchange, thus each species maintains its evolutionary independence.

Gila chub is a thick-bodied species, chunky in aspect, whereas roundtail chub is slender and elongate, and headwater chub is intermediate in meristic and morphometric characteristics (Rinne 1969, 1976, Minckley 1973, DeMarais 1986, Minckley and DeMarais 2000, Marsh and Minckley 2009). Females can reach 250 mm (10 in) in total length (TL), but males rarely exceed 150 mm (6 in)(Minckley 1969, 1973, Rinne and Minckley 1991, Schultz and Bonar 2006). Body coloration is typically dark overall, sometimes black or with diffuse, longitudinal stripes, with a lighter belly speckled with gray. The lateral scales often appear to be darkly outlined, lighter in center. Breeding males, and to a lesser extent females, develop red or orange on lower parts of the head and body and on bases of the pectoral, pelvic and anal fins.

While most reproductive activity by Gila chub occurs during late spring and summer, in some habitats it may extend from late winter through early autumn (Minckley 1973). Schultz and Bonar (2006) data from Bonita and Cienega creeks suggested that multiple spawning attempts per year per individual were likely, with a major spawn in late February to early March followed by a secondary spawn in autumn after monsoon rains. Reproductive activities in Monkey Spring (now extirpated) reportedly occurred for longer periods than in other populations, as breeding appeared to last virtually all season (Minckley 1969, 1973, 1985). Bestgen (1985) concluded that temperature was the most significant environmental factor triggering spawning.

Spawning probably occurs over submerged aquatic vegetation or root wads. Minckley (1973) observed a single female closely followed by several males over a bed of aquatic vegetation in a pond. Nelson (1993) suspected deep pools with vegetation in Cienega Creek were important sites for spawning but did not witness any associated behavior near submerged vegetation. Gila chub is considered a habitat generalist (Schultz and Bonar 2006), and commonly inhabits pools in smaller steams, cienegas, and artificial impoundments throughout its range in the Gila River basin at elevations between 609 and 1,676 m (2,000 to 5,500 ft) (Miller 1946, Minckley 1973, Rinne 1975, Weedman *et al.* 1996). Common riparian plants associated with these populations include willows (*Salix* spp.), tamarisk (*Tamarix* spp.), cottonwoods (*Populus* spp.), seep-willow (*Baccharis glutinosa*), and ash (*Fraxinus* spp.). Typical aquatic vegetation includes watercress (*Nasturtium officinale*), horsetail (*Equisetum* spp.), rushes (*Juncus* spp.), and speedwell (*Veronica anagallis-aquatica*) (USFWS 1983, Weedman *et al.* 1996).

Gila chub is a highly secretive species, remaining near cover including undercut banks, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation in deeper waters, especially pools (Rinne and Minckley 1991; Nelson 1993, Weedman et al 1996). Recurrent flooding and a natural hydrograph are important in maintaining Gila chub habitats and in helping the species maintain a competitive edge over invading nonnative aquatic species (Propst *et al.* 1986, Minckley and Meffe 1987). They can survive in larger steam habitats, such as the San Carlos River, and artificial habitats, like the Buckeye Canal (Minckley *et al.* 1977, Minckley 1985, Rinne and Minckley 1991, Stout *et al.* 1970, Rinne 1976), and they interact with spring and small-stream fishes regularly (Meffe 1985).

Young Gila chub are active throughout the day and feed on small invertebrates, aquatic vegetation (especially filamentous algae) and organic debris (Bestgen 1985, Griffith and Tiersch 1989, Rinne and Minckley 1991). Adult chub are crepuscular feeders, consuming a variety of terrestrial and aquatic invertebrates, and fishes (Griffith and Tiersch 1989, Rinne and Minckley 1991). Benthic feeding may also occur, as suggested by presence of small gravel particles.

Gila chub evolved in a fish community with low species diversity and where few predators existed, and as a result developed few or no mechanisms to deal with predation (Carlson and Muth 1989). This species is known to be associated with speckled dace (*Rhinichthys osculus*), longfin dace (*Agosia chrysogaster*), desert sucker (*Pantosteus clarki*), Sonora sucker (*Catostomus insignis*), Gila topminnow (*Poeciliopsis occidentalis*), desert pupfish (*Cyprinodon macularius*), and Santa Cruz pupfish (*Cyprinodon arcuatus*). Before the widespread introduction of nonnative fishes, Gila chub was probably the most predatory fish within the habitats it occupied. In the presence of the nonnative green sunfish (*Lepomis cyanellus*) in lower Sabino Creek, Arizona, Gila chub failed to recruit young (Dudley and Matter 2000). Direct predation by green sunfish on young Gila chub was the acknowledged cause of this observation.

Many conservation and recovery efforts have been undertaken since species listing, largely by the Gila River Basin Native Fishes Conservation Program (Robinson 2010, 2011, 2012).

Status and Distribution

Historically, Gila chub was recorded from nearly 50 rivers, streams and spring-fed tributaries throughout the Gila River basin in southwestern New Mexico, central and southeastern Arizona, and northern Sonora, Mexico (Miller and Lowe 1967, Rinne and Minckley 1970, Minckley 1973, Rinne 1976, DeMarais 1986, Sublette *et al.* 1990, Varela-Romero *et al.* 1992, Weedman *et al.* 1996) ; and, occupancy of Gila chub throughout its range was more dense, and currently-occupied sites were likely more expansive in distribution (Hendrickson and Minckley 1985, Minckley 1985, Rinne and Minckley 1991). Gila chub now occupies an estimated 10 to 15 percent of its historical range (Weedman *et al.* 1996, 70 FR 66664) and approximately 25 of these current localities are considered occupied, but all are small, isolated and face one or more threats (Weedman *et al.* 1996, 70 FR 66664). The biological status of several of these populations is uncertain, and the number of localities currently occupied may overestimate the number of remnant populations in that some might not persist if its core connected population was extirpated (eliminated).

Agua Fria River Subbasin

The Agua Fria subbasin is the system furthest downstream in the Gila River basin that currently supports or is historically known to have supported Gila chub. This subbasin sustains or recently sustained four remnant Gila chub populations. The Agua Fria River mainstem was historically occupied, but that population is considered extirpated. The four extant populations are Indian Creek, Little Sycamore Creek, Silver Creek (with replicates Larry and Lousy Canyon), and Sycamore Creek. In 1996, all remnant populations were considered threatened by Weedman *et al.* (1966), and two of the four were considered unstable.

In Silver Creek, a natural fish barrier (waterfall) has prevented invasion of green sunfish into the uppermost reaches, but the protected reach has only a few kilometers of perennial water, and the reach below is infested with nonnative green sunfish (Weedman *et al.* 1996). Natural barriers on Sycamore Creek have protected a portion of the population from warmwater nonnative fishes, but nonnative rainbow trout (*Oncorhynchus mykiss*) is present upstream, and Gila chub may be functionally extirpated below the lowermost barrier where a suite of warmwater nonnative fishes reside (Weedman *et al.* 1996). The Gila chub population in Little Sycamore Creek inhabits two short perennial reaches totaling only about 1 km in length, but nonnative fishes have not been recorded there. The Indian Creek population was not detected until 1995, and in 2005 a portion of the population was salvaged as a precaution following the Cave Creek Complex Fire and later successfully returned. Weedman *et al.* (1996) noted that cattle grazing and recreational uses within some of the streams may be additional potential threats to the populations. The replicated populations in Lousy and Larry canyons seem to be doing well, and there are no threats from nonnative fishes.

Verde River Subbasin

The Verde subbasin drainage includes the north-central Gila River basin between the Agua Fria and Salt subbasins. The Verde mainstem downstream from Sullivan Lake is mostly perennial to its confluence, and several large tributary systems contribute perennial flows, primarily from the eastern portion of the drainage. Gila chub populations are recently known from only four remnant sites within the Verde subbasin: Red Tank Draw, Spring Creek, Walker Creek, and Williamson Valley Wash. A population historically collected from Big Chino Wash is considered extirpated. There have been no replications of any Verde subbasin populations.

Williamson Valley Wash was tentatively considered extirpated by Weedman *et al*. (1996), but Bagley (2002) captured 50 individuals there in 2001. Spring Creek appears stable, and no nonnative fishes recently have been recorded from above a low (~0.5 m) diversion dam located near the mouth. Walker Creek appears stable and nonnative-free based on a number of surveys between 1978 and 2001.

Santa Cruz River Subbasin

Gila chub populations are known from three remnant sites (Cienega Creek, Sabino Canyon, and Sheehy Spring) in the Santa Cruz subbasin. The population in Cienega Creek and Mattie Canyon are the largest and most geographically widespread. The Gila chub proposed listing rule (67 FR 66664), final listing rule (70 FR 66664), and Rosemont BA (USFS 2012) state that Gila chub were captured in Empire Gulch in 1995 and 2001. That is an erroneous report unsupported by other sources (Ehret and Simms 2009, Simms 2013). The Sabino Creek population experienced bottlenecking associated with post-fire runoff in 2003, although the population was replicated into nearby Romero Canyon in 2005. Sheehy Spring is a small system that likely never supports more than ~1000 adults. Gila chub also was known historically from Monkey Spring and the mainstem Santa Cruz River, but these populations are now extirpated.

Cienega Creek is protected against nonnative fishes by at least two natural barriers, and the Gila chub population appears stable. However, headcutting along lower Wood Canyon threatens to capture Cienega Creek, which would initiate headward erosion up Cienega Creek that likely would significantly diminish Gila chub habitat. Gila chub habitat in Sabino Creek seems to be recovering since the Aspen Fire in 2003, and the stream is protected against upstream invasions of nonnative fishes by a low-head dam and multiple stream crossings. Sheehy Spring has been invaded by nonnative mosquitofish, which has displaced Gila topminnow, but the species does not appear to be significantly affecting Gila chub. Sheehy Spring, however, is a tiny drainage and is close to the mainstem Santa Cruz River, possibly enhancing its potential for upstream invasions. Green sunfish, largemouth bass, and black bullhead have been recorded in the Santa Cruz River near Sheehy Spring in the last three years (Service files).

San Pedro River Subbasin

The San Pedro River Subbasin includes the entire San Pedro River watershed upstream from the confluence with Gila River. Gila chub populations are known from three remnant sites (Hot Springs Canyon, O'Donnell Canyon, and Redfield Canyon) in the San Pedro River Subbasin. Hot Springs Canyon and O'Donnell Canyon populations are protected behind constructed fish barriers, and a barrier on Redfield Canyon is expected to be constructed during 2013 or 2014. At least four and possibly as many as six, of the nine historically-known populations within the subbasin are considered extirpated.

Upper Gila River Subbasin

Upper Gila River Subbasin includes the entire Gila River watershed upstream of the Salt River confluence, exclusive of the Santa Cruz and San Pedro subbasins. Major subdrainages include the San Carlos, San Simon, San Francisco, and upper Gila rivers (including its three forks).

There are six remnant populations of Gila chub within this unit, and five historically-occupied streams are considered extirpated. The six populations are Blue River (San Carlos) Eagle, Bonita, Harden Cienega, and Dix creeks, Arizona; and, Turkey Creek, New Mexico. The Blue River (San Carlos) population is entirely on San Carlos Apache Tribal (SCAT) lands, and there is little information available regarding its status. There are constructed fish barriers on Bonita and Dix creeks, although nonnatives remain present in lower Bonita Creek. Harden Cienega appears free of nonnatives, although there is no barrier preventing their encroachment. The Eagle Creek population was significantly impacted by severe runoff following the 2011 Wallow Fire. The Turkey Creek population appears large and relatively stable, although rainbow trout inhabit the upper reaches and some warmwater nonnative species inhabit the lower reaches. Gila chub in Turkey Creek were affected by ash flows following the Miller Fire in 2011. Individuals were salvaged from the creek before the summer rains and were repatriated in 2012.

Critical Habitat

Critical habitat for Gila chub is designated for about 160.3 miles of stream reaches in Arizona and New Mexico that includes cienegas, headwaters, spring-fed streams, perennial streams, and spring-fed ponds. Critical habitat includes the area of bankfull width plus 300 feet on either side of the banks (70 FR 66664). The bankfull width is the width of the stream or river at bankfull discharge (i.e., the flow at which water begins to leave the channel and move into the floodplain) (Rosgen 1996). Critical habitat is organized into seven areas or river units:

Area 1 - Upper Gila River, Grant County, New Mexico, and Greenlee County, Arizona, includes Turkey Creek (New Mexico), Eagle Creek, Harden Cienega Creek, and Dix Creek;

Area - 2, Middle Gila River, Gila and Pinal Counties Arizona, consists of Mineral Creek;

Area - 3, Babocomari River, Santa Cruz County, Arizona includes O'Donnell Canyon and Turkey Creek (Arizona);

Area 4 - Lower San Pedro River, Cochise and Graham counties, Arizona, includes Bass Canyon, Hot Springs Canyon, and Redfield Canyon;

Area 5 - Lower Santa Cruz River, Pima County, Arizona, includes Cienega Creek, Mattie Canyon, Empire Gulch, and Sabino Canyon;

Area 6 - Upper Verde River, Yavapai County, Arizona, includes Walker Creek, Red Tank Draw, Spring Creek, and Williamson Valley Wash; and

Area 7 - Agua Fria River, Yavapai County, Arizona, includes Little Sycamore Creek, Sycamore Creek, Indian Creek, Silver Creek, Lousy Canyon, and Larry Creek (70 FR 66664).

There are seven primary constituent elements of critical habitat, which include those habitat features required for the physiological, behavioral, and ecological needs of the species:

1. Perennial pools, areas of higher velocity between pools, and areas of shallow water among plants or eddies all found in headwaters, springs, and cienegas, generally of smaller tributaries;
2. Water temperatures for spawning ranging from 63°F to 75 °F, and seasonally appropriate temperatures for all life stages (varying from about 50°F to 86 °F;
3. Water quality with reduced levels of contaminants, including excessive levels of sediments adverse to Gila chub health, and adequate levels of pH (e.g. ranging from 6.5 to 9.5), dissolved oxygen (i.e., ranging from 3.0 ppm to 10.0 ppm) and conductivity (i.e., 100 mmhos to 1,000 mmhos);
4. Prey base consisting of invertebrates (i.e., aquatic and terrestrial insects) and aquatic plants (i.e., diatoms and filamentous green algae);
5. 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, a high degree of stream bank stability, and a healthy, intact riparian vegetation community;
6. Habitat devoid of non-native aquatic species detrimental to Gila chub or habitat in which detrimental nonnative species are kept at a level that allows Gila chub to continue to survive and reproduce; and
7. Streams that maintain a natural flow pattern including periodic flooding (70 FR 66664).

Consultation History

Our information indicates that, range wide, more than 32 consultations have been completed or are underway for actions affecting Gila chub. These opinions primarily include the effects of grazing, water developments, fire, species control efforts, recreation, sport fish stocking, native fish restoration efforts, and mining.

Environmental Baseline – Gila Chub

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Description of the Action Area

The action area for Gila chub encompasses all occupied or likely-to-be occupied reaches of stream within the Cienega Creek watershed, as these will be subject to the proposed action's effects to groundwater and surface flow hydrology. This area is described in detail in the Status of the Species and Critical Habitat within the Action Area section, below. The narrartive that follows includes accounts of rangewide effects to Gila chub, its habitat, and its critical habitat as a means to describe similar factors affecting the species within the action area.

Europeans have influenced Southern Arizona for hundreds of years, and Native Americans have done so for much longer (Hastings and Turner 1965, Bahre and Hutchinson 1985, Bahre 1991, Tellman *et al.* 1997). Often-cited human impacts in the area include vegetation type conversion, dewatering surface waters and aquifers, erosion and channel down cutting, loss or reduction of native species, introduction and spread of nonnative species, and habitat loss. As with many of the river basins in the southwest, aquatic habitats and fish communities in the Gila basin have changed from historical conditions (Miller 1961, de la Torre 1970, Naiman and Soltz 1981, Miller *et al.* 1989, Minckley and Deacon 1991, Minckley and Marsh 2009). Aquatic habitats have been fragmented and reduced in quantity and quality due to diversion, groundwater mining, and natural and human-caused changes in the watershed and hydrologic regime (de la Torre 1970, Davis 1982, Tellman *et al.* 1997).

With the arrival of Europeans, major alterations began in the Gila River basin (Rea 1983). Beaver, which were a major influence on the structure of the Gila basin aquatic ecosystem, were almost extirpated. The introduction of livestock began very early and resulted in substantial alteration of the watershed and its soil and vegetation (York and Dick Peddie 1969, Humphrey 1987, Bahre 1991). Croplands increased, often along river terraces, resulting in destabilization and erosion of floodplains (Leopold 1946, Rea 1983). Roads and trails caused extensive erosion and substantial destruction of river channels (Leopold 1921, Dobyns 1981, Rutman 1997). Diversion of water, which was already practiced by Native Americans in some areas, increased in those areas and was initiated in others (Tellman *et al.* 1997). As diversion and irrigation increased, the demand for water storage increased, resulting in a variety of large and small dams and impoundments (Haddock 1980). Improper grazing, mining, timber harvest, hay harvesting, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800s and early 1900s after a drought (Bryan 1925, Martin 1975, Hendrickson and Minckley 1984, Sheridan 1986, Webb and Betancourt 1992, Hereford 1993, Turner *et al.* 2003). By the mid 1900's, large stretches of river in the Gila basin no longer had perennial flow, and the remaining areas were separated by long dry stretches, dams, and impounded water (Brown *et al.* 1977, Rea 1983, Hendrickson and Minckley 1984, Tellman *et al.* 1997).

As a result of these changes, the riverine habitats of the Gila basin, including the Santa Cruz River (de La Torre 1970, Logan 2002) and Cienega Creek (Bodner and Simms 2008), became fragmented, and connectivity was substantially reduced. Populations of fish or other aquatic species eradicated by perturbation were not replaced by colonization (Minckley 1999, Hedrick *et al.* 2001). Habitat fragmentation contributes to the genetic isolation of populations (Parker *et al.* 1999). Population fragmentation can reduce genetic variation and viability (Minckley 1999). This, in turn, can increase the risk of extinction by reducing survival, reproduction, and dispersal. Isolation also precludes re-colonization should one or more populations be eliminated. When an inhospitable environment that imposes a high degree of threat on the remnant habitat surrounds isolated populations, these risks are compounded. This fragmentation has been a major factor in the decline of almost all of Arizona's native aquatic fauna and has resulted in the existing, where native aquatic species, particularly rarer ones, tend to be isolated in small headwater areas scattered across the tributaries of the basin (Hendrickson and Minckley 1984, Minckley 1985, Minckley and Marsh 2009).

Human disturbances of the watershed, floodplain, and stream channel change many of the factors determining channel configuration. Increased sediment off the watershed is a common result of human actions, and sediment is a major determinant of channel shape (Leopold 1997). When the dynamic equilibrium has been disrupted, the channel begins a process of adjustment as it attempts to restore a dimension, pattern, and profile that are consistent with controlling hydraulic variables (Rosgen 1996). These adjustments may lead to dramatic changes in the stream channel width, depth, and geometry that encroach on human activities, such as has occurred on the Verde River. As human activities are affected, additional flood control and channelization measures may occur, which exacerbate the problems in adjacent areas, and the channel will continue to become increasingly unstable. Some of these effects have been ameliorated in some areas, and several recovery projects are underway.

These nonnative species were imported by humans, starting with common carp (*Cyprinus carpio*) to Arizona in 1885 (Gilbert and Scofield 1898). Since that time, at least 50 species of nonnative fish have been introduced (ASU, Geographic Information Systems database of fish records, 2001) into the Gila River basin, and there are other records of incidental occurrences of another 10 to 15 species (Minckley and Marsh 2009). Many nonnative aquatic invertebrates, amphibians, reptiles, plants, and disease and parasite organisms (Sinderman 1993, Clarkson *et al.* 1997, Robinson *et al.* 1998, Bradley *et al.* 2002) have also been introduced. These species have been purposefully introduced for sport-fishing, bait, biocontrol, and ornamental fish use and releases through aquaculture, aquarium, and generalized "bait bucket" activities. They have also been accidentally introduced through interbasin water transfers (Davies *et al.* 1992, Meador 1992, 1996; Stefferud and Meador 1998, Claudi and Leach 2000), aquarium and pet releases (Welcomme 1988, Courtenay 1993, FAO 1998), and inclusion with other species being purposefully stocked (Marsh and Minckley 1982, Platz *et al.* 1990). Nonnative aquatic species have had major detrimental impacts on native aquatic fauna and have been a major factor in the listing of topminnow and pupfish, as well as many other fishes native to the Gila basin (Desert Fishes Team 2003, 2006; USFWS 1984; 40 FR 29863, 50 FR 30188, 51 FR 10842, 51 FR 23769, 51 FR 39468, 52 FR 46400, 56 FR 13374). Introduction of nonnative pathogens, parasites (Wilson *et al.* 1996, Robinson *et al.* 1998, Weedman *et al.* 1996), plants, invertebrates, amphibians, and fish negatively affects the native fishes of the Southwest. Simms (1997) noted that stock tanks in the Cienega Creek watershed contained bullfrogs (*Lithobates catebeinus*), goldfish (*Carassius auratus*), largemouth and smallmouth bass (*Micropterus salmoides* and *M. dolomieu*, respectively), and bluegill (*Lepomis macrochirus*). Fortunately, Cienega Creek appears to be largely free on nonnative fishes at present.

In summary, and Given that Cienega Creek is within the great Gila River basin discussed above, the quality and quantity of suitable aquatic habitat for threatened and endangered fish in the action area has been affected through numerous past actions resulting in reduction of riparian habitat, altered species composition, increased presence of nonindigenous aquatic species, decreased surface-water availability, changes in stream morphology, and other factors. A significant portion of the adverse impacts to the aquatic and riparian ecosystem come from the additive effect of small actions that individually may not threaten the system, but cumulatively result in continuing deterioration of the ecosystem.

Land ownership within the Cienega Creek watershed includes Forest Service, Bureau of Land Management, State Trust land, County land, and private land. Land use within and adjacent to where the proposed action will be implemented primarily consists of mining, livestock grazing, dispersed recreation (USFS 2012), and residential development (Hanson and Brott 2005). Barrel Canyon is the principal drainage system within the action area. Wasp, McCleary, and Scholefield Canyons discharge to Barrel Canyon, which discharges to Davidson Canyon and then to lower Cienega Creek in the northeastern part of the area. Empire Gulch and Gardner Canyon discharge into upper Cienega Creek in the southeastern portion of the action area.

Previous mineral exploration and production activities in the project area as well as within the watersheds within the larger action area have resulted in numerous landscape disturbances, such as mine prospects and adits, mine related access roads, and geotechnical drilling sites. Additional anthropogenic disturbances have resulted from livestock grazing and all-terrain vehicle use. Within and near the action area, there are numerous wells in the Vail and Corona de Tucson areas that support residential and ranching uses (USFS 2012, PAG 2012b). The number of wells drilled in the lower Cienega-Davidson Canyon area has increased, especially in the lower Cienega and Davidson Canyon areas (PAG 2012b). The drilling rate has also increased, with the number of wells drilled over the last 10-year period, greater than the previous 20 years (PAG 2012b). There has also been an upward trend in the amount of water pumped in the Cienega-Davidson area (Fonseca 2008), with about 804 acre-feet (af) withdrawn in 2010 (PAG 2012b). This area is within the Tucson Active Management Area, so groundwater restrictions and well reporting apply there. The number of wells in the Sonoita area has also increased in the last decade. In 2005 unpublished data, there are over 100 wells listed for the Sonoita area (Service files). We know of no data or reports demonstrating impacts to upper Cienega Creek from wells in the Sonoita-Elgin area.

Upper and lower Cienega Creek, Davidson Canyon, Empire Gulch, and Gardner Canyon are all areas with shallow groundwater (Pima Association of Governments 2012b). As can be seen in Table GC-1, these shallow groundwater areas also support perennial and intermittent stream reaches, and hydro-meso- and xeroriparian vegetation (Pima County 2000, P Pima Association of Governments 2012a, 2012b). Any reduction of the water table that supports these shallow groundwater areas will likely reduce all the parameters (except maybe xeroriparian) in Table A (Fonseca 2008) (also see Table GC-1, below), with perennial stream miles of most concern for Gila chub. The number of days with no flow (Hynes 1970), and the extent of flow in May and June are the limiting factors for fish (Fonseca 2008).

Table GC-1: Shallow groundwater areas in the Rosemont action area, Arizona. Derived from Pima County 2000.

Area	Shallow groundwater (acres)	Perennial stream (miles)	Intermittent stream (miles)	Hydro-meso riparian vegetation (acres)	Xeroriparian vegetation (acres)
Upper Cienega	2911	7.71	4.6	897	160
Lower Cienega	1651	2.7	4.8	577	56
Gardner	1210	0	0.5	-	-
Davidson	907	0.7	1.3	-	27
Empire	-	1.4	-	-	-
Mattie	-	1.3	0.4	-	-

1 Average of 4.1 miles since 2001, 3.3 miles in fiscal year 2009-2010 (PAG 2012a).

In Knight's 1996 Thesis *A Water Budget and Land Management Recommendations For Upper Cienega Creek Basin*, he presents data from Bota (1996) on mountain front recharge (Table GC-

2). Most of that mountain front recharge comes down Gardner Canyon. However, Gardner Canyon does drain much of the east side of the Santa Rita Mountains, and begins at the highest elevations. Undoubtedly, Gardner Canyon contributes a large part of the recharge for upper Cienega Creek.

Table GC-2: Mountain front recharge for the upper Cienega Creek basin, Arizona. Adapted from Knight 1996; data from Bota 1996.

Recharge Area	Recharge (ac ft/yr)	Percent of recharge
Santa Rita and Empire mountains	5564	41
Whetstone Mountains	4936	36
Mustang Mountains	1516	11
Canelo Hills	1508	11
Total	13524	99

Las Cienegas National Conservation Area (NCA) was created by Congress to "conserve, protect, and enhance" biological and other natural resources. The BLM manages Las Cienegas NCA with restrictions on multiple use activities that would impair ecological processes on watershed and riparian areas, as described in the current resource management plan (BLM 2002). Cienega Creek is subject to a number of human uses, including livestock grazing, recreation, urban and suburban development, groundwater pumping, and roads. Before BLM acquired the Las Cienegas NCA, the area was primarily used for grazing, and there were extensive agricultural fields along the creek as well (Eddy and Cooley 1983). These fields were irrigated by a system of canals and dams and protected by a canal ("the Panama Canal") that the BLM is removing to restore more natural geomorphic and hydrological conditions conducive to native fish habitat (USFWS 1998, Simms 2001). The NCA presently receives heavy human visitation, and most of Cienega Creek is readily accessible. Upstream of the NCA, the Cienega Creek watershed is primarily used for livestock grazing. However, there is extensive proliferation of ranchette development in the area surrounding Sonoita that has increased the number of wells. Several wineries and vineyards occur along the groundwater divide between Cienega Creek and Babocomari River basins. The vineyards are largely supported by groundwater wells. The environmental baseline of the Las Cienegas NCA is thoroughly discussed in the USFWS 2012 Las Cienegas Aquatic Species BO (File number 22410-2002-F-0162-R001), and USFWS 2002 Las Cienegas NCA Resource Management Plan BO (File number 22410-2002-F-0162), and are incorporated by reference (FWS 2002, 2012).

The Cienega Creek Natural Preserve is established and managed by Pima County for the protection of its unique natural and cultural resources. Although accommodated, public recreation and education activities are limited so they will not degrade these resources. A permit is required by all visitors to the Preserve. Permits are issued by the Pima County Natural Resources, Parks and Recreation Department with the intent to limit the number of daily visitors to the Preserve and to notify visitors of the restrictive and prohibited activities (Pima County Flood Control District 2013).

The Pima County Draft Multiple Species Conservation Plan (Pima County 2012a) commits Pima County to pursue the following management actions and conservation commitments for the Gila chub (and Gila topminnow)(Pima County 2012b):

- Seek to prohibit Pima County Health Department from using *Gambusia* for mosquito control in watersheds tributary to reintroduction sites and in the Cienega Creek watershed upstream of Colossal Cave Road;
- Support protection of Cienega Creek water quality via ADEQ's Outstanding Waters program;
- Identify and address management of nonnative aquatic organisms through management plans and ranch infrastructure projects on County-controlled mitigation lands in the Cienega watershed;
- Implement the Pima County Floodplain Ordinance as described in Chapter 4 (Pima County 2012a) to minimize loss of habitat for these species;
- Implement monitoring as described in Appendix O (Pima County 2012b), including recording and entering incidental observations in the Covered Species Information Database; and
- Following significant upgrades to the County's two wastewater facilities, the Santa Cruz River downstream of the facilities may show favorable conditions for the reestablishment of Gila topminnow, longfin dace, desert sucker, and Sonora sucker. Pima County will work with the USFWS following upgrades in 2016 and subsequent water-quality testing to determine if fish monitoring is a reasonable and prudent activity at that location. If so, Pima County will commit to monitoring every 5 years using electrofishing and seining using the same methods as employed by Clarkson *et al.* (2011).

The Cienega Creek Natural Preserve is part of what is referred to as the Missing Link, or Cienega Corridor. An assessment of the area, required under the legislation establishing the Las Cienegas National Conservation Area, was completed by the Sonoran Institute (Hanson and Brott 2005).

Status of the species and critical habitat within the action area

The action-area status of the Gila chub were recently described in our 2008 and 2012 BOs that addressed effects of Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas National Conservation Areas, Arizona (File numbers 22410-2008-F-0103, 22410-2002-F-0162-R001). The action areas for those BOs overlap with the action area of the proposed action; that information is updated here. The status of Gila chub in the action area continues to be stable since the 2008 and 2012 BOs were completed (USFWS 2008, 2012).

The Santa Cruz River has five tributaries with extant populations of Gila chub: Sabino Canyon, Bear Canyon, Romero Canyon (Pima County), and Sheehy Spring (Santa Cruz County) have unstable-threatened populations, and Cienega Creek (Pima and Santa Cruz counties) has the only known stable-secure population of Gila chub in existence. Lower Cienega Creek has a small population north of Interstate 10 on Pima County's Cienega Creek Natural Preserve. On the Las Cienegas NCA, the chub is found throughout Cienega Creek and lower Mattie Canyon but is absent from Empire Gulch (Ehret and Simms n.d., Simms 2013). All three creeks on the Las Cienegas NCA have designated critical habitat, and all of the critical habitat in the Cienega Creek watershed is within the action area. Regional drought has impacted stream flows in both Empire Gulch and Cienega Creek, and resulted in a decrease in the amount of perennial aquatic habitat (Duncan and Garfin 2006, Bodner *et al.* 2007, Bodner and Simms 2008).

There is no suitable habitat, or known occurrences of this species, within the actual footprint of the action; however, there is suitable, occupied habitat within the action area. Surveys for this species have not been conducted within the action area for the purposes of the proposed action. We report here on survey information for the potentially affected area including Cienega Creek and its tributaries. Gila chub have been reported recently, from the Las Cienegas NCA, and from the Cienega Creek Natural Preserve (owned and managed by Pima County), upstream of the confluence of Cienega Creek with Davidson Canyon (70 FR 66664b, Ehret and Simms n.d., Simms 2009,); both of these reaches of Cienega Creek are located within the action area. In 2002, two Gila chub were collected in the Cienega Creek Natural Preserve upstream of "railroad bridge" from a "deep pool" in the area covered by the Rincon Peak quadrangle map, on which coverage of Cienega Creek begins about 1 mile upstream of the Davidson Canyon confluence (Reinthal 2009). In 2005 and 2006, five reaches of Cienega Creek were sampled for fish during annual stream flow mapping by Pima Association of Governments. Gila chub were "observed" in Stream Reach 3, immediately upstream of the Davidson Canyon confluence (70 FR 66664b, 2006). Although Stream Reach 2, immediately downstream of the Davidson Canyon confluence, is described as "the best habitat for chub and topminnow" (70 FR 66664b), no Gila chub were reported in this reach in either 2005 or 2006 (70 FR 66664b, USFWS 2005). As part of an ongoing program established by the U.S. Bureau of Reclamation, Cienega Creek had fish monitoring conducted from 2007 through 2010 (Kesner and Marsh 2010; Marsh and Kesner 2011). Sampling was conducted at two locations in Cienega Creek: Station 1 (upstream of the confluence of Davidson Canyon) and Station 2 (Three Bridges). No Gila chub were taken at either station in 2007 or 2008 (Kesner and Marsh 2010). One Gila chub was collected at Station 1 in 2009 (Kesner and Marsh 2010), and five Gila chub were collected at Station 1 in 2010 (Marsh and Kesner 2011).

Extensive surveys in 2009 and 2011 suggest that Gila chub continue to be abundant in upper Cienega Creek (Doug Duncan, USFWS, pers. comm). Surveys in 2007 demonstrated that Gila chub are recolonizing Mattie Canyon following heavy flooding and extreme sedimentation resulting from collapse of a grade control structure in 2001. No chub have ever been observed in Empire Gulch since BLM acquired Las Cienegas NCA in 1988.

Additionally, Gila chub have been documented within upper Cienega Creek during various survey efforts from 1985 to 1995 (Weedman *et al.* 1996, Bodner *et al.* 2007, Schultz 2009). The BLM conducted chub sampling efforts in 2005, 2007, and 2008 within both reaches of upper Cienega Creek and within Mattie Canyon in 2007 and 2008, and Gila chub were captured and abundant during each effort (Ehret and Simms n.d. [2009]). BLM has conducted fish sampling almost every year in the Las Cienegas NCA since 1989 (Bodner *et al.* 2007). As part of an effort intended to create, enhance, and protect habitat for at-risk aquatic species within the Las Cienegas NCA, Caldwell *et al.* (2011) identified numerous pond sites for Gila chub reestablishment.

Native fish species in Cienega Creek on Las Cienegas NCA include Gila topminnow, longfin dace (*Agosia chrysogaster*), and Gila chub (Bagley *et al.* l991, Simms and Simms 1992). Cienega Creek is one of the last places in Arizona supporting an intact native fish fauna uncontaminated by nonindigenous fish (Bodner *et al.* 2007). The lack of a nonnative fish community raises the conservation status of Cienega Creek and contributes to its stable-secure status.

Status of Gila Chub Critical Habitat

The action area is within the 48.1 km (29.9 mi) Lower Santa Cruz/Cienega Creek Critical Habitat Unit (Unit 5) for Gila chub as described in the Final Rule (70 FR 66664). Cienega Creek and its tributaries Mattie Canyon and Empire Gulch contribute 77 percent of that, or 37 km (23 mi). The designated critical habitat in the action area represents 14 percent of all designated critical habitat.

Approximately 14.2 km (8.8 mi) of this area of critical habitat occurs in lower Cienega Creek between Interstate 10 and where Cienega Creek becomes Pantano Wash (though the area at Pantano Dam is not included). Another 13.6 km (8.4 mi) of critical habitat occurs within the Las Cienegas NCA in upper Cienega Creek, with an additional 5.2 km (3.2 mi) in Empire Gulch and 4.0 km (2.5 mi) in Mattie Canyon, on BLM and State Trust lands. All these sections of designated critical habitat contain one or more PCE: perennial pools, the necessary vegetation that provides cover, and adequate water quality. All of these sections arev also within the action area of the proposed action. There are recent documented occurrences of Gila chub in both upper and lower segments of designated critical habitat within the action area and they are, therefore, considered occupied except for Empire Gulch. The populations within lower Cienega Creek are considered unstable, and those within upper Cienega Creek and Mattie Canyon are considered stable (Weedman *et al.* 1996, 70 FR 66664).

Factors affecting species environment and critical habitat within the action area

Primary threats to designated critical habitat and Gila chub include fire, nonnative species (both present and future), and water use in lower Cienega Creek; fire and nonnative species in upper Cienega Creek; fire, grazing, and nonnative species in Mattie Canyon; and fire and grazing in Empire Gulch (70 FR 66664). We describe activities that have occurred within and near the action area to qualify the environmental baseline and the state of critical habitat.

The seven PCEs of critical habitat include: 1) Perennial pools; 2) appropriate water temperature; 3) good water quality; 4) adequate prey base; 5) sufficient cover; 6) no or minimal nonnative aquatic species; and 7) a natural hydrological cycle.

Water use

The over allocation of water resources in Arizona has already affected flows in many southern Arizona rivers (Hendrickson and Minckley 1983, Pool and Coes 1999, Logan 2002, Minckley and Marsh 2009). Groundwater pumping has eliminated habitat in the Santa Cruz River north of Tubac (Logan 2002), and threatens habitat in the San Pedro River. It is likely that some sites may not be viable in the future as a result of groundwater overdraft while other sites may improve in habitat quality and quantity. The current drought has compounded the effects of pumping on vulnerable spring sources.

Haney *et al.* (2009) compared stream baseflow, current and projected populations, and different water use scenarios for 18 watersheds in Arizona. For the base population projection (least water use scenario; reduces water demand by 30 percent by 2050 and reduces population 25 percent below base projections), demand will equal base flows in the lower Cienega watershed by 2050, though we note that this projection included diversion and off-site use of water at Pantano Dam. The proposed action includes cessation of this diversion and recharge of the water through a Managed Underground Storage Facility. In all other scenarios, municipal water demand will exceed baseflow in lower Cienega Creek. The most aggressive scenario for amount of municipal water required increases population by 25 perecent above base projections. We further note that the aforementioned recharge may offset some portion of the anticipated increases in groundwater pumping in the Vail and southeastern Tucson area.

In contrast to lower Cienega Creek, projected water demand is substantially less than base flow for the upper Cienega study watersheds for all four of the Haney *et al*. (2009) scenarios. Upper and lower Cienega Creek had the lowest water use (gal/person/day) of all 18 watersheds. Unfortunately, this also means water conservation would have less absolute impact on municipal water use.

Nonnative species

Most introductions of nonindigenous fishes and bullfrogs have been done illegally for many reasons (Aquatic Nuisance Species Task Force 1994, Rosen *et al.* 1995, USFWS 2008); the establishment of sport fish is also an appreciable source of nonindigenous fishes (Rinne *et al*. 1998). Illegal introductions of nonindigenous fishes and other aquatic invasive species are routinely made by the public (e.g., topminnow, red shiner, and guppies at Watson Wash). The release of nonindigenous fish, and likely bullfrogs, by the public has been a major factor in the spread of these species (Moyle 1976a, 1976b; Welcomme 1988). Nonindigenous fish are transported for bait and sporting purposes (Moyle 1976a, 1976b), for mosquito control (Meffe *et al.* 1983), and release of aquarium fishes (Deacon *et al.* 1964, Moore *et al.* 1976, Shelton and Smitherman 1984). The population of Gila topminnow at Watson Wash was extirpated as a result of transfers of nonindigenous fish into topminnow habitat (Voeltz and Bettaso 2003). Refer to our May 15, 2008, BO on the Central Arizona Project for a discussion on the pathways and impacts of nonindigenous aquatic species to native fish, native frogs, and their habitats (file number 22410-2007-F-0081). We incorporate that BO by reference that discussion (USFWS 2008). Bullfrogs are present in Cienega Creek and its watershed.

Additionally, with increasing access and recreational use, the vulnerability of the stream and its native fish populations to nonindigenous species invasion is intensifying. The Cienega Creek basin has been closed to fishing by the Arizona Game and Fish Commission to reduce the potential for release of illegal fish and live bait. Finally, degradation of habitats is a well-recognized factor in establishment of nonnative species (Courtenay and Stauffer 1984, Arthington *et al.* 1990, Soule 1990, Aquatic Nuisance Species Task Force 1994, Meador *et al.* 2003). In the Cienega Creek watershed, largemouth bass, green sunfish, and bullheads have been found in off-channel waters (clay pits, stock tanks, private ponds). Nonnative fish have not been found in Cienega Creek, Mattie Canyon, or Empire Gulch.

Livestock grazing

Historically, improper livestock grazing and logging likely contributed to habitat modifications noted by Miller (1950). The historical occurrence of intensive grazing and resulting effects on the land are indicated in published reports dating back to the early 1900s (Rixon 1905, Rich 1911, Duce 1918, Leopold 1921, Leopold 1924).

Livestock grazing has been shown to increase soil compaction, decrease water infiltration rates, increase runoff, change vegetative species composition, decrease riparian vegetation, increase stream sedimentation, increase stream water temperature, decrease fish populations and change channel form (Meehan and Platts 1978, Kauffman and Kruger 1984, Schulz and Leininger 1990, Platts 1991, Fleischner 1994, Ohmart 1996). Although direct impacts to the riparian zone and stream can be the most obvious sign of livestock grazing, upland watershed condition is also important because soil compaction, changes in percent cover, and vegetative type can influence the timing and amount of water and sediment delivered to stream channels (Platts 1991, Ohmart 1996, Belsky and Blumenthal 1997). As a consequence, streams are more likely to experience flood events that negatively affect the aquatic and riparian habitats and are more likely to become intermittent or dry in the fall (groundwater recharge is less when water runs off quickly) (Platts 1991, Ohmart 1996).

Livestock grazing has been an ongoing disturbance in and around the footprint of the proposed mine for over 100 years; historically at much higher levels than at present. Rosemont holds term grazing USFS permits on four allotments: Rosemont, Thurber, Greaterville, and DeBaud. While Rosemont may plan to continue their grazing as currently permitted, grazing within the security fence will be not be allowed, and grazing within the perimeter fence will be assessed upon construction of mine facilities to determine whether grazing can continue during mine operations, and if so to what extent. Livestock grazing on the Las Cienegas NCA is managed by BLM to be compatible with the natural values of the area.

Fire

Since 2002, there have been several fires that have burned over 60,700 hectares (150,000 acres) in the Coronado National Forest that are near both occupied and designated CH for Gila chub. In May 2003, Gila chub were salvaged from Sabino Canyon during the Aspen Fire and were subsequently returned and now thriving in Sabino Creek. Gila chub continue to persist, post-fire in O'Donnel Creek. No fires appear to have impacted the Gila chub in Cienega Creek, though the 2005 Florida Fire burned in upper Gardner Canyon and its tributaries.

Direct fire-related fish mortalities are most likely during intense fires in small, headwater streams with low flows (less insulation and less water for dilution) (Gresswell 1999). In these situations, water temperatures can become elevated or changes in pH may cause immediate death (Cushing and Olson 1963). Spencer and Hauer (1991) documented 40-fold increases in ammonium concentrations during an intense fire in Montana. The inadvertent dropping of fire retardant in streams is another source of direct mortality during fires.

Dr. Wayne Minshall (pers. comm., February 1995, Idaho State Univ.) has investigated the effects of fire on streams. Nutrients contributed from fires are phosphorous, which is associated with ash, and nitrogen/ammonia, which is associated with smoke. Ammonia is toxic to fish. In addition, incomplete combustion of materials creates charcoal and charcoal in the water can lead to deoxygenation. Minshall has done studies of effects of fire on water temperature (Minshall *et* *al.* 1989). They found small temperature changes in shallow ponds and small streams. They believed that the impact of fire on streams varied proportionally with the intensity and extent of burning of the watershed and the vegetation present.

Indirect effects of fire include ash and debris flows, increases in water temperature, increased nutrient inputs, and sedimentation (Swanston 1991, Bozek and Young 1994, Gresswell 1999). Ash and debris flows can cause mortality months after fires occur when barren soils are eroded during precipitation (Bozek and Young 1994, Brown *et al.* 2001, Rinne 2004, Rhodes 2007). Fish can suffocate when their gills are coated with fine particulate matter, they can be physically injured by rocks and debris, or they can be displaced downstream below impassable barriers into habitat occupied by nonnative fish. Ash and debris flows or severe flash flooding can also decimate aquatic invertebrate populations that fish may depend on for food (Molles 1985, Rinne and Medina 1992, Rinne 1996, Lytle 2000). In larger streams, refugia are typically available where fish can withstand short-term adverse conditions; small headwater streams are usually more confined, concentrating the force of water and debris (Pearsons *et al.* 1992, Brown *et al.* 2001).

The floodplains of both upper and lower Cienega Creek are well vegetated. However, the mesic nature of riparian floodplains should reduce impacts from wildfires in these areas. Because the Gila chub in the action area are not in isolated, small streams, are miles downstream from fuel-loads that create ash and debris, the impact of ash and debris flows should be small.

Climate change

The June 2012 BA contained a detailed discussion of the likely effects of climate change; the analysis is incorporated herein via reference and is expanded upon in the following paragraphs.

That southeastern Arizona and much of the American southwest have experienced serious drought recently is well known. What is known with far less certainty is how long droughts last. State-of-the-art climate science does not yet support multi-year or decade-scale drought predictions. However, instrumental and paleoclimate records from the Southwest indicate that the region has a history of multi-year and multi-decade drought (Hereford *et al.* 2002, Sheppard *et al.* 2002, Jacobs *et al.* 2005). Multi-decade drought in the Southwest is controlled primarily by persistent Pacific Ocean-atmosphere interactions, which have a strong effect on winter precipitation (Brown and Comrie 2004, Schneider and Cornuelle 2005); persistent Atlantic Ocean circulation is theorized to have a role in multi-decadal drought in the Southwest, particularly with respect to summer precipitation (Gray *et al.* 2003, McCabe *et al.* 2004, Wang *et al.* 2013). Given these multi-decade "regimes" of ocean circulation, and the severity and persistence of the present multi-year drought, there is a fair likelihood that the current drought will persist for many more years (Stine 1994, Seager *et al.* 2007), albeit with periods of high year-to-year precipitation variability characteristic of Southwest climate. There is high confidence the Southwest will experience exceptional, decades-long droughts, and they will be hotter than historical droughts (Overpeck *et al.* 2012).

The information on how climate change might impact southeastern Arizona is less certain than current drought predictions. However, virtually all climate change scenarios predict that the American southwest will get warmer during the 21st century (IPCC 2001, 2007; Overpeck *et al.*

2012). Precipitation predictions show a greater range of possibilities, depending on the model and emissions scenario, though precipitation is likely to be less (USGCRP 2001, Seager *et al.* 2007). To maintain the present water balance with warmer temperatures and all other biotic and abiotic factors constant, precipitation will need to increase to keep pace with the increased evaporation and transpiration caused by warmer temperatures.

Drought and climate change will also impact watersheds and subsequently the water bodies in those watersheds. Drought and especially long-term climate change will affect how ecosystems and watersheds function. These changes will cause a cascade of ecosystem changes, which may be hard to predict and are likely to occur non-linearly (Seager *et al.* 2007).

Many of the predictions about the impacts of climate change are based on modeling, but many predictions have already occurred. In addition, many models have underestimated the increase in greenhouse gasses. The tree die-offs and fires that have occurred in the southwest early in this century show the impacts of the current drought. Because of drought, climate change, and human population growth, negative effects to aquatic habitat in the Gila basin will continue to occur. In addition, the basin's rivers, streams, and springs continue to be degraded (Overpeck *et al.* 2012), or lost entirely. Climate change trends are highly likely to continue (Overpeck *et al.* 2012), and the impacts on species will likely be complicated by interactions with other factors (e.g., interactions with nonnative species and other habitat-disturbing activities).

<u>Increased water temperature</u>

Kundzewicz *et al.* (2007) state that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change. Species with narrow temperature tolerances will likely experience the greatest effects from climate change and it is anticipated that populations located at the margins of species hydrologic and geographic distributions will be affected first (Meisner 1990). High water temperatures suppress appetite and growth, foster disease, can influence behavioral interactions with other fish (Schrank *et al.* 2003), reduce reproductive success (Bonar *et al.* 2005), or be lethal (McCullough 1999). The temperature preferences and tolerances of Gila chub are less than 98.6 °F (37.0 °C)(Carveth *et al.* 2006).

<u>Increased occurrence of extreme events</u>

Extreme events such as drought, fires, and floods are predicted to occur more frequently because of climate change (IPCC 2007, Overpeck *et al.* 2012). It is anticipated that an increase in extreme events will most likely affect populations living at the edge of their physiological tolerances. The predicted increases in extreme temperature and precipitation events may lead to dramatic changes in the distribution of species or to their extirpation or extinction (Parmesan and Matthews 2006).

<u>Decreased streamflow</u>

Current models suggest a decrease in precipitation in the Southwest (Kundzewicz *et al.* 2007, Seager *et al.* 2007) which would lead to reduced streamflows and a reduced amount of habitat for Gila chub. Streamflow is predicted to decrease in the Southwest even if precipitation were to increase moderately (Nash and Gleick 1993, State of New Mexico 2005, Hoerling and Eischeid 2007). Winter and spring warming causes an increased fraction of precipitation to fall as rain, resulting in a reduced snow pack, an earlier snowmelt, and decreased summer base flow (Christensen *et al.* 2004, Stewart *et al.* 2004, Stewart *et al.* 2005, Regonda *et al.* 2005). Earlier snowmelt and warmer air temperatures can lead to a longer dry season. Warmer air temperatures lead to increased evaporation, increased evapotranspiration, and decreased soil moisture. These three factors would lead to decreased streamflow even if precipitation increased moderately (Garfin 2005, Seager *et al.* 2007). The effect of decreased streamflow is that streams become smaller, intermittent or dry, and thereby reduce the amount of habitat available for aquatic species. A smaller stream is affected more by air temperature than a larger one, exacerbating the effects of warm and cold air temperatures (Smith and Lavis 1975). In addition, fish isolated in pools may be subject to increased predation from terrestrial predators (ORPI 2008).

<u>Change in the hydrograph</u>

In a warmer world an enhanced hydrologic cycle is expected; flood extremes could be more common causing more large floods; droughts may be more intense, frequent, and longer-lasting (Seager *et al.* 2007). Stewart *et al.* (2005) show that timing of spring streamflow in the western U.S. during the last five decades has shifted so that the major peak now arrives 1 to 4 weeks earlier, resulting in less flow in the spring and summer. They conclude that almost everywhere in North America, a 10 to 50 percent decrease in spring-summer streamflow fractions will accentuate the seasonal summer dry period with important consequences for warm-season water supplies, ecosystems, and wildfire risks (Stewart *et al.* 2005). Rauscher *et al.* (2008) suggest that with air temperature increasing from 37 to 41 °F (3 to 5 °C), snowmelt driven runoff in the western U.S. could occur as much as two months earlier than present. Changes in the hydrograph could potentially alter native fish assemblages. Variability in the hydrographs and greater flow volume has been shown to sustain native fishes (e.g., as seen for spikedace and loach minnow) over nonnatives between periodic flood events (Rinne and Miller 2006), although flooding has extirpated reintroduced Gila topminnow populations (Weedman 1999).

<u>Drought</u>

The Southwest U.S. is currently experiencing drought conditions (CLIMAS 2013). Almost 97 percent of Arizona was abnormally dry or drier (March 2013, CLIMAS 2013). The Cienega Creek basin is in moderate drought. Portions of New Mexico are in severe drought (89%), including areas currently occupied by Gila chub (CLIMAS 2013). Although Gila chub evolved in the Southwest and have survived drought in the past, it is anticipated that a prolonged, intense drought would affect many populations, in particular those occupying small headwater streams which are likely to dry or become intermittent. In addition, there is a clear association between severe droughts and large fires in the Southwest (Swetnam and Baisan 1996) that can harm fish and their habitat.

The regional drought has impacted stream flows in both Empire Gulch and Cienega Creek, reducing the amount of perennial aquatic habitat (Bodner *et al.* 2007, Bodner and Simms 2008). Primary constituent elements one and three of critical habitat (perennial pools, areas of higher velocity between pools, and areas of shallow water; and water quality with reduced levels of contaminants, and adequate levels of pH, dissolved oxygen, and conductivity) have been negatively impacted by drought in the area. The solubility of oxygen into water is less with higher ambient temperatures (Wetzel 1983).

Fire

Since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986 (X). The total area burned is more than six and a half times the previous level (Westerling *et al.* 2006). In addition, the average length of the fire season during 1987 to 2003 was 78 days longer compared to 1970 to 1986 and the average time between fire discovery and control increased from about 8 to 37 days for the same time (Westerling *et al.* 2006). McKenzie *et al.* (2004) suggest, based on models, that the length of the fire season will likely increase and fires in the western U.S. will be more frequent and severe. In particular, they found that fire in New Mexico appears to be acutely sensitive to summer climate and temperature changes and may respond dramatically to climate warming (McKenzie *et al.* 2004).

Furthermore, drought and climate change will cause changes in fire regimes in all southeastern Arizona vegetation communities (Kitzberger *et al.* 2006). The timing, frequency, extent, and destructiveness of wildfires are likely to increase (Westerling *et al.* 2006) and may facilitate the invasion and increase of nonindigenous plants. These changed fire regimes will change vegetation communities, the hydrological cycle, and nutrient cycling in affected watersheds (Brown *et al.* 2004). Some regional analyses conservatively predict that acreage burned annually will double with climate change (MacKenzie *et al.* 2004). Such watershed impacts could cause enhanced scouring and sediment deposition, more extreme flooding (quicker and higher peak flows), and changes to water quality due to increases in ash and sediment within stream channels. Severe watershed impacts such as these, when added to reductions in extant aquatic habitats, will severely restrict sites available for the conservation of native fish and other aquatic vertebrates and make management of extant sites more difficult.

Severe wildfires capable of extirpating or decimating fish populations are a relatively recent phenomena and result from the cumulative effects of historical or ongoing grazing, which removes the fine fuels needed to carry fire and fire suppression (Madany and West 1983, Savage and Swetnam 1990, Swetnam 1990, Touchan *et al.* 1995, Swetnam and Baisan 1996, Belsky and Blumenthal 1997, Gresswell 1999). Historical wildfires in the southwest were primarily cool-burning understory fires with return intervals of 3 to 7 years in ponderosa pine (Swetnam and Dieterich 1985). Cooper (1960) concluded that before the 1950s; crown fires were extremely rare or nonexistent in the region. Effects of fire may be direct and immediate or indirect and sustained over time (Gresswell 1999).

Effects to Aquatic Species

The June 2012 BA characterizes climate change as a threat to rare plants and animals, and the extensive analysis contained in that document are incorporated herein via reference. Climate change affects the habitats where the species occur and alters physical and biological factors with which species evolved. The most obvious effects are on aquatic and riparian resources: under a hotter and drier climate, surface water is generally less available than it was historically. There are numerous references that describe a decline in aquatic resources due to an altered climate (Bogan and Lytle 2010; California Department of Water Resources 2008; Colorado River Basin Water Supply and Demand Study 2011; Lenart 2007; MacDonald 2010; Reiman and Isaak 2010). The most at-risk group of threatened, endangered, and sensitive species on the Coronado National Forest are those associated with aquatic environments. Although there are many threats that affect aquatic organisms, climate change has been shown to be a causative agent in population declines.

Effects of the Action - Gila Chub

Groundwater pumping to support residential development (and other uses) in the Cienega Creek watershed was identified as a factor influencing Gila chub in the final rule (70 FR 66664). The proposed action represents an additional increment of groundwater impacts.

Despite the inherent uncertainties in the hydrologic system and the groundwater modeling data derived from analyses of that system, we are aware of no other model results or empirical data that would more accurately inform our analyses. The existing groundwater models therefore represent the best available information with which we can analyze the groundwater-related effects of the proposed action. Given the general agreement regarding the validity and utility of the Montgomery and Associates (2010), Tetra Tech (2012), and Myers (2012) models, SWCA prepared a definitive impact analysis for seeps, springs, and riparian ecosystems for the Coronado National Forest and presented it to us on November 16, 2012 (SWCA 2012). The Coronado National Forest subsequently adopted the SWCA analysis in the second Supplemental BA (FS 2013x). These analyses were discussed in depeth within the Effects to Aquatic Ecosystems section and are incorporated herein via reference. Also note that we relied primarily on the findings of Tetra Tech (2012); these are the largest in magnitude and therefore represent the most precautionary approach for the purposes of an effects analysis.

The aforementioned model-driven changes in groundwater elevations and, when applicable, the inferred and modeled losses of surface flows supported by surface or near-surface groundwater elevations, are measurable and reasonably certain to occur, but their precise impacts on aquatic ecosystems and riparian vegetation are difficult to quantify. The subsequent analyses will therefore be primarily qualitative in nature.

Water withdrawals that reduce the surface and subsurface discharge of a stream are an adverse effect on fishes and other aquatic species. Any losses of surface water will decrease water depth and the wetted perimeter of aquatic habitat. A decrease in the wetted perimeter and depth of a stream is a loss of fish habitat. The proposed action will result in groundwater drawdowns and surface water reductions that will have varying magnitudes of effects to surface waters and, as stated above, these effects are in addition to regional groundwater withdrawals.

Reduced water availability may also indirectly result in changes in riparian communities. We do not anticipate sudden mortality of vegetation, rather a gradual transition from more mesic to more xeric species assemblages in some areas. These changes to riparian vegetation can negatively affect bank stability, shading and cover, sediment transport, and water temperature. These impacts are discussed in greater detail within the Effects to Riparian Ecosystems section of this BO.

These modeled decreases in groundwater would occur over a long time, but could cause changes in aquatic and riparian vegetation extent or health, and the reduction in stream flow could impact Gila chub and designated critical habitat (e.g., lower water level, more extensive dry reaches). As a result of groundwater drawdown, the amount or volume of water within perennial pools could decrease, and Gila chub in Cienega show a preference for pools. Reduced in-stream vegetative cover could result in reduced substrate for eggs, for prey, and escape cover for Gila chub, hence reducing the success of eggs, reducing food, and increasing the exposure of Gila chub to vertebrate predation and desiccation. Changes in water volume and flow, and extent of flow could have similar effects, in addition to loss of habitat. Another indirect effect on Gila chub could also result from prey species being negatively impacted by groundwater drawdown, hence altering predator-prey relationships. If any changes to streamflow occur during normal low flows (May and June), impacts to fishes would be most significant. One day of no flow could potentially extirpate fish from a stream reach, though refugia would likely be present. More problematic would be a 7-day no flow, where refugia would be few or nonexistent. These effects may occur at upper and lower Cienega Creek, Mattie Canyon, and Empire Gulch. Lastly, these impacts would be amplified during exceptionally dry years that are expected to increasingly occur with continuing drought and climate change (Overpeck *et al.* 2012).

Regional impacts to groundwater quality and surface water runoff quality that could make it into perennial streams is not likely under the Aquifer Protection Permit. The cone of depression associated with the mine pit may actually reduce movement of water contaminants to streams in the action area. Therefore, no impacts to Gila chub or designated critical habitat are expected to occur given the information in the various BAs. As stated in the Environmental Baseline section, above, Gila chub occur in Cienega Creek and 22.9 mi (37 km) miles of the mainstem and tributaries (Mattie Canyon and Empire Gulch) are designated as critical habitat.

The lack of information on the effects of with- and post-project water quality in the BA makes it difficult for us to analyze water quality issues as they relate to biological systems. Rosemont Copper (2012), however, summarizes baseline water quality and models the proposed action's anticipated impacts. In brief, Rosemont Copper (2012) anticipates that surface runoff will meet Aquifer Water Quality Standards. Tetra Tech (2010) analyzed the potential for the project to exceed Surface Water Quality Standards and found that the proposed action was unlikely to cause exceedence of standards in downstream areas of Davidson Canyon wash and therefore, lower Cienega Creek. We cannot ascertain if the water quality standards intende to protect biota are protective of Gila chub.

Gardner Canyon

Gardner Canyon is anticipated to experience regional aquifer drawdowns of < 0.1 foot from the cessation of mining until 50 years later (Tetra Tech 2012) (see Gardner/Cienega Confluence data in Table A-5 in the Effects to Aquatic Ecosystems section). At 150 years after mining, the effect to Gardner Canyon increases to 0.2 foot and reaches 0.5 foot at 1,000 years. As discussed above and in the Effects to Aquatic Ecosystems section, there may be additional effects from the interception of mountain front recharge.

Impacts are expected to be negligible and immeasurable in groundwater at lower Gardner

Canyon until at least 130 years after mine closure, at which time groundwater drawdown is modeled to be 0.8 ft (Tetra Tech 2010c). Groundwater drawdown would likely reduce spring and surface flow. The greatest effect to Gila chub from impacts to Gardner Canyon would be reduced surface or subsurface flows propagating downstream to both upper and then lower Cienega Creek (see discussion below).

Empire Gulch

The proposed action will appreciably affect Empire Gulch. The Upper Empire Gulch Springs data in Table A-5 in the Effects to Aquatic Ecosystems section displays the drawdowns modeled by Tetra Tech (2010); effects at this site to range from <0.1 foot of groundwater drawdown upon cessation of mining to 0.2 foot at 20 years, 0.5 foot at 50 years, 2.5 feet at 150 years, and 6 feet at 1,000 years. The sping-fed hydrology (Bodner and Simms 2008) of Empire Gulch render it particularly vulnerable to diminishment of the groundwater that may sustain the springs. We are also concerned with intercxeption of mountain front recharge, which may further affect surface flows. This would affect Gila chub via reduced surface or subsurface flows propagating downstream to both upper and then lower Cienega Creek (see discussion below).

The modeled groundwater drawdown would reduce the amount or volume of water in Empire Gulch itself, including perennial pools. This would impact the PCEs of water quantity and vegetative cover present within critical habitat there. However, since Gila chub are not known to occur in Empire Gulch, impacts to individual chub are not likely. Also, as long as Chiricahua leopard frogs occur at the headspring, it is very unlikely that Gila chub would be intentionally released there, as chub can prey on frog tadpoles and eggs.

It is possible, given the long time of the proposed action that Gila chub could naturally move into Empire Gulch. In that event, indirect effects on Gila chub habitat could impact breeding and foraging within these areas. These impacts would be more likely to occur near the confluence with Cienega Creek, which is expected to have less groundwater drawdown than the Empire Gulch headspring, and is closer to source populations in Cienega Creek.

Upper Cienega Creek

Upper Cienega Creek is that portion of the stream in Reaches 1, 2, and 3 (the latter includes the narrows) (see Figure A-1 in the Effects to Aquatic Ecosystems section). Gardner Canyon and Empire Gulch, along with Mattie Canyon, are the major tributaries in this reach.

The USGS Cienega Creek stream gage (0948550) is situated near the narrows in the upstream portion of Reach 3 (see Figure A-1). Tetra Tech (2012) modeled drawdowns of <0.1 foot from the end of mining and at 20, 50, and 150 years later. Drawdowns reach 0.25 feet and 0.5 feet at 150 and 1,000 years, respectively. Again, we are concerned with diminished recharge within the watershed at this site. Table A-2 in the Effects to Aquatic Ecosystems section is based on SWCA (2012) and describes the hydrologic effects to upper Cienega Creek. The effects don't manifest until 1,000 years after the cessation of mining, but at that point a 0.16-mile decrease in wetted stream length, a 0.02 cubic foot per second loss of discharge, and 51 acre-feet per annum of lost riparian evapotranspiration are anticipated.

Indirect effects to Gila chub, such as groundwater drawdowns and changes in riparian community composition will or are reasonably certain to occur within the action area in upper Cienega Creek.

Davidson Canyon Wash

Barrel Canyon is a tributary to Davidson Canyon Wash. Barrel Canyon, in which Gila chub do not occur, will be primarily affected by the reduced runoff that will result from the placement of mine tailings in its upper watershed, rather than by drawdowns in the aquifer beneath the stream. SWCA (2012) estimated that ephemeral surface runoff yield in Barrel Canyon will be reduced from between 17.2 to 45.8 percent; the former value is associated with the Barrel Alternative (the proposed action). SWCA (2012) further extrapolated that this 17.2 percent reduction would equate to a 4.3 percent reduction of runoff 12 miles downstream in the lower reaches (2, 3, and 4) of Davidson Canyon Wash. Peak flows will also be affected; by 22 percent at the Highway 83 Bridge and an extrapolated 5.6 percent in Davidson Canyon Wash.

As stated in the Effects to Aquatic Ecosystems section, the uppermost reaches of Davidson Canyon Wash (Reaches 1 and 2) (see Figure A-1) are anticipated to experience minimal groundwater drawdowns of <0.01 foot from the cessation of mining to 1,000 years (Tetra Tech 2012). Reaches 3 and 4 of Davidson Canyon Wash (see Figure A-1) may also be relatively unaffected by groundwater drawdowns. Tetra Tech predicted groundwater drawdowns in Davidson Canyon Wash at the downstream end of Reach 4 (see the Davidson/Cienega Confluence data in Table A-5) of <0.1 foot from 0 to 150 years after mining and 0.1 foot at 1,000 years.

Lower Cienega Creek

Lower Cienega Creek includes Reaches 4 and 5 as described in SWCA (2012) (see Figure A-1 in the Effects to Aquatic Ecosystems section). Tetra Tech (2012) modeled groundwater drawdowns of <0.01 foot at the USGS stream gage in Reach 5 for all time steps from the cessation of mining to 1,000 years; this is to be expected at such a relatively large distance from the mine pit.

Lower Cienega Creek, however, will also experience the accumulation of effects of groundwater drawdown and surface flow diminishment throughout the affected portion of its watershed. The effects to Barrel Canyon, Davidson Canyon Wash, Gardner Canyon, Empire Gulch, and the uppermost reaches of Cienega Creek represent incremental, additive effects to the lower reaches of Cienega Creek.

The Pima Association of Governments (2003b) has estimated that Davidson Canyon Wash subflow contributes 8 to 24 percent of the baseflow in Lower Cienega Creek. Given SWCA's finding that Davidson Canyon Wash will experience a 4.3 percent reduction in surface flows from the placement of tailings in Barrel Canyon (a tributary) (see above), we anticipate a 0.3 to 1.0 percent reduction in lower Cienega Creek baseflows. Again, these anticipated reductions are to annual yields, and may not describe any reductions in the dry-season baseflows are crucial to conserving to Gila chub.

The minimal reduction in lower Cienega Creek subflow from the Barrel Canyon and Davidson Canyon Washs systems will occur in addition to surface flow reductions in other upstream areas (see Gardner Canyon, Empire Gulch, and Upper Cienega Creek sections, bove as well as in the subsequent narrative), the influence of climate change on baseline conditions over time, and the effects of cumulative actions. The end result will be an incremental, detrimental effect on aquatic ecosystems in lowermost Cienega Creek.

Peak flow reductions will also result from the proposed action; these were discussed in the Effects to Aquatic Ecosystems section. We cannot ascertain the precise effect that reduced peak flows from Barrel Canyon (modeled to be 22 percent) and thence Davidson Canyon Wash (extrapolated to be 5.6 percent) will have on lower Cienega Creek (see Effects to Aquatic Ecosystems section). It is reasonable to assume the effects will be appreciabhly less than 5.6 percent, as flood flow hydrology will remain largely intact in the eastern portions of the Cienega Creek watershed (including Empire Gulch, Gardner Canyon, and Mattie Canyon).

We note, however, that peak flows are responsible for the movement of sediment. A small reduction in sediment transport has been modeled for Davidson Canyon and Cienega Creek below their confluence (SWCA 2012), but is not anticipated to have a large effect given the remaining, unaffected sediment supply present within channels and tributaries (Rosemont Copper Company 2012). There may nevertheless be interactions between the expected changes in both peak flow hydrology and available sediment supply (Simon *et al*. 2007), making it difficult to predict future changes in sediment-related channel geometry. We note that Rosemont Copper Company (2012) predicts a slight narrowing in channel top width. This seems reasonable, given that any reduction in the magnitude of peak flows will affect floods of all return intervals, including the approximately 1.5-year return interval events that constitude channel-forming flows (Rosgen 1994, Moody *et al*. 2003).

It is not clear if the modeled change in sediment and the channel narrowing will affect Gila chub positively or negatively; effects will depend on multiple variables (e.g. timing, quantity, amount of flow in Barrel Canyon, Davidson Canyon Wash, and ultimately, the Gila chub habitat (and critical habitat) in Cienega Creek.

Even though Gila chub have never been recorded in Reach 5 of Cienega Creek (below the confluence with Davidson Canyon), there appears to be suitable habitat and it is designated critical habitat, and there is a nearby source population of Gila chub upstream. Therefore, it is reasonably certain that Gila chub will occur during the timeframe of the action. Thus, even though effects are expected to be minimal in this area, effects may begin during mine operation, and continue for 1,000 years. Any loss of flow, wetted perimeter, and pool depth is an effect on Gila chub.

The groundwater modeling results do not discuss the potential for groundwater drawdowns to occur at Mattie Canyon; the site is outside of the 5-foot drawdown perimeter discussed in SWCA (2012). However, since lower Mattie Canyon is close to the stream gage, and drawdown at the gage may also occur in the groundwater system associated with the tributary. Reductions of groundwater at Mattie Canyon may be slightly less than at the gage because Mattie Canyon is slightly further from the mine pit, and east of Cienega Creek. However, a reduction in groundwater that reduces surface flow and subflow, will affect Gila chub and critical habitat in Mattie Canyon as is discussed above.

Analyses undertaken by Westland Resources (2012X) but not included in the three iterations of the BA or in SWCA (2012) correlated extent of surface flow in lower Cienega Creek with depth-to-groundwater in adjacent wells. Their results, based on averages in June, show there would small decreases (<2% of average) in length of streamflow. Also, because it is based on averages, the extent of streamflow and proportional reduction in extent of streamflow would be greater than two percent in drier times. Lastly, they were very conservative in their approach and assumptions. The amount of flow reduction they show should be considered a minimum.

Effect of the Proposed Conservation Measures – Gila Chub

The proposed action contains many conservation measures. Rosemont has agreed to monitor changes in groundwater and surface water quantity and quality and to update both groundwater and surface water models based on data obtained from monitoring efforts. Tracking what occurs with surface and groundwater will be crucial for determining any effects of the mine on water, and subsequently to species dependent on that water. The BA contained no actions if monitoring shows groundwater drawdown greater than what was modeled. If this were to occur, reinitiation of consultation would likely be necessary.

Because the effects of the action to Gila chub will be long-term and off-site, conservation measures can only be realized off-site. The two conservations measures discussed below, are outside the footprint of the mine, though one is in the action area. Other than the monitoring mentioned above, two conservation measures should promote conservation and recovery of Gila chub. A full description of the conservation measures can be found in the proposed action section of this BO.

The Cienega Creek Watershed Conservation Fund will fund $200,000 a year for 10 years for development and implementation of measures intended to preserve and enhance aquatic and riparian ecosystems and the federally listed aquatic and riparian species that depend on them. Projects may include surveys for and the removal of non-native species in the watershed. Funds can be used for restoration activities and adaptive management. Rosemont will acquire and close one well near the diversion dam in lower Cienega Creek. Also, Rosemont will acquire over 1100 af of water rights, and transfer and sever and transfer them for conservation purposes.

About 825 acre feet (af) annually will be used for aquifer recharge below Pantano Dam. To accomplish this, a “managed underground storage facility (MUSF)” will be permitted through the [Arizona Department of Water Resources]. This will allow surface water flows currently diverted for golf course irrigation to be captured and discharged back to the streambed below the Pantano Dam within the Cienega Creek Natural Preserve. Flow will be captured at the existing in-channel grated diversion, and then released into the stream channel below the dam. Gila topminnow and longfin dace have been observed right above the dam, on the dam, and in the scour pool below the dam. It is certain that fish have been and will continue to go into the diversion, and suffer death or injury. Though Gila chub have not been found within several miles, the possibility exists given the time-frame of analysis and the mitigating effects of Cienega Creek Watershed Conservation Fund before groundwater drawdown impacts lower Cienega Creek. The City of Tucson and Pima County (2009) expect that up to 3000 linear feet of riparian and aquatic habitat would form. Whether or not that habitat is suitable for chub, given the reduced stream gradient below the dam, remains to be seen. There would at least be a pool below the dam. The actions taken under this conservation measure should enhance the resiliency and suitability of Cienega Creek for Gila chub, especially in the lower creek, at least in the short-term. Under the threat of continuing long-term drought and climate change, enhancing system resiliency is a key component for adapting to climate change and reducing its affects (Overpeck *et al.* 2012).

Also, Rosemont will purchase about 1,200 acres of land along Sonoita Creek (Sonoita Creek Ranch) with about 590 af of certificated surface water rights from Monkey Spring. This is near Patagonia, and outside of the action area. The land will be transferred to a conservation entity for management of the property. In addition, Rosemont will fund $150,000 a year for 10 years for resource management. An additional $100,000 ($20,000 annually for five years) will be provided for management against nonnative species, generally in the two existing ponds on the property that are maintained with water from Monkey Spring. At a minimum Gila chub and Gila topminnow will be established in the ponds after nonnatives are removed from them. Because this parcel is outside of the action area, this action represents recovery in lieu of threat removal (FWS 1994). The environmental baseline and recovery status of Gila chub should be improved by actions taken at Sonoita Creek Ranch. Also, the source of Monkey Spring appears to be the regional aquifer, which should be somewhat buffered from local groundwater pumping and climate change.

Summary of Effects – Gila Chub

- Groundwater levels have historically been variable;
- The environmental baseline shows increasing trends in water use in parts of the action area;
- The current extended drought and climate change are highly likely to negatively impact many system components from the upper parts of the watershed to where Cienega Creek becomes Pantano Wash through:
    - Changes in upland vegetation and fire regime;
    - Higher ambient and water temperatures;
    - Increased variability in stream hydrographs;
    - More frequent severe events;
- The proposed conservation measures will not preclude all anticipated effects to surface water from occurring;
- The proposed conservation measures at Sonoita Creek Ranch will allow conservation in lieu of threat removal;
- Impacts to groundwater, and thus surface water, are reasonably certain to occur in designated critical habitat and areas occupied by Gila chub; and
- Impacts to wetted stream perimeter and water depth are anticipated to be long-term (50-150 or more years after closure).

Cumulative Effects – Gila Chub

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

In 1991, the American Fisheries Society adopted a position Statement regarding cumulative effects of small modifications to fish habitat (Burns 1991). Though the American Fisheries

Society use of the term "cumulative" differs from the definition in the ESA, the statement concludes that accumulation of, and interaction between, localized or small impacts, often from unrelated human actions, pose a serious threat to fishes.

Unregulated activities on Federal and non-Federal lands, such as trespass livestock, inappropriate use of OHVs, illegal introduction of nonindigenous aquatic species, and residential and commercial development on lands within watersheds containing threatened and endangered aquatic animals, are cumulative effects and can adversely affect the species through a variety of avenues.

Other activities, such as recreation, are increasing. Increasing recreational, residential, or commercial use of non-Federal lands near or within the contributing watersheds of the riparian areas would likely result in increased cumulative adverse effects to occupied, as well as potentially-occupied native aquatic animal habitat through increased water use, increased pollution, and increased alteration of the stream banks through riparian vegetation suppression, bank trampling, changing flow regimes, and erosion. We note that recreation use on Federal lands is not a cumulative effect and that much of the stream frontage along Cienega Creek is in Federal (BLM) ownership. Receational use of Pima County lands, while restricted, is also a cumulative effect. Lastly, the right-of-way vegetatation maintenance activities conducted by Tucson Electric Power, which result in nearly-complete removal of riparian vegetation in the affected area (Pima County Regional Flood Control District 2009), are also a cumulative effect.

Cumulative effects to native aquatic animals include ongoing activities in the watersheds in which the species occurs such as livestock grazing and associated activities outside of Federal allotments, irrigated agriculture, groundwater pumping, stream diversion, bank stabilization, channelization without a Federal nexus, and recreation. Some of these activities, such as irrigated agriculture, are declining and are not expected to contribute substantially to cumulative long-term adverse effects to native aquatic animals.

There are many conservation actions being considered by the AGFD for native fish and frogs. Two important conservation actions are the approved Safe Harbor Agreements for the Chiricahua leopard frog and the topminnow and pupfish. While these two agreements and any other conservation actions taken by AGFD are likely to be federally funded or approved, it is likely some of them will have no Federal nexus.

The U.S. Census predicts that Arizona will be the second fastest growing state in the country through 2030, adding an additional 5.6 million people (U.S. Census 2005). During the 2010 Census, Arizona maintained its standing as having the second fastest population growth rate by growing more than 20 percent between 2000 and 2010 (Pollard and Mather 2010). If these predictions hold true, already severe threats to Gila chub and its habitat will worsen, primarily due to increased human demand for surface and ground water and decreased supply. Water demands continue to increase as the population increases. Most of Arizona's developed areas' groundwater is pumped out faster than the aquifer can recharge, resulting in more dependence on freshwater sources from nearby rivers (U.S. Environmental Protection Agency 2011). Groundwater pumping is likely to be the greatest impact cumulatively, since it is minimally regulated by the State.

Additionally, the majority of the lands in the Cienega Corridor are Arizona State Trust Lands, most of which are currently leased for cattle grazing. The Arizona State Constitution mandates that State Trust Lands produce the maximum economic benefit for the beneficiaries of the Trust, most of which are school districts. One of the primary ways in which the State Land Department raises funds is to auction its Trust Lands for commercial or residential development (Hanson and Brott 2005). Activities on residential and commercial inholdings within watersheds containing Gila chub can adversely affect the species through poor land management practices and water withdrawal. These effects have not been quantified within the action area.

Conclusion – Gila Chub

After reviewing the current status of the Gila chub, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Gila chub. Pursuant to 50 CFR 402.02, "jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. We present this conclusion for the following reasons:

1. No direct effects from operation of the mine are expected;
2. Rosemont will monitor groundwater drawdown and the USFS will compare observed drawdown to modeled drawdown. Groundwater drawdown greater than modeled may require reinitiation of section 7 consultation;
3. The Cienega Creek Watershed Conservation Fund will, for the short-term at least, protect and potentially increase habitat for Gila chub by funding actions management and restoration actions in the watershed, protecting water rights, and creating habitat;
4. The Cienega Creek Watershed Conservation Fund is likely to increase ecosystem resiliency in the face of the expected groundwater drawdown from Rosemont Mine, and impacts from climate change;
5. The severance and transfer downstream senior water rights to upstream reaches of Cienega Creek is proposed to occur by no later than January 1, 2016. If successfully executed, these *in situ* water rights may be employed to protect against future diversions of surface water by junior appropriators.
6. The Sonoita Creek Ranch will create new habitat for Gila chub from a reliable water source (Monkey Spring);
7. Indirect effects from groundwater drawdown are difficult to predict at the distances from the drawdown (Rosemont Mine), and over a long time (1,000 years);
8. Groundwater drawdown is not expected to be less than 0.25 ft at all of the modeled locations within and upstream of Gila chub habitat until 150 years after mine closure; and
9. Conservation and recovery actions have taken place since species listing, continue to occur, with more actions in planning. Therefore, we believe the status of the species is improving.
10. The magnitude of the proposed action's effects and the implementation of conservation measures, as described in Conclusions 1, 3, 4, 5, 6, 7, and 8, above) mean that the recovery potential of Gila chub and the species critical habitat will not be diminished.

Based on the above analyses and summary, it is the FWS's biological opinion that the proposed action will not alter the ability of the designated CH PCEs to function properly. As such, Gila chub designated Critical Habitat (CH) will remain functional to serve its intended conservation role for the species. Therefore, we conclude that the proposed action is not likely to destroy or adversely modify Gila chub designated CH nor affect its role in recovery of the species.

INCIDENTAL TAKE STATEMENT – GILA CHUB

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined in section 3 of the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is defined at 50 CFR 17.3 to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined at 50 CFR 17.3 as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of the agency action, is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take Anticipated – Gila Chub

We anticipate that the proposed action may result in incidental take of Gila chub. Incidental take will be difficult to detect for the following reasons: population levels cannot be accurately described with existing information and techniques, dead animals are difficult to find, cause of death may be difficult to determine, and losses may be masked by seasonal fluctuations in numbers or other causes. The incidental take is expected to be in the form of harm through the loss of habitat from groundwater drawdown, and harm, harassment, and mortality from water diversion and management at Pantano Dam and Monkey Spring. Therefore, the following level of take of this species will be exceeded by reduction of groundwater levels 50 percent greater than modeled at any modeled time interval at any modeled location, because groundwater loss will lead to loss of surface water and Gila chub habitat.

We note that the location of wells needed to ascertain compliance with this surrogate measure of incidental take are not necessarily known at this time. Wells situated along streams of interest are influenced by recharge from the streams, ET losses, etc. We also note that, should groundwater reductions directly attributable to the proposed action be noted at sites near streams (and distant from the mine pit), adaptive management measures to mitigate those declines could have long been foreclosed. We anticipate that some suite of wells associated with monitoring for the Aquifer Protection Permit will be able to serve the purpose of groundwater model veification and thus, the level of incidental take.

Effect of the Take – Gila Chub

In this BO, the FWS determined that the above level of anticipated take is not likely to result in jeopardy to the Gila chub.

Reasonable and Prudent Measures and Terms and Conditions

The FWS believes implementation of the conservation measures in the proposed action minimize take of Gila chub. Therefore, no reasonable and prudent measures or terms and conditions are necessary.

Conservation Recommendations – Gila Chub

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or CH, to help implement recovery plans, or to develop information. The FWS recommends the following conservation activities:

1. Rosemont and the eventual owner or manager of Pantano Dam could consider changing how water is diverted there to reduce fish entrainment. An infiltration gallery would be ideal to reduce entrainment;

2. Rosemont and the eventual owner or manager of Sonoita Creek Ranch could consider changing how water is diverted at Monkey Spring to reduce fish entrainment. An infiltration gallery would be ideal to reduce entrainment;

3. We recommend that USFS and Rosemont coordinate with the Cienega Watershed Partnership, AGFD, the F.R.O.G. Project, and our office in an effort to work with private landowners to remove any source populations of nonnative aquatic species from lands in the area;

4. Continue to assist us and the AGFD in conserving and recovering the Gila chub;

5. Assist us with the completion and implementation of the Gila chub recovery plan;

6. Acquire instream flow water rights to ensure perennial flow in streams with Gila chub;

7. Continue to work with the FWS and AGFD to remove nonnative species and reestablish Gila chub throughout its historical range in Arizona;

8. Continue fish surveys on National Forest lands to determine the extent that other chub, such as the headwater chub, may occupy those streams

9. Continue to work cooperatively with us and AGFD to establish populations of Gila chub wherever possible.

For the FWS to be kept informed of actions minimizing or avoiding adverse effect or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

Status of the Species – Gila Topminnow

Gila topminnow was listed as endangered in 1967 without critical habitat (32 FR 4001). Only Gila topminnow populations in the United States, and not in Mexico, are listed under the ESA. The reasons for decline of this fish include past dewatering of rivers, springs and marshlands, impoundment, channelization, diversion, regulation of flow, land management practices that promote erosion and arroyo formation, and the introduction of predacious and competing nonnative fishes (Miller 1961, Minckley 1985). Other listed fish suffer from the same impacts (Moyle and Williams 1990). Life history information can be found in the 1984 recovery plan (USFWS 1984), the draft revised Gila topminnow recovery plan (Weedman 1999), and references cited in the plans.

Gila topminnow are highly vulnerable to adverse effects from nonnative aquatic species (Johnson and Hubbs 1989). Predation and competition from nonnative fishes have been a major factor in their decline and continue to be a major threat to the remaining populations (Meffe *et al.* 1983, Meffe 1985, Brooks 1986, Marsh and Minckley 1990, Stefferud and Stefferud 1994, Weedman and Young 1997, Minckley and Marsh 2009). The native fish fauna of the Gila basin and of the Colorado basin overall, was naturally depauperate and contained few fish that were predatory on or competitive with Gila topminnow (Carlson and Muth 1989). In the riverine backwater and side-channel habitats that formed the bulk of Gila topminnow natural habitat, predation and competition from other fishes was essentially absent. Thus Gila topminnow did not evolve mechanisms for protection against predation or competition and is predator- and competitor-naive. Due to the introduction of many predatory and competitive nonnative fish, frogs, crayfish, and other species, Gila topminnow could no longer survive in many of their former habitats, or the small pieces of those habitats that had not been lost to human alteration. Both large (Bestgen and Propst 1989) and small (Meffe *et al.* 1983) nonnative fish cause problems for Gila topminnow as can nonnative crayfish (Fernandez and Rosen 1996) and bullfrogs.

It has long been known and thoroughly documented, that, western mosquitofish *Gambusia affinis* (mosquitofish) has major deleterious effect**s** on individual Gila topminnow and their populations (Minckley *et al.* 1977, Meffe *et al.* 1983, Minckley *et al.* 1991, Minckley 1999, Voeltz and Bettaso 2003). These publications and others (Miller 1961, Meffe *et al.* 1982, Duncan *in press*) have made it abundantly clear that mosquitofish negatively impact topminnow, and documented the likely mechanisms responsible (Schoenherr 1974, Meffe 1984, 1985).

The Sonoran topminnow (*Poeciliopsis occidentalis*) was listed in 1967. The species was later revised to include two subspecies, *P. o. occidentalis* and *P. o. sonoriensis* (Minckley 1969, 1973). *P. o. occidentalis* was known as the Gila topminnow, and *P. o. sonoriensis* was known as the Yaqui topminnow. *P. occidentalis*, including both subspecies, was collectively known as the Sonoran topminnow. Both subspecies are protected under the ESA. Minckley (1999) stated that the Yaqui topminnow and Gila topminnow are separate species named *P. sonoriensis* and *P. occidentalis,* respectively (Nelson *et al.* 2006). Other researchers make the same argument (Quattro *et al.* 1996, Hedrick *et al.* 2001, Hedrick and Hurt 2012). The name change has not been made to 50 CFR 17.11.

Historically, the Gila topminnow was abundant in the Gila River drainage in Arizona and was one of the most common fishes of the Colorado River basin, particularly in the Santa Cruz system (Hubbs and Miller 1941). Gila topminnow also were recorded from the Gila River basin in New Mexico (Minckley and Marsh 2009). In the last 50 years, they were reduced to only 16 naturally occurring populations. Presently, only 8 of the 16 known natural Gila topminnow populations are considered extant (Table GT-1)(Weedman and Young 1997, Voeltz and Bettaso 2003, Duncan *in press*). There have been at least 200 wild sites stocked with Gila topminnow, however, topminnow persist at only 33 of these localities (Table GT-2). Of these, two sites are outside topminnow historical range and one contains nonnative fish (Voeltz and Bettaso 2003). All of these sites except two are in New Mexico. Many of the reestablished sites are very small and may not contain viable populations, as defined in the draft revised recovery plan (Weedman 1999). In addition several of the 33 sites have been reestablished in the last few years, and their eventual disposition is unknown.

The *Sonoran Topminnow Recovery Plan* (USFWS 1984) established criteria for down- and de-listing. Criteria for down-listing were met for a short period. However, due to concerns regarding the status of several populations, down-listing was delayed. Subsequently, the number of reestablished populations dropped below that required for down-listing, where it has remained. The Yaqui topminnow is now included within the *Yaqui Fishes Recovery Plan* (USFWS 1995). A draft revised recovery plan for the Gila topminnow is available (Weedman 1999). The plan's short-term goal is to prevent extirpation of the species from its natural range in the US and reestablish it into suitable habitat within historical range.

The status of the species is mixed. An active recovery program actively stocks Gila topminnow in Arizona and New Mexico, reestablishing topminnow in "new" sites (Robinson 2010, 2011, 2012). However, natural sites continue to slowly decline. Gila topminnow has gone from being one of the most common fishes of the Gila basin to one that exists at about 41 localities (8 natural and 33 stocked). Many of these localities are small d highly threatened. The theory of island biogeography can be applied to these isolated habitat remnants, as they function similarly (Meffe 1983, Laurenson and Hocutt 1985). Species on islands are more prone to extinctions than continental areas that are similar in size (MacArthur and Wilson 1967). Meffe (1983) considered extirpation of Gila topminnow populations almost as critical as recognized species extinctions. Moyle and Williams (1990) noted that fish in California that are in trouble tend to be endemic, restricted to a small area, part of fish communities with fewer than five species, and found in isolated springs or streams. Gila topminnow has most of these characteristics.

Table GT-1. Status of natural Gila topminnow populations in the US.

Site	Ownership	Extant?[1,8]	Nonnatives?	Mosquitofish?	Habitat Size[2]	Threats[3]
Bylas Spring[5]	San Carlos	YES	NO[4]	NO[4]	S D	M/ N G
Cienega Creek	BLM/County	YES	NO	NO	L	H/ R N W U M
Coal Mine Spring	AGFD	YES	NO	NO	S	L/ G
Cocio Wash	BLM	NO 1982	DRY	DRY	S	H/ M
Cottonwood Spring	Private	YES	NO	NO	S	M/ N W

Fresno Canyon[7]	State Parks	YES	NO[9]	NO[4]	M	H/ N U
Middle Spring[5]	San Carlos	YES	NO[4]	NO[4]	S	H/ N G
Monkey Spring	Private	YES	NO	NO	S	L/ W U
Redrock Canyon	USFS	NO 2008[10]	YES	YES	M D	H/ W R G N
Salt Creek[5]	San Carlos	YES	NO[4]	NO[4]	S	M/ N G
San Pedro River	Private	NO 1976	YES	YES	-	H/ W N G R
Santa Cruz River San Rafael Tumacacori	Private, State Parks, TNC	NO[6] NO 2003	YES YES[4]	YES YES	L D	H/ W N R G C U
Sharp Spring	State Parks	NO 2004	YES	YES	M	H/ N G
Sheehy Spring	TNC	NO 1987	YES	YES	S	H/ N G
Sonoita Creek	Private, TNC, State Parks	YES	YES	YES	L D	H/ W N G

[1] if no, last year recorded
[2] Size L = large M= medium S = small D = disjunct
[3] Immediacy H = high M = moderate L = low
Type W = water withdrawal C = contaminants R = recreation N = nonnatives
G = grazing M = mining U = urbanization
[4] none recently, they have been recorded
[5] renovated
[6] in Mexico 2006, US in 1993
[7] includes Sonoita Creek below Patagonia Lake
[8] Recent records are those less than 10 years old
[9] Fresno Canyon renovated in 2007 and is free of nonnatives- Sonoita Creek has many nonnatives
[10] Stefferud and Stefferud 2008
The Bylas Springs complex, Bylas Spring, Middle Spring, and Salt Creek count as one natural site.

Table GT-2. Reestablished wild populations of Gila topminnow that are likely extant. In Arizona unless noted otherwise (Voeltz and Bettaso 2007, FWS files).

Site Name	Year stocked (discovered)	Mixed/pure	Lineage(s)	Fish From:
AD Wash	1993	Pure	Sharp Spring	Dexter NFH
Ben Spring	2011	Pure	Cottonwood Springs	
Bleak Spring	2005	Pure	Bylas	San Carlos
Bonita Creek (upper)	2010	Pure	Bylas Spring	Dudleyville pond
Buckhorn Spring	2011	Pure	Sharp Spring	
Burro Cienega, NM	2008	Pure	Bylas Spring	Dudleyville pond

Campaign Creek	1983 - **Failed**	Mixed	Monkey/Bylas/Cocio	BTA
	2001	Mixed	Sharp/Cienega	ASU ARC
Cement Spring	2005	Pure	Bylas	San Carlos
Chalky Spring	2009	Pure	Sharp Spring	
Charlebois Spring	1983	Mixed	Monkey/Bylas/Cocio	BTA
Cherry Spring (Muleshoe)	2007-2008	Pure	Bylas Spring	Dudleyville pond
Cold Spring (#85)	1985	Pure	Monkey Springs	
Cottonwood Spring (Goldfield Mountains)	2008	Mixed	Monkey Springs	Boyce Thompson Arboretum
Cottonwood Artesian	1982 - **Failed**	Mixed	Monkey/Bylas/Cocio	BTA
	2001	Pure	Bylas Springs	ASU ARC
Dutchman Grave Spring	1983- **Failed**	Mixed	Monkey/Bylas/Cocio	BTA
	2006	Mixed	Monkey/Bylas/Cocio	BTA
Fossil Creek (#280)	2007-2010	Pure	Sharp Spring	
Headquarters Spring (Muleshoe)	2008	Pure	Bylas Spring	Dudleyville pond
Horse Thief Draw	2011	Pure	Cottonwood Springs	
Howard Well	2008	Pure	Bylas Spring	Dudleyville pond
Larry Creek trib	2005	Pure	Coalmine Spring	Coalmine Spring
Lime Creek	Dispersal from Lime Cabin Spring (1996)	Mixed	Monkey/Bylas/Cocio (Lime Cabin Spring stocked in 1982)	BTA
Lousy Canyon	1999, 2006	Pure	Coalmine Spring	Coalmine Spring
Morgan City Wash	2009	Pure	Sharp Spring	
Mud Springs	1982	Mixed	Monkey/Bylas/Cocio	BTA
Murray Spring	2011	Pure	Cottonwood Springs	
O'Donnell Creek	1974	Pure	Monkey	Monkey
Redrock Wildlife Area NM	2010	Pure	Bylas Spring	Dudleyville pond
Secret Spring (#331, Muleshoe)	2007	Pure	Bylas Spring	Dudleyville pond
Swamp Spring (Muleshoe)	2007-2008	Pure	Bylas Spring	Dudleyville pond
Tule Creek	1981	Mixed	Monkey/Bylas/Cocio	BTA
Unnamed Drainage 68b	Dispersal from Mesquite Tank	Mixed	Monkey/Bylas/Cocio (Mesquite Tank @	BTA

	#2 (1985)		stocked in 1982)	
Walnut Spring	1982	Mixed	Monkey/Bylas/Cocio	BTA
Usery Park	2011	Pure	Cottonwood Springs	

<u>Consultation History</u>

Our information indicates that, range wide, over 100 formal consultations have been completed for actions affecting Gila topminnow. These opinions primarily include the effects of grazing, water developments, fire, species control efforts, recreation, land management planning, native fish restoration efforts, and mining.

Environmental Baseline – Gila Topminnow

The portion of the action area associated with Gila topminnow encompasses all occupied or likely-to-be occupied reaches of stream within the Cienega Creek watershed, as these will be subject to the proposed action's effects to groundwater and surface flow hydrology. This area is described in detail in the Status of the Species and Critical Habitat within the Action Area section, below. The narrartive that follows includes accounts of rangewide effects to Gila topminnow and its habitat as a means to describe similar factors affecting the species within the action area.

The environmental baseline for the action area, and specifically for aquatic species, was thoroughly discussed in the Gila chub section of this BO. It is incorporated here by reference; specifics for the Gila topminnow will be discussed here.

Status of the species within the action area

The action area for the Gila chub encompasses the occupied stream reaches in the Cienega Creek watershed. The action-area status of the Gila topminnow was described in our 2008 and 2012 BOs that addressed effects of Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas National Conservation Areas, Arizona (File numbers 22410-2008-F-0103, 22410-2002-F-0162-R001). The action areas for those BOs overlap with the action area of the proposed action; that information is updated here. Other background information can be found in the Gila chub section of this BO. There is no designated critical habitat for Gila topminnow.

The natural population of Gila topminnow in Las Cienegas continues to be the only extant one on public lands and it is by far the largest of all remaining natural populations in the United States (Simms and Simms 1992, Bodner *et al.* 2007). The only other public land population, Redrock Canyon on the Coronado National Forest, was extirpated in 2008 (Duncan *in press*). The first repatriation of Gila topminnow into the upper Cienega Creek watershed took place in October 2001 at Empire Gulch, followed with additional releases. However, reestablishment of Gila topminnow at Empire Gulch has failed (Simms 2010, Service files). This is likely due to high levels of aquatic vegetation and aquatic invertebrate predators of Gila topminnow in Empire Gulch (Bodner *et al.* 2007).

On May 7, 2012, AGFD stocked 974 Gila topminnow and 656 desert pupfish *Cyprinodon* *macularius* (lower Colorado River stock), were stocked into Road Canyon Tank in the Las Cienegas NCA. Gila topminnow were acquired from Cienega Creek, and hence were Cienega Creek lineage. The AGFD's Nongame Branch and BLM staff visited Road Canyon Tank on July 9, 2012 and reported seeing hundreds of topminnow and about 20 desert pupfish (Robinson 2013).

On May 8, 2012 AGFD and BLM staff stocked 833 Gila topminnow into one pool in Nogales Spring and 910 into two pools in Little Nogales Spring. Fish were collected from Cienega Creek (and hence were Cienega Creek lineage) earlier in the day. AGFD Nongame Branch and BLM staff visited the two springs on July 10, 2012. Between 50 to 100 Gila topminnow, of which about 37 were juveniles, were observed in Nogales Spring. In the upper stocking pool in Little Nogales Spring, about 100 Gila topminnow were observed, about half of which were juveniles. Adults and juveniles were also observed in the stream for several hundred meters below the upper stocking location. In the lower stocking pool over 100 Gila topminnow were observed (Robinson 2013).

BLM management actions that have improved riparian and aquatic habitat for other species on Cienega Creek, coupled with drought, have caused topminnow to become significantly rarer in the upper perennial reach (Bodner *et al.* 2007, Duncan *in press*). The lower reach of upper Cienega Creek appears to have a stable Gila topminnow population (Bodner *et al.* 2007). There are also perennial sections of Cienega Creek north (downstream) of Interstate 10 that hold topminnow (Kesner and Marsh 2010).

Gila topminnow was first documented from Cienega Creek in the 1970's. In addition to Gila topminnow, Cienega Creek supports two other native fishes (Bagley *et al.* 1991, Simms and Simms 1991), the longfin dace and the endangered Gila chub. Cienega Creek is one of the last places in Arizona supporting an intact native fish fauna uncontaminated by nonindigenous fish and is one of the natural Gila topminnow populations not contaminated by mosquitofish (Weedman 1999, Voeltz and Bettaso 2007, Duncan *in press*).

Cienega Creek and its Gila topminnow habitat are subject to a number of human uses, including livestock grazing, recreation, urban and suburban development, groundwater pumping, and roads. Before BLM acquired the area, it was primarily used for grazing, but there were also extensive agricultural fields along the creek (Eddy and Cooley 1983). These fields were irrigated by a system of canals and dams that locally destroyed Gila topminnow habitat and created severe erosion. The BLM is removing these developments and has reconstructed part of the creek to restore more natural geomorphic and hydrologic conditions (USFWS 1998a, Simms 2001).

The lower reach of upper Cienega Creek appears to have a stable Gila topminnow population, but because of how data were collected, even that is uncertain (Bodner *et al.* 2007). The Cienega Creek topminnow population is still considered a viable population, and it is still the largest by far in the U.S.

Gila Topminnow populations in upper Cienega Creek as a whole have declined by 15.6 percent per (Bodner *et al.* 2007). They found this trend to be highly significant, although it only explained 10 percent of the variation in fish abundance. Trends were vastly different between the upper and lower reaches. Topminnow populations in the lower reach were stable over this 16-year period. However, Gila topminnow numbers in the upper reach declined dramatically over the same time.

Gila topminnow was discovered on Pima County's Preserve in 2002, as was Gila chub. Longfin dace also occur there. Use of the Preserve is limited to recreation, which is limited to 20 people per day. Several clay pits, sand and gravel mines, and other mineral development occurs or is planned in the area. Some of the clay pits close to the preserve have been known to contain water and nonindigenous fish and bullfrogs. Fortunately, to date no nonindigenous fish have been found in Cienega Creek in the Preserve. There is a diversion at the downstream-most end of perennial flow. All base flow is diverted down a grate.

In 2004, AGFD personnel captured 30 Gila topminnow at the confluence of Davidson Canyon and Cienega Creek (Voeltz 2004). As part of an ongoing program established by the U.S. Bureau of Reclamation, Cienega Creek was one location where fish monitoring was conducted from 2007 through 2010 (Kesner and Marsh 2010; Marsh and Kesner 2011). Sampling was conducted at two locations in Cienega Creek: Station 1 (upstream of the confluence of Davidson Canyon) and Station 2 (downstream of the confluence with Davidson Canyon). They caught 26 Gila topminnow in 2007, 96 in 2008, 61 in 2009, and 255 in 2010. Gila topminnow were captured by the BLM within the lower and upper reaches of upper Cienega Creek in 2005, 2007, and 2008. Many topminnow were observed in Mattie Canyon in 2006, and one was captured within Mattie Canyon in 2007 (Bodner *et al.* 2007); however, none were observed in 2008 (Ehret and Simms 2009). As part of an effort intended to create, enhance, and protect habitat for at-risk species within the Las Cienegas NCA, Caldwell *et al.* (2011) identified numerous new suitable renovated pond sites for Gila Topminnow reestablishment within Upper and Lower Cienega Creek and within other portions of the Empire Valley.

<u>Monkey Spring</u>

Monkey Spring is located 1.2 mi (2 km) south of Cottonwood Spring and several hundred feet east of Sonoita Creek. It originates on a sideslope above Monkey Canyon, a tributary of Sonoita Creek. Before diversion, the spring flowed through a marsh then over a travertine terrace that resulted in a waterfall of about 40 ft (12 m) into the canyon (Minckley 1973). In the late 1800's a dam was built across the terrace and the flow diverted into a ditch (see also Chamberlain 1904). The artificial pond later drained when attempts to deepen it resulted in breaking the seal on the bottom. The springhead and a short reach are excluded from livestock grazing. The spring continues to be diverted into a cement ditch, and then pipes, that take it to the Sonoita Creek floodplain for irrigation. Some flow periodically drains into the pond and provides transient Gila topminnow habitat.

Monkey Spring is privately owned and is not accessible to the public. The ranch on which it is located is now being subdivided. Although the portion containing Monkey Spring is not part of the present subdivision, its future is not secure, and part of the water rights have been sold with the subdivided land. Additional water use to support development may affect Monkey Spring and Sonoita Creek.

Gila topminnow was first documented in Monkey Spring in 1904 (Chamberlain). Monkey

Spring is the most genetically differentiated of the Gila topminnow populations (Hedrick and Parker 1998, Hedrick *et al.* 2001, Parker *et al.* 1999) in the Gila basin. Historically, two other native fish occurred in Monkey Spring, the Santa Cruz pupfish (*Cyprinodon arcuatus*) and Gila chub (Minckley 1973). The pupfish went extinct, and Gila chub was extirpated after nonindigenous sport fish were introduced (Minckley 1973). Yaqui catfish, a native of the Rio Yaqui basin to the east and south, were introduced into a reservoir fed by Monkey Springs in 1899, but died out sometime after 1950 (Chamberlain 1904, Minckley 1973). At present, there are no nonindigenous fish in Monkey Spring (Voeltz and Bettaso 2003). Previous landowners introduced the nonindigenous fish in the past, and this remains a possibility.

Factors affecting species environment within the action area

The action-area status of the Gila topminnow was described in our 2008 and 2012 BOs that addressed effects of Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas National Conservation Areas, Arizona (File numbers 22410-2008-F-0103, 22410-2002-F-0162-R001). The action areas for those BOs overlap with the action area of the proposed action; that information is updated here. The factors affecting the Gila chub are the same ones affecting the Gila topminnow; so that section of this BO is incorporated here by references. There is no designated critical habitat for Gila topminnow.

Effects of the Action - Gila Topminnow

The effects of the action to Gila topminnow will be very similar to those described for Gila chub. Therefore, that discussion in this BO is incorporated here by reference. Any effects that may affect the Gila topminnow differently than Gila chub, will be discussed below.

Climate change may be less problematic for Gila topminnow compared to Gila chub. Gila topminnow have about a 2^{o} C higher tolerance of water temperature than Gila chub (Carveth *et al.* 2006). Gila topminnow are also likely to respond better to reduced dissolved oxygen in the water; topminnow can survive with dissolved oxygen at 1ppm, while chub require at least 3ppm. Also, amount of stream flow is a factor in dissolved oxygen; generally the less the flow, the less the amount of dissolved oxygen.

As for how the modeled groundwater drawdowns will impact Gila topminnow, many of the impacts will be the same as for Gila chub. However, a reduction in the wetted perimeter will be more deleterious for topminnow than Gila chub, since Gila topminnow prefer and use shallow waters much more than chub. Therefore, habitat that is likely to be occupied by topminnow in the future (when drawdowns occur) will be lost or reduced by the proposed action. Losses of habitat resulting from the groundwater drawdown associated with the proposed action may impact Cienega Creek north of I-10 (The Preserve), Cienega Creek on Las Cienegas NCA, and Mattie Canyon. The modeled loss of surface water in the northern reaches of upper Cienega Creek is more of a concern than the southern reaches, because the best topminnow populations on the NCA occur there (Bodner *et al.* 2007). In addition, BLM's Cieneguita wetland project in the lower Empire Gulch drainage is slated to receive Gila topminnow (BLM 2007) in the next two years. Groundwater losses near the confluence of Empire Gulch and Cienega Creek could impact the Cieneguita wetlands.

Since attempts to establish Gila topminnow in Empire Gulch have failed, the modeled groundwater decline at the Empire Gulch Spring is not likely to impact Gila topminnow, at least certainly not in the near term. There are no discussions on releasing topminnow into any part of Empire Gulch. The problems with excess aquatic vegetation and shade in the spring run would need to change before Gila topminnow releases were entertained.

Because the effects of the action to Gila topminnow will be off-site, conservation measures can only be realized off-site. The two conservations measures discussed below are outside the footprint of the mine, though one is in the action area. Other than the monitoring mentioned above, two conservation measures should promote conservation and recovery of Gila topminnow. A full description of the conservation measures can be found in the proposed action section of this BO.

The Cienega Creek Watershed Conservation Fund will provide $200,000 a year for 10 years for development and implementation of measures intended to preserve and enhance aquatic and riparian ecosystems and the federally listed aquatic and riparian species that depend on them. The funds can be used to support approved management efforts by Pima County and others to control invasive aquatic species that presently occur (bullfrogs), or may occur later. Funds can be used for restoration activities and adaptive management. Rosemont will acquire and close one well near the diversion dam in lower Cienega Creek. Also, Rosemont will acquire over 1100 af of water rights, and transfer them for conservation purposes, or sever them.

About 825 acre-feet per annum (afa), will be used for aquifer recharge below Pantano Dam. To accomplish this, a "managed underground storage facility (MUSF)" will be permitted through the ADWR. This will allow surface water flows currently diverted for golf course irrigation to be captured and discharged back to the streambed below the Pantano Dam within the Cienega Creek Natural Preserve. Flow will be captured at the existing in-channel grated diversion, and then released into the stream channel below the dam. Gila topminnow and longfin dace have been observed right above the dam, on the dam, and in the scour pool below the dam. It is certain that fish have been and will continue to go into the diversion, and suffer death or injury. The City of Tucson and Pima County (2009) expect that up to 3000 linear feet of riparian and aquatic habitat would form below Pantano Dam. How much habitat will be suitable for topminnow remains to be seen, but it is highly likely suitable topminnow habitat will form below the dam. The actions taken under this conservation measure should enhance the resiliency and suitability of Cienega Creek for Gila topminnow, especially in the lower creek, at least in the short-term. Under the threat of continuing long-term drought and climate change, enhancing system resiliency is a key component for adapting to climate change and reducing its affects (Overpeck *et al.* 2012).

Also, Rosemont will purchase about 1,200 acres of land along Sonoita Creek (Sonoita Creek Ranch) with about 590 afa of certificated surface water rights from Monkey Spring. This is near Patagonia, and outside of the action area. The land will be transferred to a conservation entity for management of the property. In addition, Rosemont will fund $150,000 a year for 10 years for resource management. An additional $100,000 ($20,000 annually for five years) will be provided for management against nonnative species, generally in the two existing ponds on the property that are maintained with water from Monkey Spring. An evolutionary significant unit of Gila topminnow occurs in Monkey Spring (Hedrick *et al.* 2001); acquisition of even part of the water rights will provide some protection to this natural topminnow population. Gila chub and Gila topminnow will be established in the ponds after nonnatives are removed from them. Because this parcel is outside of the action area, this action represents recovery in lieu of threat removal. The environmental baseline and recovery status of Gila topminnow should be improved by actions taken at Sonoita Creek Ranch. Also, the source of Monkey Spring appears to be the regional aquifer, which should be somewhat buffered from local groundwater pumping and climate change.

The environmental baseline and recovery status of Gila topminnow should be improved by actions taken at Sonoita Creek Ranch. The proposed action is implements tasks in the draft revised Gila topminnow recovery plan (Weedman 1999). This is a vitally important area for Gila topminnow conservation, because many natural topminnow populations are in the area, and reestablishment sites are limited there.

Summary of Effects – Gila Topminnow

- Groundwater levels have historically been variable;
- The environmental baseline shows increasing trends in water use in some areas of the action area;
- The current extended drought and climate change are highly likely to negatively impact many system components from the upper parts of the watershed to where Cienega Creek becomes Pantano Wash through:
    - Changes in upland vegetation and fire regime;
    - Higher ambient and water temperatures;
    - Increased variability in stream hydrographs;
    - More frequent severe events;
- The proposed conservation measures will not preclude all anticipated effects to surface from occurring;
- Acquisition of Sonoita Creek Ranch is a significant benefit to a critically important natural Gila topminnow population;
- Impacts to groundwater, and thus surface water, are reasonably certain to areas occupied by Gila topminnow; and
- Impacts to wetted stream perimeter and water depth are anticipated to be long-term (50-150 or more years after closure).

Cumulative Effects – Gila Topminnow

The cumulative effects for the action area, and specifically for aquatic species, was thoroughly discussed in the Gila chub section of this BO. It is incorporated here by reference.

Conclusion – Gila Topminnow

After reviewing the current status of the Gila topminnow, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Gila topmminnow. Pursuant to 50 CFR 402.02, "jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. We present this conclusion for the following reasons:

1. No directs effects from operation of the mine are expected;
2. Rosemont will monitor groundwater drawdown and the USFS will compare observed drawdown to modeled drawdown. Groundwater drawdown greater than modeled may require reinitiation of section 7 consultation;
3. The Cienega Creek Watershed Conservation Fund will, for the short-term at least, protect and potentially increase habitat for Gila chub by funding actions management and restoration actions in the watershed, protecting water rights, and creating habitat;
4. The Cienega Creek Watershed Conservation Fund is likely to increase ecosystem resiliency in the face of the expected groundwater drawdown from Rosemont Mine, and impacts from climate change;
5. The Sonoita Creek Ranch will create new habitat for Gila topminnow that is created from a reliable water source (Monkey Spring);
6. The Sonoita Creek Ranch will provide additional protection to an evolutionarily significant unit of Gila topminnow, and proposes to implement actions in the draft revised Gila topminnow recovery plan;
7. Indirect effects from groundwater drawdown are difficult to predict at the distances from the drawdown (Rosemont Mine), and over a long time (1,000 years);
8. Groundwater drawdown is not expected to be more than 0.1 ft in any of the modeled locations until 150 years after mine closure; and
9. Conservation and recovery actions have taken place since the species was listed, continue to occur, with more actions in planning. Therefore, we believe the status of the species is static or improving.
10. The magnitude of the proposed action's effects and the implementation of conservation measures, as described in Conclusions 1, 3, 4, 5, 6, 7, 8, and 9, above) mean that the recovery potential of Gila chub topminnow will not be diminished.
11. Critical habitat has not been designated for the Gila topminnow; none will be affected.

INCIDENTAL TAKE STATEMENT – GILA TOPMINNOW

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined in section 3 of the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is defined at 50 CFR 17.3 to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined at 50 CFR 17.3 as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of the agency action, is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take Anticipated – Gila Topminnow

We anticipate that the proposed action may result in incidental take of Gila topminnow. Incidental take will be difficult to detect for the following reasons: population levels cannot be accurately described with existing information and techniques, dead fish are difficult to find, cause of death may be difficult to determine, and losses may be masked by seasonal fluctuations in numbers or other causes. The incidental take is expected to be in the form of harm through the loss of habitat from groundwater drawdown, and harm, harassment, and mortality from water diversion and management at Pantano Dam and Monkey Spring. Therefore, the following level of take of this species will be exceeded by reduction of groundwater levels 50 percent greater than modeled at any modeled time interval at any modeled location, because groundwater loss will lead to loss of surface water and Gila topminnow habitat.

Effect of the Take – Gila Topminnow

In this BO, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the Gila topminnow.

Reasonable and Prudent Measures and Terms And Conditions

The FWS believes implementation of the conservation measures in the proposed action minimize take of Gila topminnow. Therefore, no reasonable and prudent measures or terms and conditions are necessary.

Conservation Recommendations – Gila Topminnow

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species, to help implement recovery plans, or to develop information. The FWS recommends the following conservation activities:

1. The USFS and Rosemont should coordinate with the Cienega Watershed Partnership, AGFD, the F.R.O.G. Project, and our office in efforts to work with private landowners to remove populations of nonnative aquatic species from lands in the area;
2. The USFS should continue to assist us and the AGFD in conserving and recovering the Gila topminnow;
3. The USFS should assist us with the completion and implementation of the Gila topminnow revised recovery plan;
4. Rosemont should consider releasing Gila topminnow into water features on the mine site, when the site is suitable, and the release of topminnow would not conflict with other conservation actions;

5. Rosemont should consider acquiring the remaining water rights for Monkey Spring and the fee title property with Monkey Spring;
6. Rosemont should consider acquiring the water rights for Cottonwood Spring;
7. The USFS should acquire instream flow water rights to ensure perennial flow in streams with Gila topminnow;
8. The USFS should continue to work with the FWS and AGFD to remove nonnative species and reestablish Gila topminnow throughout its historical range in Arizona;
9. The USFS should continue fish surveys on the NF lands to determine the extent that Gila topminnow occupy those streams; and
10. The USFS should continue to work cooperatively with us and AGFD to establish populations of Gila topminnow wherever possible within historical range.

For the FWS to be kept informed of actions minimizing or avoiding adverse effect or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

Status of the Species - Huachuca Water Umbel

The Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) (umbel) is an herbaceous, semi-aquatic to occasionally fully aquatic, perennial plant with slender, erect leaves that grow from creeping rhizomes. The leaves are cylindrical, hollow with no pith, and have septa (thin partitions) at regular intervals. The yellow/green or bright green leaves are generally 0.04 to 0.12 inch in diameter and often 1 to 2 inches tall, but can reach up to 8 inches tall under favorable conditions. Three to ten very small flowers are borne on an umbel that is always shorter than the leaves. The fruits are globose, 0.06 to 0.08 inch in diameter, and usually slightly longer than wide (Affolter 1985).

On January 6, 1997, we listed the umbel as an endangered species (62 FR 665; FWS 1997). Critical habitat was designated on the upper San Pedro River, Garden Canyon on Fort Huachuca, Scotia Canyon and other areas of the Huachuca Mountains, the San Rafael Valley, and Sonoita Creek on July 12, 1999 (64 FR 37441; FWS 1999). No recovery plan has been developed, but a draft recovery plan is anticipated to be complete in 2013.

Distribution/Abundance

Umbel has been documented from sites in Santa Cruz, Cochise, and Pima counties, Arizona, and in adjacent Sonora, Mexico, west of the continental divide (Haas and Frye 1997, Saucedo-Monarque 1990, Warren *et al*. 1989, Warren *et al*. 1991, Warren and Reichenbacher 1991, Anderson 2006). The plant has been extirpated from six sites. The extant sites occur primarily in five major watersheds - San Pedro River, Santa Cruz River, Río Yaqui/Bavispe, Río Sonora, and Río Magdalena. All sites are between 3,500 and 7,250 feet in elevation.

Habitat

The umbel grows in cienegas (marshy wetlands), and along streams, rivers, and springs in southeastern Arizona and northeastern Sonora, Mexico, typically in mid-elevation wetland communities often surrounded by relatively arid environments. These wetland communities are usually associated with perennial springs and stream headwaters, have permanently or seasonally saturated highly organic soils, and have a low probability of flooding or scouring (Hendrickson and Minckley 1984). The water umbel can grow in saturated soils or as an emergent in water depths up to about 10 inches. Cienegas support diverse assemblages of animals and plants, of which many species are of limited distribution, such as the umbel (Hendrickson and Minckley 1984). The surrounding non-wetland vegetation can be desert scrub, grassland, oak woodland, or conifer forest (Arizona Game and Fish Department 1997).

Umbel has an opportunistic strategy that ensures its survival in healthy riverine systems, cienegas, and springs. In upper watersheds that generally do not experience scouring floods, umbel occurs in microsites where interspecific plant competition is low. At these sites, umbel occurs on wetted soils interspersed with other plants at low density, along the periphery of the wetted channel, or in small openings in the understory. In stream and river habitats, umbel can occur in backwaters, side channels, and nearby springs. The upper Santa Cruz River and associated springs in the San Rafael Valley, where a population of umbel occurs, is an example of a site that meets these conditions. The types of microsites required by umbel were generally lost from the main stems of the San Pedro and Santa Cruz rivers when channel entrenchment occurred in the late 1800s.

Habitat on the upper San Pedro River is recovering, and umbel has recently recolonized small reaches of the main channel. Cienegas, perennial streams, and rivers in the desert southwest are extremely rare. The Arizona Game and Fish Department (1993) estimated that riparian vegetation associated with perennial streams comprises about 0.4% of the total land area of Arizona, with present riparian areas being remnants of what once existed. The State of Arizona (1990) estimated that up to 90 percent of the riparian habitat along Arizona's major desert watercourses has been lost, degraded, or altered. The physical and biological habitat features essential to the conservation of umbel include a riparian plant community that is fairly stable over time and not dominated by non-native plant species, a stream channel that is relatively stable but subject to periodic, non-scouring flooding, refugial sites (sites safe from catastrophic flooding), and a substrate (soil) that is permanently wet or nearly so, for growth and reproduction of the plant.

Life History

The umbel flowers from March through October with most flowering in June through August (Arizona Game and Fish Department 1997). The species reproduces sexually through flowering and asexually from rhizomes, the latter probably being the primary reproductive mode. The umbel is also suspected of self-pollination (Johnson *et al*. 1992). An additional dispersal opportunity occurs as a result of the dislodging of clumps of plants, which then may re-root in a different site along aquatic systems. Fruits develop from July through September, and water disperses the seeds (Arizona Game and Fish Department 1997). Seeds from plants grown in an aquarium have been seen sticking to the aquarium sides and germinating 1-2 weeks after falling from the parent plant (Johnson *et al*. 1992).

After a flood, umbel can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. This response was recorded at Sonoita Creek in August 1988, when a scouring flood removed about 95% of the umbel population (Gori *et al*. 1990). One year later, the umbel had recolonized the stream and was again codominant with watercress (*Rorippa nasturtium-aquaticum*, Warren *et al*. 1991). However, two patches of umbel on the San Pedro River were lost during a winter flood in 1994, and the species had still not recolonized that area as of May 1995, demonstrating the dynamic and often precarious nature of occurrences within a riparian system (Al Anderson, Grey Hawk Ranch, in litt. 1995). The expansion and contraction of umbel populations appear to depend on the presence of "refugia" where the species can escape the effects of scouring floods, a watershed that has an unaltered hydrograph, and a healthy riparian community that stabilizes the channel.

Density of umbel plants and size of populations fluctuate in response to both flood cycles and site characteristics. Some sites, such as Black Draw, have a few sparsely distributed clones, possibly due to the dense shade of the even-aged overstory of trees, dense non-native herbaceous layer beneath the canopy, and deeply entrenched channel. The Sonoita Creek population occupies 14.5 percent of a 5,385 square foot patch of habitat (Gori *et al*. 1990). Some populations are as small as 11 to 22 square feet. The Scotia Canyon population, by contrast, has dense mats of leaves. Scotia Canyon contains one of the larger umbel populations, occupying about 57% of the 4,756 foot perennial reach (Gori *et al*. 1990, Falk and Warren 1994).

While the extent of occupied habitat can be estimated, the number of individuals in each population is difficult to determine because of the intermeshing nature of the creeping rhizomes and the predominantly asexual mode of reproduction. A "population" of umbel may be composed of one or many genetically distinct individuals.

Threats

Overgrazing, mining, hay harvesting, timber harvest, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800s and early 1900s (Bryan 1925, Martin 1975, Hastings and Turner 1980, Dobyns 1981, Hendrickson and Minckley 1984, Sheridan 1986, Bahre 1991, Webb and Betancourt 1992, Hereford 1993). A major earthquake near Batepito, Sonora, approximately 40 miles south of the upper San Pedro Valley, resulted in land fissures, changes in groundwater elevation, and spring flow, and may have preconditioned the San Pedro River channel for rapid flood-induced entrenchment (Hereford 1993,

Geraghty and Miller, Inc. 1995). These events contributed to long-term or permanent degradation and loss of cienega and riparian habitat on the San Pedro River and throughout southeastern Arizona and northeastern Sonora. Much habitat of the umbel and other cienega-dependent species was presumably lost at that time.

Wetland degradation and loss continues today. Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, chaining, agriculture, mining, sand and gravel operations, road building, non-native species introductions, urbanization, wood cutting, and recreation all contribute to riparian and cienega habitat loss and degradation in southern Arizona. The local and regional effects of these activities are expected to increase with the increasing human population.

Limited numbers of populations and the small size of populations make the umbel vulnerable to extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of this taxon to a relatively small area in southeastern Arizona and adjacent areas of Mexico increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought, could eliminate populations or cause extinction. Populations are in most cases isolated, as well, which makes the chance of natural recolonization after extirpation less likely. Small populations are also subject to demographic and genetic stochasticity, which increases the probability of population extirpation (Shafer 1990, Wilcox and Murphy 1985).

Critical Habitat

Seven Critical Habitat units have been designated for umbel; all are in Santa Cruz and Cochise counties, Arizona, and include stream courses and adjacent areas out to the beginning of upland vegetation. The Scotia, Sunnyside, and Bear canyon units (3, 4, and 6) are within the Coronado National Forest. The remaining Units are in lands adjacent to Forest lands. The following general areas are designated as critical habitat (see legal descriptions for exact critical habitat boundaries):

Unit 1-approximately 1.25 mile of Sonoita Creek southwest of Sonoita;
Unit 2-approximately 2.7 miles of the Santa Cruz River on both sides of Forest Road 61, plus approximately 1.9 miles of an unnamed tributary to the east of the river;
Unit 3-approximately 3.4 miles of Scotia Canyon upstream from near Forest Road 48;
Unit 4-approximately 0.7 mile of Sunnyside Canyon near Forest Road 117 in the Huachuca Mountains;
Unit 5- approximately 3.8 miles of Garden Canyon near its confluence with Sawmill Canyon;
Unit 6- approximately 1.0 mile of Rattlesnake Canyon and 0.6 mile of an unnamed canyon, both of which are tributaries to Lone Mountain Canyon; approximately 1.0 mile of Lone Mountain Canyon; and approximately 1.0 mile of Bear Canyon; an approximate 0.6-mile reach of an unnamed tributary to Bear Canyon; and
Unit 7- approximately 33.7 miles of the San Pedro River from the perennial flow reach north of Fairbank (Arizona Department of Water Resources 1991) to 0.13 mile south of Hereford, San Pedro Riparian National Conservation Area.

The primary constituent elements of critical habitat for umbel include, but are not limited to, the habitat components that provide:

1. Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of umbel;
2. A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for umbel expansion;
3. A riparian plant community that is relatively stable over time and in which non-native species do not exist or are at a density that has little or no adverse effect on resources available for umbel growth and reproduction; and
4. In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers that allow each population to survive catastrophic floods and recolonize larger areas.

Activities that may destroy or adversely modify critical habitat include those that alter the primary constituent elements to the extent that the value of critical habitat for both the survival and recovery of umbel is appreciably diminished. Such activities are also likely to jeopardize the continued existence of the species.

Environmental Baseline - Huachuca Water Umbel

The action area for the Huachuca water umbel includes the occupied portions of the Cienega Creek watershed, as described below. Prior to 2001, the sole Huachuca water umbel metapopulation known from the action area was in Empire Gulch in Las Cienegas National Conservation Area (NCA) [Engineering and Environmental Consultants (EEC) 2001, Pima County 2001]. Since that time, the species has been found in other locations within the action area: in a small patch along Cienega Creek in the county's reserve upstream from of the confluence of Cienega Creek and Davidson Canyon (EEC 2001, Pima County 2001); in Las Cienegas NCA, from the confluence of Cienega Creek with Gardner Canyon north to the northern boundary of the NCA; and in middle reaches of Cienega Creek (AGFD 2011). The Huachuca water umbel metapopulations within Las Cienegas NCA include (BLM 2011): (1) 19 patches recorded between the headwaters of Cienega Creek near the southern boundary of the NCA, north to the confluence of Cienega Creek with Gardner Canyon; (2) 61 patches recorded between the confluence of Cienega Creek with Mattie Canyon, north to Powerline Road; (3) 16 patches recorded within Cienega Creek between the Narrows Powerline Road, north to the Narrows; (4) one patch recorded within Lower Empire Gulch between Rattlesnake Tank and the confluence with Cienega Creek; and (5) three patches recorded within Mattie Canyon between the spring source and the confluence with Cienega Creek. Mattie Canyon is not anticipated to be affected by the proposed action but is included here because of its role in serving as a seed and patch source site for downstream reaches of Cienega Creek. There is no critical habitat for Huachuca water umbel in the action area.

The Pima Association of Governments (PAG) monitors ecological conditions on Cienega Creek within the Pima County Cienega Creek Preserve and reports the data to the Pima County Regional Flood Control District (RFCD) (Mier 2012 pers. comm.). Recent drought conditions and anthropogenic alterations have affected the stream's hydrology. As of the summer of 2012, the length of wetted stream within the Preserve was 1.24 miles, the shortest in a period of record going back to 1975. This contrasts to the wet years of the early 1980s when up 9.5 miles of the creek within the Preserve exhibited perennial flow. PAG has found that stream discharge and groundwater levels are correlated to streamflow length, matching the rise and fall of the seasons and the downward trend with drought. Since September 2009, when the region lacked a monsoon season, the wells have remained at 5-7 feet below their pre-drought levels, with levels in June 2012 slightly below last June 2011 and 7 feet below pre-drought. Stream volume is at 14% of pre-drought flow (similar to flow length's comparison), with 0.12 cfs flowing.

Cienega Creek is thus susceptible to inter-annual changes in weather as well as longer-term changes in the regional climate. Anthropogenic impacts act to further reduce the stream's hydrologic resilience. For example, PAG stated that the Arizona Department of Transportation pumped water from the alluvium while constructing a new overpass at Marsh Station Road in 2010 and 2011, and this withdrawal appears to have been a factor contributing to approximately 10 feet of groundwater decline in the two wells nearest the pumping site. PAG also noted that there has been some recovery since that time.

We have completed one other formal consultation (and a reinitiation thereof) within the action area for a project affecting Huachuca water umbel: our February 21, 2012, *Reinitiated Biological Opinion on Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas National Conservation Areas, Arizona* (File number 22410-2012-F-0162-R001), and its predecessor consultation, our December 31, 2008, *Biological Opinion on Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas National Conservation Areas, Arizona* (File number 22410-2008-F-0103). These proposed actions included measures to restore Huachuca water umbel to sites within the San Pedro Riparian National Conservation Area (RNCA) and within Las Cienegas National Conservation Area (NCA); the latter is within the action area for the proposed action. To date, the species has only been reestablished within the San Pedro RNCA.

Effects of the Action - Huachuca Water Umbel

Huachuca water umbel is an aquatic to semi-aquatic plant that requires adjacency to open water and very moist substrates. As such, the effects to the species are in many respects similar to those of threatened and endangered fishes as well as to the woody riparian vegetation that serves as a nesting and foraging substrate for obligate riparian birds. The sections of this BO pertaining to the effects of the proposed action to Gila chub and southwestern willow flycatcher describe the process whereby stream flows would be diminished to the extent that aquatic habitat is reduced and riparian vegetation reduced in vigor and areal extent, respectively. These analyses are hereby incorporated into this section via reference.

Leenhouts *et al*. (2005) examined interactions between hydrologic processes and riparian vegetation within the San Pedro RNCA on the San Pedro River, a neighboring watershed situated east of the Cienega Creek system. The specific objectives of the study were to: (1) determine the water needs of riparian vegetation through the riparian growing season; (2) to quantify the total water use of riparian vegetation; and (3) to determine the source of water used by key riparian plant species. The authors integrated analyses of vegetation functional groups, groundwater and surface water hydrology, and spatial and temporal variations thereof.

Although Huachuca water umbel occurs in the San Pedro RNCA, this species was not specifically evaluated by Leenhouts *et al*. (2005). Huachuca water umbel would fall within the authors' Hydric Herbaceous Perennial functional group which includes smooth scouring rush (*Equisetum laevigatum*), hardstem bulrush (*Schoenoplectus acutus*), Torrey rush (*Juncus torreyi*), cattail (*Typha latifolia* and *T. domingensis*), watercress (*Rorippa nasturtium-aquaticum*), water speedwell (*Veronica anagallis-aquatica*), sand spikerush (*Eleocharis montevidensis*), and Baltic rush (*J. arcticus* var. *balticus*). Leenhouts *et al*. (2005) found that cover of hydric perennial herbs was most abundant in an approximately 1-meter wide strip along the channel margins; these species depend on shallow, inflowing ground water to sustain stream base flows and moisten surface soils. This group had high abundance only at sites with perennial or near-perennial streamflow, declining sharply in abundance as flows became intermittent as well as across floodplains of increasing elevation above the stream. While the Leenhouts *et al*. (2005) study was conducted on the San Pedro River, the physiologic needs of hydric perennial plants would indicate similar ecological responses within any stream in which they occur, including the nearby Cienega Creek system.

Leenhouts *et al*. (2005) also examined the spatial arrangement of plants in relation to streamflow permanence (as a surrogate for depth to groundwater) in order to assess the changes that could occur under conditions of declining groundwater levels. As streamflow became more intermittent and depth to the alluvial ground-water table increased, herbaceous species, such as bulrush and rushes, declined in abundance. In addition, streamside-zone species composition shifted towards more mesic herbaceous species, including the nonnative rhizomatous perennial Bermuda grass (*Cynodon dactylon*). This sod-forming species is relatively drought- and flood-tolerant and became the most common mesic riparian perennial as stream flow became intermittent (Stromberg *et al*. 2005).

Huachuca water umbel, with its shallow root system, is a poor competitor; population numbers tend to be lower in areas with a high density of native or nonnative plant species competition (Titus *et al*. 2002). As Huachuca water umbel is sensitive to interspecific competition, requiring both ample light penetration and little competition for nutrients (Zuhlke *et al*. 2002, Vernadero 2011, USFWS 2001), competition from Bermuda grass will hasten the decline of the listed species in sites where alluvial groundwater levels have declined but still occasionally remain within the range that would otherwise support a hydric herbaceous perennial plant community. Other researchers studying Huachuca water umber in the San Pedro RNCA have noted that Bermuda grass presence reduces the number of exploitable sites for Huachuca water umbel making it a threat to umbel dispersal (Vernadero 2011).

Effects to the Aquatic and Riparian Ecosystems - Huachuca Water Umbel

The section in this BO entitled Effects to Aquatic Ecosystems describes the hydrologic basis for effects to the streams in which Huachuca water umbel occurs. The subsequent analysis of effects to riparian vegetation, of which the species is a component, appears in the Effects to Riparian Ecosystems section. These prior analyses are incorporated herein via reference.

Based on these prior analyses, we are particularly concerned with the modeled drawdowns in Empire Gulch and in the vicinity of Empire Gulch's confluence with Cienega Creek within Las Cienegas NCA, as well as within the lowermost reaches of Cienega Creek, such as in the Pima County Cienega Creek Preserve. The relevant aspects of these analyses are reiterated in the narrative that follows.

Empire Gulch

Tetra Tech (2010) modeled the effects at the Empure Gulch Springs site to range from <0.1 foot of groundwater drawdown upon cessation of mining to 0.2 foot at 20 years, 0.5 foot at 50 years, 2.5 feet at 150 years, and 6 feet at 1,000 years (see Table A-5).

Upper Cienega Creek

The USGS Cienega Creek stream gage (0948550) is situated near the narrows in the upstream portion of Reach 3 (see Figure A-1). Tetra Tech (2010) modeled regional groundwater drawdowns at the uppermost USGS Cienega Creek stream gage site of <0.1 foot from the end of mining and at 20, 50, and 150 years later. Drawdowns reach 0.25 feet and 0.5 feet at 150 and 1,000 years, respectively. We remain concerned with diminished recharge within the watershed at this site; our concerns are described in the Gardner Canyon and Empire Gulch analyses in the Effects to Aquatic Ecosystems section, above. Table A-2, also found in the Effects to Aquatic Ecosystems section, is based on SWCA (2012), and describes appreciable effects to upper Cienega Creek, including an 0.16-mile decrease in stream length, a decrease in baseflow of 0.02 cfs, and a decrease in riparian ET of 51 afa.

Lower Cienega Creek

Tetra Tech (2010) modeled groundwater drawdowns of <0.01 foot at the lowermost USGS stream gage in Cienega Creek at all intervals from the cessation of mining to 1,000 years; this is to be expected at such a large distance from the mine pit. The loss of runoff from the placement of tailings in Barrel Canyon has a relatively greater effect.

Given SWCA's finding that Davidson Canyon Wash will experience a 4.3 percent reduction in runoff (surface flows) from the placement of tailings in its watershed and the Pima Association of Governments' (2003b) estimate that the wash contributes 8 to 24 percent of the baseflow in Lower Cienega Creek, we anticipate that there will be a 0.3 to 1.0 percent reduction in the latter stream.

As discussed above, Table 7 in SWCA (2012) (also see Table A-5 in tis document) summarizes various hydrologic and environmental effects resulting from groundwater drawdowns. Table A-3, in the Effects to Aquatic Ecosystems section, in cludes the SWCA (2012) findings wherein lower Cienega Creek will experience 0.31 foot of drawdown, no loss of stream length, a 0.02 cfs loss of discharge, and 8 afa in reduced riparian ET at 150 years after mining. By 1,000 years, SWCA (2012) predicted 0.98 foot of drawdown, a 0.29-mile reduction in stream length, a 0.04 cfs loss of discharge, and 221 afa in reduced riparian ET. The latter effects are appreciable.

Summary of Adverse Effects - Huachuca Water Umbel

We reiterate that the 5-foot threshold for reliably modeling changes in ground water elevation posited by SRK (2012) does not mean we cannot consider changes of less than that magnitude. Moreover, the results of the groundwater models have much greater utility in determining trends in groundwater elevation than in determining actual values and/or magnitudes of change. In this regard, the aquatic habitat of the Huachuca water umbel (occupied areas in Empire Gulch and Cienega Creek) is likely to experience a contraction in wetted length and a reduced wetted perimeter (which may also be expressed as a narrowing of top-width).

As discussed in the effects analysis for the southwestern willow flycatcher, reduced surface flows characterize the most visible aspect of riparian effects, but don't describe their full extent. Moreover, the flycatcher analysis was concerned primarily with the sustenance and recruitment of woody riparian vegetation; the effects to a near-aquatic plant such as Huachuca water umbel would be more immediate and severe. Surface flows in alluvial reaches of Cienega Creek exist in locations where the thalweg (lowest elevation portion of the channel) of the stream intersects the alluvial water table. A longitudinal contraction in surface flows would be a component of a more-lengthy (and also longitudinal) reduction in shallow, subsurface flows, with alluvial groundwater in areas adjacent to dewatered reaches also dropping below critical depths for Huachuca water umbel. In areas where the depth to groundwater has exceeded the species' ability to access water, individual patches would senesce and eventually die unless they could: (1) reproduce asexually and access more moist microsites via the spread of rhizomes; and/or (2) colonize new, well-watered reaches via the spread of seeds generated in occupied sites upstream. A longitudinal contraction in surface flows would also be accompanied by a narrowing of the stream's top width, and such a narrowing of a stream can be expected to result in Huachuca water umbel rooting closer to the centerline of the channel, as the water-dependent plant grows towards the remaining, available water. Additionally, plants tolerant of drier conditions, potentially including nonnative species, could colonize the less-well watered lateral sites and indirectly or directly compete with Huachuca water umbel. This is problematic in that the proposed action will leave flood flows in reaches above Davidson Canyon Wash largely unaffected. Vegetation that establishes itself in a narrowed low-flow channel will be subject to scouring from peak flows. Flood scour could be further exacerbated if the larger herbaceous and woody vegetative communities suffer mortality sufficient to reduce the stability of the stream's banks, where Huachuca water umbel occurs. While Huachuca water umbel requires low to moderate severity floods to create niches for colonization, excessive flooding is intolerable to populations and may result in extinctions locally (Warren *et al*. 1991; Warren *et al*. 1989).

Effects of the Proposed Conservation Measures - Huachuca Water Umbel

The proposed action includes: (1) eight conservation measures specifically pertaining to aquatic species; (2) a Cienega Creek Watershed restoration and water right protection program; and (3) the restoration of wetlands within the Sonoita Creek Ranch (see the Aquatic Species: Gila Chub, Gila Topminnow, and Huachuca Water Umbel; Cienega Creek Watershed; and Sonoita Creek Ranch subsections in the Description of the Proposed Conservation Measures section, above).

Six of the eight aquatic species conservation measures' stated purpose is to implement various monitoring programs to: (1) verify groundwater model results (via monitoring wells in key locations); (2) to ensure the chemical integrity of the regional groundwater (via the Aquifer Protection Permit) and streams (via the Arizona Department of Environmental Quality's National Pollution Discharge Elimination System permit: NPDES); and (3) assess alterations in channel geomorphology that may result from altered peak flow hydrology and sediment dynamics. The benefit of well monitoring is to obtain empirical data related to changes in groundwater storage, which may then be used to verify or update the groundwater models. The primary benefit of the monitoring of water quality is to provide an early warning and recommendation for corrective actions prior to the onset of gross changes in chemistry or geomorphology that would be most likely to kill or displace Huachuca water umbel. Successful implementation of these measures will help ensure that water quality remains within applicable standards, but we note that the tolerance of Huachuca water umbel to metals, changes in acidity/basicity, and other factors is not known.

The Cienega Creek Watershed conservation measure contains two elements: (1) severance and transfer of water rights; and (2) establishment of the Cienega Creek Watershed Conservation Fund. The program commits to: (1) transfer 150 acre-feet of water rights to a suitable entity for *in situ* use to preserve and enhance the aquatic and riparian ecosystem use in the upper Cienega Creek watershed area and an additional 100 acre-feet to Pima County for similar uses within the Cienega Creek Preserve; (2) transfer 825 acre-feet per annum to aquifer recharge and riparian restorations downstream from Pantano Dam (at which point lower Cienega Creek becomes Pantano Wash); and (3) make annual payments of $200,000 for 10 years to a Conservation fund managed and controlled by the AGFD or other designated conservation partner.

The Cienega Creek Watershed program may eventually have appreciable value in conserving Huachuca water umbel if the effort results in the retention of water in occupied areas. The mitigative value of the water rights- related component of the conservation measure must be considered speculative at this time, as the action depends on the successful navigation of complex administrative and legal proceedings involving the Arizona Department of Water Resources, AGFD, BLM, and, potentially, other permitted and certificated water rights holders. Recognizing this uncertainty, the Rosemont may require until January 1, 2016, to fully implement this proposed conservation measure.

The proposed establishment and funding of the Cienega Creek Watershed Conservation Fund is anticipated to be beneficial to Huachuca water umbel, but its exact mitigative value is prospective and cannot be ascertained in advance. We presume that actions beneficial to the aquatic environment in which Huachuca water umbel occur will be implemented, and while we cannot know if such actions will be implemented, we note that reestablishment of Huachuca water umbel is feasible (Environment and Natural Resource Division 2012). Similarly, the anticipated 3,000 linear feet of surface flow that will be made available below Pantano Dam may permit the establishment of a Huachuca water umbel metapopulation, though it is not clear if Cienega Creek Watershed Conservation Fund monies could be applied at this downstream site.

Rosemont has also acquired the right to purchase approximately 1,200 acres of land along Sonoita Creek with approximately 590 acre-feet of certificated surface water rights from Monkey Spring along Sonoita Creek. These lands and appurtenant water rights will be protected in perpetuity and made available to the AGFD or other suitable land trust or conservation organization. As is the case with Cienega Creek, above, the site, if deemed biologically appropriate, could provide a site for establishment of Huachuca water umbel. Given the current lack of specific plans to restore and maintain Huachuca water umbel at this site, we must also consider the mitigative value of this conservation measure to be somewhat speculative.

Cumulative Effects - Huachuca Water Umbel

The Cumulative Effects sections for the Gila chub and southwestern willow flycatcher are incorporated herein via reference. In brief, of the cumulative actions relevant to the proposed action, we are primarily concerned with the withdrawal of groundwater from wells in vicinity of Cienega Creek, Sonoita, and Elgin.

Conclusion - Huachuca Water Umbel

The magnitude of the proposed action's adverse effects is difficult to ascertain in light of natural variability and uncertainties regarding baseline conditions that may change independently from the effects of the proposed action change over time, but all three groundwater models indicate that the proposed action will result in a small – but measurable - downward trend in groundwater availability and surface discharges. We anticipate that an indeterminate number of individual Huachuca water umbel patches will fail to persist in Cienega Creek and Empire Gulch over time, and that Huachuca water umbel metapopulations will be reduced in extent at the scale of the stream reach. It is, however, unlikely that the proposed action will result in large reductions of perennial stream reaches in the action area and thus, Huachuca water umbel is unlikely to be extirpated from the Cienega Creek watershed. Lastly, the mitigative value of the proposed conservation measures is currently speculative, but could result in the restoration of Huachuca water umbel to new sites and long-term protection of stream flows.

After reviewing the current status of Huachuca water umbel, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the proposed Rosemont Mine project is not likely to jeopardize the continued existence of the species. Our rationale for this conclusion is as follows:

1. Modeled declines groundwater elevation will result in decrease in stream length, wetted perimeter and baseflows in the Cienega Creek Watershed at time scales varying from 20 to 1,000 years. If groundwater model results and the associated deceases in stream length and baseflow are valid, these losses will be potentially severe in Empire Gulch, minimal in the upper and low reaches of the mainstem of Cienega Creek, and will reduce the vigor and extent of Huachuca water umbel in the affected areas.
2. These effects to Huachuca water umbel are not likely to jeopardize the species because it occurs elsewhere in the Santa Cruz, San Pedro, and Yaqui river watersheds in sites unaffected by the proposed action.
3. The relatively wide distribution of the Huachuca water umbel within distinct watersheds and the low likelihood that the proposed action will extirpate the species entirely from the Cienega Creek watershed mean that the proposed action is unlikely to preclude recovery.
4. Rosemont will monitor water quality and quantity as well as channel geometry within Davidson Canyon Wash (a tributary to Cienega Creek), any or all of which may help validate model results and provide advanced notice for unforeseen effects to the aquatic environment. Unforeseen effects to aquatic and riparian ecosystems may necessitate reinitiation of formal consultation.
5. Rosemont will sever and transfer downstream senior water rights to upstream reaches of Cienega Creek by no later than January 1, 2016. If successfully executed, these *in situ* water rights may be employed to protect against future diversions of surface water by junior appropriators. Rosemont will also fund a conservation program to implement to-be-determined projects within the Cienega Creek watershed. If the water rights cannot be successfully severed and transferred, reinitiation of formal consultation may be warranted.
6. Rosemont has also acquired the rights to purchase the Sonoita Creek Ranch and, upon transfer to the AGFD or other suitable entity, the site will undergo aquatic, wetland, and riparian restorations. These projects will be vetted by FWS and other appropriate entities, and may include the reestablishment of Huachuca water umbel**.**

7. Critical habitat has been designated for Huachuca water umbel, but none is present in the action area. Critical habitat will not be affected nor will that critical habitat's ability to function in the recovery of the species be impaired.

INCIDENTAL TAKE STATEMENT - HUACHUCA WATER UMBEL

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

Conservation Recommendations - Huachuca Water Umbel

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the FS participate in recovery planning efforts for the Huachuca water umbel. We will be preparing a recovery plan in the near future and would like to incorporate agency expertise.
2. We recommend that the FS continue with its ongoing efforts to arrest erosion and restore ecosystems on streams on the Coronado National Forest within which Huachuca water umbel occurs.
3. We recommend that the FS participate in genetic studies, such as those underway by Fort Huachuca, in order to determine population and metapopulation dynamics of Huachuca water umbel throughout its range.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

Effects to Riparian Ecosystems

This section includes an analysis of the effects of the proposed action on riparian ecosystems. The southwestern willow flycatcher is an obligate riparian bird and the Huachuca water umbel is a semi-aquatic plant that occurs in streams and riparian areas; the analyses contained herein are incorporated via reference into the respective species' analyses.

Effects to the riparian ecosystems must be based on a classification system. Riparian vegetation may be classified in various ways. Brown (1982), National Wetlands Inventory (2013) methods are widely applied, but available maps are outdated and are of insufficiently fine resolution to be applicable to the action area. Three sources of riparian mapping are available for the area of analysis: Pima County, the Forest Service, and WestLand Resources Inc. (the latter conducted on behalf of Rosemont Copper). Each source represents different techniques, definitions, and geographic coverage. The Draft EIS used a combination of these mapping sources, primarily relying on mapping by WestLand Resources Inc. for the mine site and on Pima County mapping to define hydroriparian and mesoriparian areas elsewhere along major stream corridors.

The Coronado NF considered both public comments and input from cooperating agencies regarding riparian classification and has determined to employ the Pima County riparian mapping source in the eventual Final EIS. The Forest Service's own mapping coverage was considered too limited in geographic extent and largely ignored xeroriparian areas. The Pima County mapping was largely based on remote photographic analysis and generally encompassed a wider swath along washes than the mapping efforts conducted by WestLand Resources Inc., which were based in part on field surveys. However, the underlying purpose of the Pima County riparian mapping was to identify corridors of overall wildlife habitat, whereas the site-specific mapping by WestLand Resources Inc. focused on identifying the extent of specific vegetation species. Determining the presence of wider habitat corridors and their impact to biological resources was one of the primary purposes of analyzing impacts to riparian vegetation for NEPA purposes, and this largely informed the Coronado NF's decision to select the Pima County mapping. Use of the Pima County mapping offers three benefits: an appropriate focus on habitat corridors, consistency across the area of analysis, and extensive geographic coverage. It is for these reasons that we have adopted the same riparian classification method in this BO.

It is recognized that discrepancies have arisen between the Pima County and WestLand Resources, Inc. mapping efforts. WestLand Resources Inc. (2010) noted that Pima County mapping overestimated riparian resources 86% of the time in 43 riparian area widths measured in Barrel and Scholefield Canyons. These differences in acreage were determined by the Coronado NF to be acceptable for NEPA analysis, given the different criteria used by Pima County. However, in several reaches of Barrel and Davidson Canyons, discrepancies were also evident concerning the overall species types indicated by Pima County mapping and those observed in the field by WestLand Resources Inc. In these cases, acreages were not been changed, but the overall type of habitat was reinterpreted from that used by Pima County. For the purposes of the analyses contained in this BO, the areal extent of impacts to riparian vegetation represents the maximum anticipated effect of the proposed action.

The Supplemental BA, using Pima County mapping, states that there are a total of approximately 22,114 acres of riparian vegetation in the action area. These vegetation communities are present in drainages within the action area and along downstream portions of Box, McCleary, Sycamore, Scholefield, Wasp, Barrel, Davidson, and Gardner Canyons; Empire Gulch; and Cienega Creek. In addition to the riparian vegetation listed below as occurring in riparian areas in the action area, Emory oak, Mexican blue oak, and Arizona white oak are common in Box, McCleary, Sycamore, Scholefield, Wasp, and Barrel Canyons. Further, while many springs support some individuals of species considered to indicate hydroriparian habitat, only two springs had mappable areas of hydroriparian vegetation: Scholefield No. 1 spring supports about 0.3 acre of wetland, and Fig Tree spring supports about 0.5 acre of riparian habitat, with a very limited wetland area. These water sources provide habitat for aquatic species within the action area. Pima County's riparian mapping source is used for this project, and the following riparian habitat types are mapped within the action area (Pima County 2012).

Hydroriparian

Hydroriparian habitats are mesic (wet) in nature, and generally associated with perennial watercourses and/or springs. Plant communities are dominated by obligate or preferential wetland plant species such as Goodding's willow (*Salix gooddingii*) and Fremont cottonwood (*Populus fremontii*) and also include velvet ash (*Fraxinus velutina*), seep willow (*Baccharis salicifolia*), Arizona walnut (*Juglans major*), tamarisk or salt cedar (*Tamarix* spp.), and mesquite (*Prosopis* spp.). The cottonwood/willow forest is a typical example of this habitat type. The following drainages and associated riparian habitat contain stretches that are mapped as hydroriparian: Cienega Creek, Gardner Canyon, Empire Gulch, Davidson Canyon, and Barrel Canyon. Approximately 7,332 acres of hydroriparian habitat are located within the action area. Note that field analysis indicates that Barrel Canyon likely does not represent hydroriparian habitat despite being mapped as such; no perennial water sources are present, nor are any individuals of the types of species (cottonwood/willow) that indicate hydroriparian habitat present, based on field observations. Rather, the riparian areas of Barrel Canyon are better classified as xeroriparian habitat.

Aquatic vegetation that is unique to the springs and seeps is present within the action area. Vegetation at these springs and seeps includes obligate wetland plants (i.e., almost always occur under natural conditions in wetlands) such as seep monkey flower (*Mimulus guttatus*) and water speedwell (*Veronica anagallis-aquatica*), along with facultative wetland plants (i.e., usually occur in wetlands, but occasionally found in nonwetlands) such as smooth horsetail (*Equisetum laevigatum*) and Arizona giant sedge (*Carex spissa* var. *ultra*). Other riparian plant species documented at springs and seeps in the action area include sycamore (*Plantanus wrightii*), willow (*Salix* spp.), netleaf hackberry (*Celtis reticulata*), and deergrass (*Muhlenbergia rigens*). Within the action area, moist soil or surface water (both lentic and lotic systems) and associated aquatic vegetation are known to occur at the several springs (e.g., Deering, Upper Empire Gulch, Fig Tree, Mudhole, Oak, Ojo Blanco, Rosemont, Scholefield No. 1, Sycamore, and Water Develop) (WestLand 2011g, 2012a). Areas of aquatic habitats are too small to map; therefore, they do not appear in Figure 6 of the Supplemental BA (Figure I-4 in this document).

Xeroriparian

Xeroriparian habitats are located in xeric (dry) sites, and are generally associated with an ephemeral water supply unconnected to discharges from a regional aquifer. These communities typically contain plant species also found in upland habitats; however, these plants are typically larger and/or occur at higher densities than adjacent uplands. Approximately 14,782 acres of xeroriparian habitat are located within the action area. Xeroriparian habitat is further divided into four subclasses to reflect the amount of vegetation present. Pima County Regional Flood Control District's Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines (Pima County Regional Flood Control District 2011) define the xeroriparian subcategories as follows:

- **Xeroriparian A:** The most dense xeroriparian subcategory with a Total Vegetative Volume Greater than 0.856 cubic meters per square meter (m^3/m^2). Xeroriparian A habitat is present in stretches of Cienega Creek, Empire Gulch, and Davidson Canyon where vegetation consists of mesquite and netleaf hackberry. Approximately 145 acres of xeroriparian A habitat are located within the action area.
- **Xeroriparian B:** Moderately dense xeroriparian subcategory with a Total Vegetative Volume less than or equal to 0.856 m^3/m^2 and greater than 0.675 m^3/m^2. Xeroriparian B habitat is present in stretches of Cienega Creek, Gardner Canyon, Empire Gulch, Davidson Canyon, and Barrel Canyon where vegetation consists of mesquite, scattered cottonwood, netleaf hackberry, burrobrush (*Hymenoclea monogrya*), juniper (*Juniperus* sp.), and acacia (*Acacia* spp.). Approximately 7,122 acres of xeroriparian B habitat are located within the action area.
- **Xeroriparian C:** Less dense xeroriparian subcategory with a Total Vegetative Volume less than or equal to 0.675 m^3/m^2 and greater than 0.500 m^3/m^2. Xeroriparian C habitat is present in stretches of Cienega Creek, Gardner Canyon, Empire Gulch, and Davidson Canyon where

vegetation consists of mesquite, desert broom (*Baccharis sarothroides*), burrobrush, desert willow (*Chilopsis linearis*), hackberry (*Celtis* sp.), and juniper. Approximately 7,341 acres of xeroriparian C habitat are located within the action area.

- **Xeroriparian D:** Less dense to sparse plant density xeroriparian subcategory that provides hydrologic connectivity to other riparian habitat areas with a Total Vegetative Volume less than or equal to 0.500 m^3/m^2. Xeroriparian D habitat is present in stretches of Cienega Creek and Davidson Canyon where vegetation consists of acacia and desert broom. Approximately 174 acres of xeroriparian D habitat are located within the action area.

Table R-1, below, summarizes the acreages of riparian vegetation within the affected streams, using the reach-by-reach classification found in Figure A-1 in the Effects to Aquatic Ecosystems section.

Table R-1. Riparian affected environment adapted from SWCA (2012)

Reach Name	Acres	Pima County Class	Dominant Riparian Plants
Cienega Creek 1	695.13	Hydroriparian	Cottonwood and Goodding's willow**
Cienega Creek 1	364.69	Xeroriparian B	Large mesquites and scrub mesquites with scattered cottonwoods**
Cienega Creek 2	2,086.96	Hydroriparian	Mature cottonwood and Goodding's willow**
Cienega Creek 2	323.98	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 2	65.58	Xeroriparian C	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 3	382.27	Hydroriparian	Mature cottonwood and Goodding's willow with young velvet ash**
Cienega Creek 3	35.88	Xeroriparian B	Mesquite and netleaf hackberry**
Cienega Creek 3	126.96	Xeroriparian C	Mesquite with desert broom and burrobrush**
Cienega Creek 3	0.78	Xeroriparian D	Acacia, desert willow, ironwood paloverde, mesquite, soapberry*
Cienega Creek 4	11.15	Xeroriparian A	Mature mesquite and netleaf hackberry**
Cienega Creek 4	179.52	Xeroriparian B	Mesquites with burrobrush**
Cienega Creek 4	656.81	Xeroriparian C	Less dense mesquites with burrobrush**
Cienega Creek 4	38.58	Xeroriparian D	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 4	2138.93	Hydroriparian	Mature cottonwoods and ash with some Goodding's and seep willow**
Cienega Creek 5	4.86	Xeroriparian A	Mesquite**
Cienega Creek 5	21.75	Xeroriparian B	Mesquites with burrobrush**
Cienega Creek 5	168.15	Xeroriparian C	Less dense mesquites with desert broom and burrobrush**
Cienega Creek 5	49.91	Xeroriparian D	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 5	463.95	Hydroriparian	Cottonwood and willow gallery forest**
Gardner Canyon 1	422.26	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Gardner Canyon 1	381.08	Xeroriparian C	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Gardner Canyon 1	523.96	Hydroriparian	Cottonwood, willow, seepwillow, sycamore, hackberry*
Gardner Canyon 2	129.29	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Gardner Canyon 2	121.51	Hydroriparian	Cottonwood, willow, seepwillow, sycamore, hackberry*
Empire Gulch	86.00	Xeroriparian A	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	631.39	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	127.90	Xeroriparian C	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	407.46	Hydroriparian	Large cottonwood willow gallery**
Davidson Canyon 1	84.03	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Davidson Canyon 1	99.20	Hydroriparian***	Large ash trees**
Davidson Canyon 2	355.61	Xeroriparian B	Mesquites, hackberry**
Davidson Canyon 2	31.23	Xeroriparian C	Small mesquites, desert willow**
Davidson Canyon 2	33.95	Xeroriparian D	acacia, desert broom**
Davidson Canyon 2	570.38	Hydroriparian***	Seep willow, Arizona walnut, cottonwood**
Davidson Canyon 3	0.50	Xeroriparian B	Juniper**
Davidson Canyon 3	28.93	Xeroriparian C	Mesquite, hackberry**
Davidson Canyon 3	26.21	Xeroriparian D	Desert broom, acacia**
Davidson Canyon 3	71.05	Hydroriparian***	Willows, ash, tamarisk**
Davidson Canyon 4	5.71	Xeroriparian A	Large mesquite, hackberry**
Davidson Canyon 4	5.05	Xeroriparian B	Mesquite**
Davidson Canyon 4	50.42	Xeroriparian C	Small mesquite, juniper**
Davidson Canyon 4	3.27	Xeroriparian D	Desert broom, acacia**
Davidson Canyon 4	174.78	Hydroriparian	Willows, ash, tamarisk, and cottonwood**
Barrel Canyon 1	192.54	Hydroriparian***	Large mesquites, oak, juniper, desert willow, sumac**
Barrel Canyon 1	21.74	Xeroriparian B	Small mesquites, juniper, hackberry**

Barrel Canyon 2	12.39	Hydroriparian***	Seep willow**
Total Hydroriparian	**7,940.51**		
Total Xeroriparian A	**107.72**		
Total Xeroriparian B	**2,575.69**		
Total Xeroriparian C	**1,637.06**		
Total Xeroriparian D	**152.7**		
* From generic Pima County habitat type descriptions (CITE PIMA COUNTY RIPARIAN APPENDIX).			
** From actual field observations (WestLand Resources Inc. 2010, 2012a).			
*** The Pima County habitat designation does not match field descriptions of species types; for purposes of analysis, these areas are considered xeroriparian/mesoriparian instead of hydroriparian			

General Effects to Riparian Ecosystems

The proposed action will affect riparian systems via the withdrawal of groundwater from the aquifer that sustains portions of springs and streams as well as by alterations in surface runoff patterns within the watershed of the streams. In addition, there may be some effect to mountain front recharge (and subsequent discharge to streams and riparian vegetation) due to the pit and infrastructure. The hydrologic basis for these effects is discussed in detail within the Effects to Aquatic Ecosystems section, and is incorporated herein via reference.

The effect of increased depth to groundwater on riparian vegetation has been investigated by Stromberg *et al*. (1996), Scott *et al*. (1999), Horton *et al*. (2001b), and Merritt and Bateman 2012. Others have investigated riparian response to spatial variations in groundwater depth (i.e. as stream courses changed from perennial to intermittent along their course) (Leenhouts *et al*. 2005, Stromberg *et al*. 2005; Stromberg *et al*. 2007a and 2007b), or changes resulting from the operation of impoundments (Horton *et al*. 2001a, Shafroth *et al*. 2002). It is also important to note that riparian vegetation tends to develop in response to local conditions; communities that exist in sites with highly variable alluvial groundwater levels tend to have rooting depths capable of withstanding relatively larger variations in groundwater level than sites where groundwater elevations are more consistent (Shafroth *et al*. 2000). The streams in the action area exhibit high variability. The variation was described by SWCA (2012), and was summarized in the Effects to Aquatic Ecosystems section.

It is difficult to apply these prior investigations' quantitative results directly to the action area, but one key finding is that increasing depths to groundwater will eventually result in downgrades of a given sites' riparian community (i.e., hydroriparian communities would suffer decreased vigor and extent, eventually transitioning to a xeroriparian community). It is also possible that the groundwater declines resulting from the proposed action, while seemingly minor, will increase current or future levels of hydrologic variation to the point that present-day riparian communities cannot perpetuate themselves.

Maintenance of existing stands of cottonwood and/or willow forests requires the presence of relatively shallow groundwater. Lite and Stromberg (2005) found that cottonwood and Goodding's willow plants were able to compete successfully with non-native saltcedar plants when the maximum depth to groundwater was less than or equal to 8 feet. Leenhouts *et al*. (2005) found that cottonwoods and willow forests on the upper San Pedro River were dense and multiaged among sites where annual maximum ground-water depths averaged less than about 3 meters (9.8 feet) (and where streamflow permanence was greater than about 60 percent, and intra-annual ground-water fluctuation was less than about 1 meter). Others have found the ideal depth appears to be approximately 3 to 5 feet, depending on the species and soil conditions at the site (Parametrix 2008). Cottonwood and willow growth and survival suffer from water stress when groundwater declines below key depth thresholds, particularly if the declines are rapid; the proposed action's effects do not exhibit such immediacy. Seasonal declines of 1 meter have caused mortality of saplings of cottonwood and willow (Shafroth *et al*. 2000). Mature cottonwood trees have been killed by abrupt, permanent drops in the water table of 1 meter, with lesser declines (0.5 meter) reducing stem growth (Scott *et al*. 1999, 2000).

The aforementioned depths to groundwater were in reference to the needs of mature willows and cottonwoods. The recruitment of new individuals requires near-surface levels of groundwater during seed germination, followed by a relatively gradual decline in depth that allows roots to pursue the retreating alluvial groundwater. Leenhouts *et al*. (2005) state that manner in which cottonwoods and willows become established is linked to flood flow hydrology. Both species are relatively short-lived (about 100 to 150 years) and have vernally adapted reproduction strategies. Conditions for establishment are not consistently favorable at any given location year after year, so cohorts of these trees establish only during occasional favorable years. The timing of floodflows is critical, as both species produce seeds that are viable during the relatively brief period when high spring flows are usually declining and exposing base, damp sediments (Fenner *et al*. 1984). A typical pattern is for fall or winter floods to scour and redeposit flood-plain sediments, creating potential seed beds for these plants to establish without competition from an existing overstory; seed beds are then moistened by elevated (flood flows). Goodding's willow disperses seeds somewhat later in the season than does cottonwood (although the dispersal periods overlap) and, as the flood waters recede, establishes on sites that are lower and closer to the stream.

The rates of flood-water recession (i.e. the descending limb of the hydrograph) and subsequent decline in alluvial water table elevation influence seedling survival in Fremont cottonwood, Goodding's willow and other *Populus* and *Salix* species. During spring when flood waters are receding and seedlings are establishing on sediment bars, ground-water declines of greater than 1 to 3 centimeters per day can cause seedling death (Segelquist *et al.* 1993, Mahoney and Rood, 1998, Shafroth *et al.* 1998, Amlin and Rood 2002). Rood and Mahoney (1990) and Tyree *et al*. (1994) found that gradual decline of stream discharge after flooding allowed cottonwood seedlings' root systems to maintain contact with the ground water and avoid cavitation (gaps in the water flowing within xylem). In locations where the proposed action will appreciably reduce groundwater elevations beneath streams, we would expect the descending limb of spring hydrographs to steepen (declining less gradually), as discharge-driven channel recharge would first need to saturate a greater volume of alluvium relative to the more well-saturated alluvium present in an unaffected stream.

Sustained ground-water declines throughout the summer to depths greater than 1 or 2 meters below land surface (depending on soil texture, weather, and species) also can preclude establishment of the new cohort (Kalischuk *et al.* 2001, Amlin and Rood 2002). Willow seedlings are less tolerant of water-table decline than cottonwood seedlings (and more tolerant of inundation) and show greatest growth under no water-table decline (continually saturated soils; Horton and Clark, 2001, Amlin and Rood 2002).

Merritt and Bateman (2012) examined Cherry Creek, a central Arizona tributary of the upper

Salt River, and modeled changes in riparian vegetation as a result of increasing the depth of groundwater from the surface. The relative frequency of riparian forest to shrubland decreased significantly as a function of increasing depth to groundwater, ranging from 58 percent (%) at base groundwater level to 5% at 6.6 feet (2 meters) below base level. A simulated groundwater decline of 6.6 feet (2 meters) below base level resulted in a nearly complete loss of riparian forest and conversion of the valley bottom to shrubland. Predicted loss of riparian forest averaged 4% per 4 inches (.33 feet) (10 centimeters) of groundwater decline.

We are aware of the difference in time scales between the aforementioned studies and the temporal progression of the modeled effects of the proposed action. Some of the referenced investigations were intra-annual and none were performed over the up-to-1,000-year terms of the modeling for the proposed action. Again, we refer to Shafroth *et al*. (2000), which would seem to indicate that riparian vegetation communities could adapt to a slow progression of groundwater elevation over a lengthy time period (as is often the case in the reach-specific sections, below), provided that maximum depths to groundwater were not exceeded.

Gardner Canyon

As stated in the Effects to Aquatic Ecosystems section, and under the maximum modeled effect scenario, Gardner Canyon is anticipated to experience regional aquifer drawdowns of < 0.1 foot from the cessation of mining until 50 years later (Tetra Tech 2010) (see Gardner/Cienega Confluence data in Table A-5). At 150 and 1,000 years after mining, the effect to Gardner Canyon increases to 0.2 foot and 0.5 foot, respectively. The groundwater drawdowns in the aquifer supplying Gardner Canyon are not likely to be solely capable of measurably reducing the extent or health of the approximately 645 acres of hydroriparian and 933 acres of xeroriparian (Classes B and C) vegetation in Reaches 1 and 2 of Gardner Canyon, but will be additive to other effects, primarily drought and long-term climate change.

Empire Gulch

The proposed action will measurably affect the hydrology of Empire Gulch at the Upper Empire Gulch Springs site (see Upper Empire Gulch Springs data in Table A-5). Effects are modeled to range from 0.1 foot of drawdown upon cessation of mining to 0.2 foot at 20 years, 0.5 foot at 50 years, 2.5 feet at 150 years, and 6 feet at 1,000 years (Tetra Tech 2012). As stated in the Effects to Aquatic Ecosystems section, the spring-fed nature of the stream within Empire Gulch is relatively more vulnerable to alterations in the groundwater conditions that sustain the spring discharges. The appreciable groundwater drawdowns discussed above will likely reduce the resilience of ground- and surface water-dependant vegetation in the near term (0 to 20 years). The appreciably increased depths to groundwater and diminished surface flows anticipated to occur in the 150 to 1,000-year timeframe will have more serious, deleterious effects.

The groundwater declines resulting from the proposed action are likely to diminish surface flows in Empire Gulch and cause mortality and/or a downward community transition of some portion of the stream's approximately 407 acres of hydroriparian vegetation. The lost hydroriparian vegetation may be replaced by xeric species, resulting in an increase in the 845 acres of Class A, B, and C xeroriparian vegetation present in Empire Gulch. There is also the potential that some portions of existing xeroriparian vegetation that are partially replying on alluvial groundwater will suffer educed vigor.

Lastly, the current depth to groundwater in Empire Gulch in areas mainted by spring discharge (but not immediately adjacent to the spings) is not known. If ongoing drought has already resulted in decreased groundwater elevations (as might be anticipated from reduced spring discharges), mortality thresholds for riparian plants could be exceeded appreciably sooner and/or the aerial extent of effects could be greater.

Upper Cienega Creek

Upper Cienega Creek in Reaches 1, 2, and 3, contains approximately 3,164 acres of hydroriparian vegetation. This riparian community will be affected by modeled drawdowns of <0.1 foot from the end of mining and at 20 and 150 years later. Drawdowns reach 0.25 feet and 0.5 feet at 150 and 1,000 years, respectively. Upper Cienega Creek's 917 acres of xeroriparian vegetation in Classes B, C, and D may increase in extent as it replaces lost hydroriparian vegetation, though some effects to xeroriparian plant species facultatively using alluvial groundwater might also occur.

Table A-2, which appears in the Upper Cienega Creek subsection of the Effects to Aquatic Ecosystems section, displays a decrease in riparian evapotranspiration (ET) of 51 acre feet per annum (AFA) at 1,000 years. The decreased riparian ET corresponds to a loss of riparian vegetation, though we cannot determine if the loss would be the result of mortality, conversion to more xeric types, or a combination of the two.

Barrel Canyon

As stated in the Effects to Aquatic Ecosystems section, the proposed action will affect Barrel Canyon primarily by the placement of tailings in the stream channel and its watershed, which will reduce surface runoff by approximately 17.2 percent over the long term. The largest effects will occur prior to the implementation of concurrent reclamation activities.

Barrel Canyon contains approximately 205 acres of hydroriparian and 22 acres of Class-B xeroriparian vegetation, though SWCA (2012) noted that the areas mapped as hydroriparian were more xeric and should likely be classified as xeroriparian.

Davidson Canyon Wash

Tetra Tech (2012) modeled drawdowns of less than 0.1 foot for all time steps from 0 to 1,000 years. We therefore anticipate no measurable effects to the approximately 915 acres of hydroriparian vegetation and 625 acres of xeroriparian vegetation in classes A, B, C, and D located in Reaches 1, 2, 3, and 4 of Davidson Canyon Wash.

The Effects to Aquatic Ecosystems section discusses the effects of changed runoff patterns in Davidson Canyon Wash. The stream's upper watershed will be subject to altered surface water runoff patterns due to the aforementioned placement of tailings and stormwater retention in Barrel Canyon and retention of stormwater within the mine site. SWCA (2012) extrapolated a 4.3 percent reduction in runoff in the lower reaches of Davidson Canyon Wash. The effect of this small, but measurable reduction in runoff on the recruitment, retention, and succession of riparian communities is difficult to predict, particularly because the 4.3 percent reduction is in average annual yield, which cannot describe discharge-based effects during crucial, low flow periods.

Lower Cienega Creek

Lower Cienega Creek (Reaches 4 and 5 in Figure A-1) supports approximately 2,603 acres of hydroriparian and 1,131 acres of Class A, B, C, and D xeroriparian vegetation. Tetra Tech (2012) modeled groundwater drawdowns of <0.1 foot at the USGS stream gage in Reach 5 (09484560) for all time steps from the cessation of mining to 1,000 years. Drawdowns of such low magnitude, absent other effects, are not anticipated to affect riparian vegetation.

Reach 5, which we again note is downstream of the Davidson Canyon Wash confluence, is nevertheless anticipated to experience the full suite of the proposed action's accumulated, adverse effects. While recognizing the potential for these effects, the fate of diminished surface flows is uncertain, as infiltration and/or riparian evapotranspirative losses vary spatially and temporally. The effects have nevertheless been modeled and represent the best available information.

The effects to riparian vegetation in lowermost Cienega Creek include all drawdown-driven surface flow alterations in upstream reaches (and in Empire Gulch in particular) as well as runoff reductions from the placement of tailings within the upper reaches of Barrel Canyon. Pima County's estimation that Davidson Canyon subflow contributes 8 to 24 percent of baseflow in Reach 5 of Cienega Creek and SWCA's (2012) interpolation that the subflow reduction could be approximately from 0.3 to 1.0 percent percent makes it reasonable to anticipate at least limited effects to riparian vegetation in the lowermost reaches of Cienega Creek (Reach 5). We refer to Table A-3 in the Lower Cienega Creek subsection of the Effects to Aquatic Ecosystems section, wherein Montgomery [(2010, cited in SWCA (2012)] predicted a 221 afa decrease in riparian ET in lower Cienega Creek 1,000 years after mining.

Westland (2012b) conducted an analysis of existing data pertaining to depth to groundwater and surface flows in a reach of lower Cienega Creek to determine the degree to which impoundment of surface runoff at the mine site and the modeled drawdowns might affect surface flows in lower Cienega Creek. The findings of Westland (2012x) are that there will be an estimated, immediate reduction of approximately 24 linear feet of wetted stream in lower Cienega Creek as a result of reduced runoff from areas impounded by the mine (and the stormwater capture within). After 100 years, an additional 88 feet of wetted stream, for a total of 112 feet, of lower Cienega Creek could be lost due to groundwater drawdown. Should regional drought conditions persist, these changes would be in addition to the ongoing reductions in stream flow extent measured by the Pima Association of Governments (2012).

We caution that reduction in the length of wetted channel does not necessarily characterize the potential full extent of riparian effects. Surface flows in alluvial reaches of Cienega Creek exist in locations where the thalweg (deepest part) of the stream intersects the alluvial water table. A longitudinal contraction in surface flows would necessarily be accompanied by a more-lengthy, longitudinal reduction in shallow, subsurface flows, with alluvial groundwater in some areas potentially dropping below critical depths for emergent, shallow-rooted plants, herbaceous shrubs, as well as broadleaf riparian trees.

The longitudinal contraction in surface flows would also be accompanied by a narrowing of the riparian strand and/or a transition to more xeric types (i.e. tamarisk, desert broom, etc.). The diminished lateral extent of shallow groundwater would also reduce the wetted perimeter of the stream. Stream top-width is a useful surrogate for wetted perimeter, and such a narrowing of a stream can be expected to result in vegetative recruitment encroaching closer to the centerline of the channel. This is problematic since the proposed action will leave flood flows in reaches above Davidson Canyon Wash largely unaffected. Vegetation that establishes itself in a narrowed low-flow channel is likely to be subject to scouring from the still-intact peak flows. Flood scour could be further exacerbated if vegetative communities suffer mortality sufficient to reduce streambank stability.

Status of the Species – Southwestern Willow Flycatcher

A complete description of the biology of the southwestern willow flycatcher (*Empidonax traillii extimus*) is contained in the *Southwestern Willow Flycatcher Recovery Plan* (FWS 2002); a summary of the information appears below.

Description

The southwestern willow flycatcher is a small grayish-green passerine bird (Family Tyrannidae) measuring approximately 5.75 inches. The song is a sneezy "fitz-bew" or a "fit-a-bew", the call is a repeated "whit." It is one of four currently recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993). It is a neotropical migrant that breeds in the southwestern U.S. and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Stiles and Skutch 1989, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The historical breeding range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987).

Listing and Critical Habitat

The southwestern willow flycatcher was listed as endangered, without critical habitat on February 27, 1995 (FWS 1995). Critical habitat was later designated on July 22, 1997 (FWS 1997a). A correction notice was published in the Federal Register on August 20, 1997 to clarify the lateral extent of the designation (FWS 1997b).

On May 11, 2001, the 10th circuit court of appeals set aside designated critical habitat in those states under the 10th circuit's jurisdiction (New Mexico). The FWS decided to set aside critical habitat designated for the southwestern willow flycatcher in all other states (California and Arizona) until it could re-assess the economic analysis.

On October 19, 2005, the FWS re-designated critical habitat for the southwestern willow flycatcher (FWS 2005). A total of 737 river miles across southern California, Arizona, New

Mexico, southern Nevada, and southern Utah were included in the final designation. The lateral extent of critical habitat includes areas within the 100-year floodplain.

On August 15, 2011, the FWS proposed a revision to the critical habitat designation, identifying stream segments in each of the 29 Management Units where there are recovery goals (FWS 2011). These segments totaled 2,090 stream miles. Similar to the 2005 rule, the lateral extent of critical habitat includes only the riparian areas within the 100-year floodplain. About 790 stream miles were identified as areas we will consider for exclusion from the final designation under section 4(b) (2) of the ESA.

The 2005 critical habitat designation remained in place until the final rule was published on January 3, 2013 (78 FR 344). The final rule designated approximately 208,973 acres of streams and riparian areas within the 100-year floodplain or flood-prone areas along approximately 1,975 stream miles in California, Nevada, Utah, Colorado, Arizona, and New Mexico.

A final recovery plan for the southwestern willow flycatcher was signed by the FWS Southwestern Region Director and released to the public in March, 2003 (FWS 2002). The Plan describes the reasons for endangerment, current status of the flycatcher, addresses important recovery actions, includes detailed issue papers on management issues, and provides recovery goals. Recovery is based on reaching numerical and habitat related goals for each specific Management Unit established throughout the subspecies range and establishing long-term conservation plans (FWS 2002).

Habitat

The southwestern willow flycatcher breeds in dense riparian habitats from sea level in California to approximately 8,500 feet in Arizona and southwestern Colorado. Historical egg/nest collections and species' descriptions throughout its range describe the southwestern willow flycatcher's widespread use of willow (*Salix* spp.) for nesting (Phillips 1948, Phillips *et al*. 1964, Hubbard 1987, Unitt 1987). Currently, southwestern willow flycatchers primarily use Geyer willow (*S. geyeriana*), coyote willow (*S. exigua*), Goodding’s willow (*S. gooddingii*), boxelder (*Acer negundo*), saltcedar (*Tamarix* sp.), Russian olive (*Elaeagnus angustifolio*), and live oak (*Quercus agrifolia*) for nesting. Other plant species less commonly used for nesting include: buttonbush (*Cephalanthus* sp.), black twinberry (*Lonicera involucrata*), cottonwood (*Populus* spp.), white alder (*Alnus rhombifolia*), blackberry (*Rubus ursinus*), and stinging nettle (*Urtica* spp.). Based on the diversity of plant species composition and complexity of habitat structure, four basic habitat types can be described for the southwestern willow flycatcher: monotypic willow, monotypic exotic, native broadleaf dominated, and mixed native/exotic (Sogge *et al*. 1997).

The flycatcher’s habitat is dynamic and can change rapidly: nesting habitat can grow out of suitability; saltcedar habitat can develop from seeds to suitability in about four to five years; heavy runoff can remove/reduce habitat suitability in a day; or river channels, floodplain width, location, and vegetation density may change over time. The flycatcher’s use of habitat in different successional stages may also be dynamic. For example, over-mature or young habitat not suitable for nest placement can be occupied and used for foraging and shelter by migrating, breeding, dispersing, or non-territorial southwestern willow flycatchers (McLeod *et al*. 2005, Cardinal and Paxton 2005). Flycatcher habitat can quickly change and vary in suitability, location, use, and occupancy over time (Finch and Stoleson 2000).

Tamarisk is an important component of the flycatcher's nesting and foraging habitat in the central part of the flycatcher's breeding range in Arizona, southern Nevada and Utah, and western New Mexico. In 2001 in Arizona, 323 of the 404 (80 percent) known flycatcher nests (in 346 territories) were built in a tamarisk tree (Smith *et al*. 2002). Tamarisk had been believed by some to be a habitat type of lesser quality for the southwestern willow flycatcher, however comparisons of reproductive performance (FWS 2002), prey populations (Durst 2004) and physiological conditions (Owen and Sogge 2002) of flycatchers breeding in native and exotic vegetation has revealed no difference (Sogge *et al*. 2005). The southwestern willow flycatcher is an insectivore, foraging in dense shrub and tree vegetation along rivers, streams, and other wetlands.

The introduced tamarisk leaf beetle was first detected affecting tamarisk within the range of the southwestern willow flycatcher in 2008 along the Virgin River in St. George, Utah. Initially, this insect was not believed to be able to move into or survive within the southwestern United States in the breeding range of the flycatcher. Along this Virgin River site in 2009, 13 of 15 flycatcher nests failed following vegetation defoliation (Paxton *et al*. 2010). As of 2012, the beetle has been found in southern Nevada/Utah and northern Arizona/New Mexico within the flycatcher's breeding range. Because tamarisk is a component of about 50 percent of all known flycatcher territories (Durst *et al*. 2008), continued spread of the beetle has the potential to significantly alter the distribution, abundance, and quality of flycatcher nesting habitat and impact breeding attempts.

Breeding biology

Arizona Distribution and Abundance

While numbers have significantly increased in Arizona (145 to 459 territories from 1996 to 2007) (English *et al*. 2006, Durst *et al*. 2008), overall distribution of flycatchers throughout the state has not changed much. Currently, population stability in Arizona is believed to be largely dependent on the presence of two large populations (Roosevelt Lake and San Pedro/Gila River confluence). Therefore, the result of catastrophic events or losses of significant populations either in size or location could greatly change the status and survival of the bird. Conversely, expansion into new habitats or discovery of other populations would improve the known stability and status of the flycatcher.

Fire

The evidence suggests that fire was not a primary disturbance factor in southwestern riparian areas near larger streams (FWS 2002). Yet, in recent time, fire size and frequency has increased on the lower Colorado, Gila, Bill Williams, and Rio Grande rivers. The increase has been attributed to increasing dry, fine fuels as a result of the cessation of flood flows and human caused ignition sources. The spread of the highly flammable plant, tamarisk, and drying of river areas due to river flow regulation, water diversion, lowering of groundwater tables, and other land practices is largely responsible for these fuels. A catastrophic fire in June of 1996, destroyed approximately a half mile of occupied tamarisk flycatcher nesting habitat on the San Pedro River in Pinal County. That fire resulted in the forced dispersal or loss of up to eight pairs of flycatchers (Paxton *et al*. 1996). Smaller fires have occurred along the upper most portion of the San Pedro River closer to the Mexico Border and another large fire occurred on the lower San Pedro River at the Nature Conservancy's San Pedro Preserve between Winkelman and Dudleyville in 2004. Recreationists cause over 95 percent of the fires on the lower Colorado River (FWS 2002).

Mortality and Survivorship

There are no extensive records for the actual causes of adult southwestern willow flycatcher mortality. Incidents associated with nest failures, human disturbance, and nestlings are typically the most often recorded due to the static location of nestlings, eggs, and nests. As a result, nestling predation and brood parasitism are the most commonly recorded causes of southwestern willow flycatcher mortality. Also, human destruction of nesting habitat through bulldozing, groundwater pumping, and aerial defoliants has been recorded in Arizona (T. McCarthey, AGFD, pers. comm.). Human collision with nests and spilling the eggs or young onto the ground have been documented near high use recreational areas (FWS 2002). A southwestern willow flycatcher from the Greer Town site along the Little Colorado River in eastern Arizona, was found dead after being hit by a vehicle along SR 373. This route is adjacent to the breeding site (T. McCarthey, AGFD, pers. comm.).

Past Consultations

Since listing in 1995, approximately 210 Federal agency actions have undergone (or are currently under) formal section 7 consultation throughout the flycatcher's range. This list of consultations can be found in the administrative record for this consultation. Since flycatcher critical habitat was finalized in 2005, at least 33 formal opinions have been completed in Arizona (within and outside designated critical habitat). While many opinions were issued for the previous critical habitat designation, the stream reaches and constituent elements have changed.

Activities continue to adversely affect the distribution and extent of all stages of flycatcher habitat throughout its range (development, urbanization, grazing, recreation, native and non-native habitat removal, dam operations, river crossings, ground and surface water extraction, etc.). Introduced tamarisk eating leaf beetles were not anticipated to persist within the range of the southwestern willow flycatcher. However, they were detected within the breeding habitat (and designated critical habitat) of the flycatcher in 2008 along the Virgin River near the Town of St. George, Utah. In 2009, beetles were also known to have been detected defoliating habitat within the range of flycatcher habitat in southern Nevada, and along the Colorado River in the Grand Canyon and near Shiprock in Arizona. Stochastic events also continue to change the distribution, quality, and extent of flycatcher habitat.

Conservation measures associated with some consultations and Habitat Conservation Plans have helped to acquire lands specifically for flycatchers on the San Pedro, Verde, and Gila rivers in Arizona and the Kern River in California. Additionally, along the lower Colorado River, the U.S. Bureau of Reclamation is currently attempting to establish riparian vegetation to expand

and improve the distribution and abundance of nesting flycatchers. A variety of Tribal Management Plans in California, Arizona, and New Mexico have been established to guide conservation of the flycatchers. Additionally, during the development of the critical habitat rule, management plans were developed for some private lands along the Owens River in California and Gila River in New Mexico. These are a portion of the conservation actions that have been established across the subspecies' range.

Environmental Baseline – Southwestern Willow Flycatcher

The southwestern willow flycatcher is an obligate riparian bird and thus, the status of riparian ecosystems within the action area is crucial to the species' Environmental Baseline. The riparian vegetative communities present in the action area are described in Table R-1 within the Effects to Riparian Ecosystems section. Table SWF-1, below, displays the subset of sites from Table R-1 that constitute the southwestern willow flycatcher habitat (and critical habitat) affected by the proposed action. We again note that the determination to employ the Pima County riparian mapping may overestimate the exnat acreage of the various classes of riparian vegetation.

Table SWF-1. Riparian affected environment within Southwestern Willow Flycatcher habitat and critical habitat adapted from SWCA (2012) and based on Pima County (2012) mapping

Reach Name	Acres	Pima County Class	Dominant Riparian Plants
Cienega Creek 1	695.13	Hydroriparian	Cottonwood and Goodding's willow**
Cienega Creek 1	364.69	Xeroriparian B	Large mesquites and scrub mesquites with scattered cottonwoods**
Cienega Creek 2	2,086.96	Hydroriparian	Mature cottonwood and Goodding's willow**
Cienega Creek 2	323.98	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 2	65.58	Xeroriparian C	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Cienega Creek 3	382.27	Hydroriparian	Mature cottonwood and Goodding's willow with young velvet ash**
Cienega Creek 3	35.88	Xeroriparian B	Mesquite and netleaf hackberry**
Cienega Creek 3	126.96	Xeroriparian C	Mesquite with desert broom and burrobrush**
Cienega Creek 3	0.78	Xeroriparian D	Acacia, desert willow, ironwood paloverde, mesquite, soapberry*
Empire Gulch	86.00	Xeroriparian A	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	631.39	Xeroriparian B	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	127.90	Xeroriparian C	Acacia, desert willow, ironwood, paloverde, mesquite, soapberry*
Empire Gulch	407.46	Hydroriparian	Large cottonwood willow gallery**
Total Hydroriparian in upper Cienega Creek and Empire Gulch			**3571.82**
Total Xeroriparian A in upper Cienega Creek and Empire Gulch			**86**
Total Xeroriparian B in upper Cienega Creek and Empire Gulch			**1355.94**
Total Xeroriparian C in upper Cienega Creek and Empire Gulch			**320.44**
Total Xeroriparian D in upper Cienega Creek and Empire Gulch			**0.78**
* From generic Pima County habitat type descriptions (CITE PIMA COUNTY RIPARIAN APPENDIX).			
** From actual field observations (WestLand Resources Inc. 2010d, 2012a, 2012b).			

Status of the Flycatcher in the Action Area

Tha action area includes the streams and associated riparian communities affected by the proposed action, as detailed within the Effects to Aquatic Ecosystems and Effects to Riparian Ecosystem sectiona, above. Flycatcher surveys and detections have been limited within the action area. AGFD (Ellis *et al*. 2008) reported the results of flycatcher presence and absence surveys occurring between 1993 and 2006 along five reaches of Cienega Creek (in order from upstream to downstream, are Empire/ Cienega–Cienega Creek, Cienega Creek near Cross Hill, Cienega Narrows, Cienega Creek–Narrows to Coldwater, and Cienega Creek). Most recently, in 2011 the BLM (Radke 2011) conducted surveys along lower Empire Gulch and upper Cienega

Creek and from 2010 to 2012, Pima County (Rodden 2010, 2011,2012) conducted flycatcher surveys along a mile portion of lower Cienega Creek.

Between 1993 and 2006, the reach of Cienega Creek in which territorial flycatchers were documented was the uppermost portion (Cienega Creek), where a pair and nest were located in 2001 (within the critical habitat segment). Two migrant flycatchers were documented in the same reach of Cienega Creek—one in 1999 and one in 2003. A willow flycatcher of an unknown subspecies (*Empidonax traillii ssp.*) was documented at the Empire Gulch Monitoring Avian Productivity and Survivorship (MAPS) station in July 2006 (Institute for Bird Populations 2006). Please note that the subsequent use of the term "willow flycatcher" refers to birds for which the subspecies cannot be definitively determined; these are individuals that are during migration. The term "flycatcher" is used throughout this document when a bird has been identified as a southwestern willow flycatcher based on observation of territorial behavior and breeding activity in the subspecies' known range.

A single flycatcher territory was detected along Cienega Creek in 2001 (Smith *et al*. 2002) and a second likely territory along Empire Gulch in 2011 (BLM 2012, Paxton 2012). Regarding the more recent detection, migrant willow flycatchers and possibly a territorial flycatcher were detected along Cienega Creek and lower Empire Gulch. Two migrant flycatchers were detected along Cienega Creek. A willow flycatcher was detected twice in early June along Empire Gulch, which was followed by the capture of two hatch-year flycatchers at the Empire Gulch MAPS station. The combination of the hatch-year flycatchers being netted with the nearby June detection of a flycatcher led the BLM to conclude that this bird was likely a breeder (BLM 2012). When interpreting these observations, a USGS representative (Paxton 2012), noted that he could not determine with certainty the flycatcher's breeding status, but the combination of these instances did seem promising for a flycatcher territory to exist nearby. USGS then mentioned a similar scenario that occurred in southern Nevada which resulted in the discovery of a nearby breeding population.

From 2010 to 2012, an approximately 1-mile length of the so-called Claypit Reach of Cienega Creek was surveyed by Pima County in order to evaluate a potential Partners for Fish and Wildlife project that would remove tamarisk. No flycatchers were detected the three seasons that this portion of lower Cienega Creek was surveyed (Rodden 2010, 2011, 2012).

Status of Flycatcher Critical Habitat in the Action Area

We revised the flycatcher critical habitat designation in 2013, including reaches of Cienega Creek and Empire Gulch within the Las Cienegas National Conservation Area in Pima County. Specifically, we designated a 17.9-km (11.1-mi) segment of Cienega Creek and two segments of Empire Gulch; an isolated 0.4-km (0.3-mi) upper segment of Empire Gulch and a second 1.3-km (0.8-mi) lower segment of Empire Gulch that connects to Cienega Creek. The Cienega Creek portion of the critical habitat is located within Reaches 1, 2, and 3 (see Figure A-1). Empire

Gulch was not subdivided for groundwater modeling purposes, so groundwater decline-driven effects to the two portions of critical habitat in the stream cannot be described separately.

Cienega Creek was identified in the Recovery Plan as an area with substantial recovery value (FWS 2002, p. 91), while the adjacent Empire Gulch was not identified in the Plan, but was only recently reported as likely having a flycatcher territory. These stream segments fall within the Santa Cruz Management Unit and were designated (along with a portion of the Santa Cruz River) to follow and meet the geographic and territory and habitat-related goals described in the Plan (FWS 2002). The Santa Cruz Management Unit is, in turn, a component of the Gila Recovery Unit. These areas, as are all critical habitat segments, are anticipated to provide flycatcher habitat for metapopulation stability, gene connectivity through this portion of the flycatcher's range, protection against catastrophic population loss, and population growth and colonization potential. We also designated critical habitat to support the feeding and sheltering needs of migratory and dispersing flycatchers. Overall, these river segments and associated flycatcher habitat are anticipated to support the strategy, rationale, and science of flycatcher conservation.

The areas designated as flycatcher critical habitat are designed to provide sufficient riparian habitat for breeding, non-breeding, territorial, dispersing, and migrating flycatchers in order to reach the geographic distribution, abundance, and habitat-related recovery goals described in the Recovery Plan (FWS 2002, pp. 77–85).

In general, the physical or biological features (PBF) of critical habitat for nesting flycatchers are found in the riparian areas within the 100-year floodplain or flood-prone area. Flycatchers use riparian habitat for feeding, sheltering, and cover while breeding, migrating, and dispersing. It is important to recognize that flycatcher habitat is ephemeral in its presence, and its distribution is dynamic in nature because riparian vegetation is prone to periodic disturbance (such as flooding) (FWS 2002, p. 17). Even with the dynamic shifts in habitat conditions, one or more of the primary constituent elements (elements of the physical and biological factors) described below are found throughout each of the units that we designated as critical habitat.

Flycatcher habitat may become unsuitable for breeding through maturation or disturbance of the riparian vegetation, but it may remain suitable for use during migration or for foraging. This situation may be only temporary, and vegetation may cycle back into suitability as breeding habitat (FWS 2002, p. 17). Therefore, it is not practical to assume that any given breeding habitat area will remain suitable over the long term or persist in the same location (FWS 2002, p. 17). Thus, flycatcher habitat that is not currently suitable for nesting at a specific time, but is useful for foraging and migration, can still be important for flycatcher conservation. Feeding sites and migration stopover areas are important components for the flycatcher's survival, productivity, and health, and they can also be areas where new breeding habitat develops as nesting sites are lost or degraded (FWS 2002, p. 42). These successional cycles of habitat change are important for long-term persistence of flycatcher habitat.

Based on our current knowledge of the life history and ecology of the flycatcher and the relationship of its life-history functions to its habitat, it is important to recognize the interconnected nature of the physical or biological features that provide the primary constituent elements of critical habitat. Specifically, we consider the relationships between river function, hydrology, floodplains, aquifers, and plant growth, which form the environment essential to flycatcher conservation.

The hydrologic regime (stream flow pattern) and supply of (and interaction between) surface and subsurface water is a driving factor in the long-term maintenance, growth, recycling, and regeneration of flycatcher habitat (FWS 2002, p. 16). As streams reach the lowlands, their gradients typically flatten and surrounding terrain opens into broader floodplains (FWS 2002, p. 32). In these geographic settings, the stream-flow patterns (frequency, magnitude, duration, and timing) will provide the necessary stream-channel conditions (wide configuration, high sediment deposition, periodic inundation, recharged aquifers, lateral channel movement, and elevated groundwater tables throughout the floodplain) that result in the development of flycatcher habitat (Poff *et al.* 1997, pp. 770–772; FWS 2002, p. 16). Allowing the river to flow over the width of the floodplain, when overbank flooding occurs, is integral to allow deposition of fine moist soils, water, nutrients, and seeds that provide the essential material for plant germination and growth. An abundance and distribution of fine sediments extending farther laterally across the floodplain and deeper underneath the surface retains much more subsurface water, which in turn supplies water for the development of the vegetation that provides flycatcher habitat and micro-habitat conditions (FWS 2002, p. 16). The interconnected interaction between groundwater and surface water contributes to the quality of riparian vegetation community (structure and plant species) and will influence the germination, density, vigor, composition, and the ability of vegetation to regenerate and maintain itself (Arizona Department of Water Resources 1994, pp. 31–32).

Considering these issues and other information regarding the biology and ecology of the species, we have determined that the flycatcher requires the essential physical or biological features (PBF) described below.

*Space for Individual and Population Growth and for Normal Behavi*or

Streams of lower gradient and more open valleys with a wide or broad floodplain are an essential physical or biological feature of flycatcher habitat. In some instances, streams in relatively steep, confined areas can also support flycatcher breeding habitat (FWS 2002, p. D-13). These areas support the abundance of riparian vegetation used for flycatcher nesting, foraging, dispersal, and migration.

Streams of lower gradient and more open valleys with a wide and broad floodplain are the geological settings that are known to support flycatcher breeding habitat from near sea level to about 2,600 m (8,500 ft) in elevation in southern California, southern Nevada, southern Utah, southern Colorado, Arizona, and New Mexico (FWS 2002, p. 7). Sometimes, the low-gradient wider floodplain exists only at the habitat patch itself within a stream that is otherwise steeper in gradient (FWS 2002, p. D-12). Flycatchers can occupy and breed in very small, isolated habitat patches and may occur in fairly high densities within those small patches.

Many willow flycatchers are found along streams using riparian habitat during migration (Yong and Finch 1997, p. 253; FWS 2002, p. E-3). Migration stopover areas can be similar to breeding habitat or riparian habitats with less vegetation density and abundance compared to areas for nest placement (the vegetation structure is too short or sparse or the patch is too small) (FWS 2002, p. E-3). Such migration stopover areas, even though not used for breeding, are critically important resources affecting productivity and survival (FWS 2002, p. E-3). The variety of riparian habitat occupied by migrant flycatchers ranges from small patches with shorter and sparser vegetation to larger more complex breeding habitats.

Food, Water, Air, Light, Minerals, or Other Nutritional or Physiological Requirements

Food

The presence of a wide range of invertebrate prey, including flying and ground- and vegetation-dwelling species of terrestrial and aquatic origins is an essential physical or biological feature of flycatcher habitat.

The flycatcher is somewhat of an insect generalist (FWS 2002, p. 26), taking a wide range of invertebrate prey including flying, and ground- and vegetation-dwelling species of terrestrial and aquatic origins (Drost *et al.* 2003, pp. 96–102). From an analysis of the flycatcher diet along the South Fork of the Kern River, California (Drost *et al.* 2003, p. 98), flycatchers consumed a variety of prey from 12 different insect groups. Flycatchers have been identified targeting seasonal hatchings of aquatic insects along the Salt River arm of Roosevelt Lake, Arizona (Paxton *et al.* 2007, p. 75).

Flycatcher food availability may be largely influenced by the density and species of vegetation, proximity to and presence of water, saturated soil levels, and microclimate features such as temperature and humidity (FWS 2002, pp. 18, D-12). Flycatchers forage within and above the tree canopy, along the patch edge, in openings within the territory, over water, and from tall trees as well as herbaceous ground cover (Bent 1960, pp. 209–210; McCabe 1991, p. 124). Flycatchers employ a “sit and wait” foraging tactic, with foraging bouts interspersed with longer periods of perching (Prescott and Middleton 1988, p. 25).

Water

Flowing streams with a wide range of stream flow conditions that support expansive riparian vegetation is an essential physical feature of flycatcher habitat. The most common stream flow conditions are largely perennial (persistent) stream flow with a natural hydrologic regime (frequency, magnitude, duration, and timing). However, in the Southwest, hydrological conditions can vary, causing some flows to be intermittent, but the floodplain can retain surface moisture conditions favorable to expansive and flourishing riparian vegetation. These appropriate conditions can be supported by managed water sources and hydrological cycles that mimic key components of the natural hydrologic cycle. Flycatcher nesting habitat is largely associated with perennial (persistent) stream flow that can support the expanse of vegetation characteristics needed by breeding flycatchers, but there are exceptions. Flycatcher nesting habitat can persist on intermittent (ephemeral) streams that retain local conditions favorable to riparian vegetation (FWS 2002, p. D-12).

In the Southwest, hydrological conditions at a flycatcher breeding site can vary remarkably within a season and between years (FWS 2002, p. D-12). At some locations, particularly during drier years, water or saturated soil is only present early in the breeding season (May and part of June) (FWS 2002, p. D-12). At other sites, vegetation may be immersed in standing water during a wet year but be hundreds of meters from surface water in dry years (FWS 2002, p. D-12). Where a river channel has changed naturally, there may be a total absence of water or visibly saturated soil for several years. In such cases, the riparian vegetation and any flycatchers breeding within it may persist for several years (FWS 2002, p. D-12).

Sites for Germination or Seed Dispersal

Elevated subsurface groundwater tables and appropriate floodplain fine sediments are essential physical or biological features of flycatcher habitat. These features provide water and seedbeds for the germination, growth, and maintenance of expansive growth of riparian vegetation needed by the flycatcher.

Subsurface hydrologic conditions may in some places (particularly at the more arid locations of the Southwest) be equally important to surface water conditions in determining riparian vegetation patterns (Lichivar and Wakely 2004, p. 92). Where groundwater levels are elevated to the point that riparian forest plants can directly access those waters, it can be an area for breeding, non-breeding (unpaired), territorial, dispersing, foraging, and migrating flycatchers. Elevated groundwater helps create moist soil conditions believed to be important for nesting conditions and prey populations (FWS 2002, pp. 11, 18), as further discussed below.
Depth to groundwater plays an important part in the distribution of riparian vegetation (Arizona Department of Water Resources 1994, p. 31) and, consequently, flycatcher habitat. The greater the depth to groundwater below the land surface, the less abundant the riparian vegetation (Arizona Department of Water Resources 1994, p. 31). Localized, perched aquifers (a saturated area that sits above the main water table) can and do support some riparian habitat, but these systems are not extensive (Arizona Department of Water Resources 1994, p. 31).

The abundance and distribution of fine sediment deposited on floodplains is critical for the development, abundance, distribution, maintenance, and germination of the plants that grow into flycatcher habitat (FWS 2002, p. 16). Fine sediments provide seed beds to facilitate the growth of riparian vegetation for flycatcher habitat. In almost all cases, moist or saturated soil is present at or near breeding sites during wet and non-drought years (FWS 2002, p. 11). The saturated soil and adjacent surface water may be present early in the breeding season, but only damp soil is present by late June or early July (FWS 2002, p. D-3). Microclimate features (temperature and humidity) facilitated by moist or saturated soil, are believed to play an important role where flycatchers are detected and nest, their breeding success, and availability and abundance of food resources (FWS 2002, pp. 18, D-12).

Cover or Shelter

Riparian tree and shrub species that provide cover and shelter for nesting, breeding, foraging, dispersing, and migrating flycatchers are essential physical or biological features of flycatcher habitat.

Riparian vegetation provides the flycatcher cover and shelter while migrating and nesting. Placing nests in dense vegetation provides cover and shelter from predators or nest parasites that would seek out flycatcher adults, nestlings, or eggs. Similarly, using riparian vegetation for cover and shelter during migration provides food-rich stopover areas, a place to rest, and shelter or cover along migratory flights (FWS 2002, pp. D-14, F-16). Riparian vegetation used by migrating flycatchers can sometimes be less dense and abundant than areas used for nesting (FWS 2002, p. D-19). However, migration stopover areas, even though not used for breeding, may be critically important resources affecting local and regional flycatcher productivity and survival (FWS 2002, p. D-19).

Sites for Breeding, Reproduction, or Rearing (or Development) of Offspring

Reproduction and Rearing of Offspring

A variety of riparian tree and shrub species is an essential physical or biological feature of flycatcher habitat. Typically, dense, expansive riparian forests provide habitat to place nests. Riparian vegetation with these characteristics, with a mosaic of open spaces, typically surrounds locations to place nests or along river segments and provides vegetation for foraging, perching, dispersal, and migration, and habitat that can develop into nesting areas through time. Riparian habitat characteristics such as dominant plant species, size and shape of habitat patches, tree canopy structure, vegetation height, and vegetation density are important parameters of flycatcher breeding habitat, although they may vary widely at different sites (FWS 2002, p. D-1).

Flycatchers nest in thickets of trees and shrubs ranging in height from 2 m to 30 m (6 to 98 ft) (FWS 2002, p. D-3). Nest sites typically have dense foliage at least from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low, dense tree canopy (FWS 2002, p. D-3). Regardless of the plant species' composition or height, breeding sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings creating a mosaic that is not uniformly dense (FWS 2002, p. 11).

Canopy density (the amount of cover provided by tree and shrub branches measured from the ground) at various nest sites ranged from 50 to 100 percent (FWS 2002, p. D-3). Flycatcher breeding habitat can be generally organized into three broad habitat types—those dominated by native vegetation (typically willow), by exotic (nonnative) vegetation (typically salt cedar), and those with mixed native and those dominated by exotic plants (typically salt cedar and willow). These broad habitat descriptors reflect the fact that flycatchers inhabit riparian habitats dominated by both native and nonnative plant species.

Flycatchers have been recorded nesting in patches as small as 0.1 ha (0.25 ac) along the Rio Grande, and as large as 70 ha (175 ac) in the upper Gila River, New Mexico (FWS 2002, p. 17). The mean reported size of flycatcher breeding patches was 8.6 ha (21.2 ac), with the majority of sites toward the smaller end, as evidenced by a median patch size of 1.8 ha (4.4 ac) (FWS 2002, p. 17).

With only some exceptions, flycatchers are generally not found nesting in confined floodplains (typically those bound within a narrow canyon) (Hatten and Paradzick 2003, p. 780) or where only a single narrow strip of riparian vegetation less than approximately 10 m (33 ft) wide develops (FWS 2002, p. D-11).

While riparian vegetation too mature, too immature, or of lesser quality in abundance and breadth may not be used for nesting, it can be used by breeding flycatchers for foraging (especially if it extends out from larger patches) or during migration for foraging, cover, and shelter (Sogge and Tibbitts 1994, p. 16; Sogge and Marshall 2000, p. 53).

Primary Constituent Elements for Flycatcher

Primary constituent elements are those specific elements of the physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species.
Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determined that the primary constituent elements specific to the flycatcher are:

(1) 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 is comprised of trees and shrubs (that can include Gooddings willow, coyote willow, Geyer's willow, arroyo willow, red willow, yewleaf willow, pacific willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, velvet ash, poison hemlock, blackberry, seep willow, oak, rose, sycamore, false indigo, Pacific poison ivy, grape, Virginia creeper, Siberian elm, and walnut) and some combination of:

> (a) Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 m (about 6 to 98 ft). Lower-stature thickets (2 to 4 m or 6 to 13 ft tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle- and lower-elevation riparian forests;
> (b) Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy;
> (c) Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground);
> (d) 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 ha (0.25 ac) or as large as 70 ha (175 ac).

(2) 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).

Effects to Southwestern Willow Flycatchers

The section in this BO entitled Effects to Aquatic Ecosystems describes the hydrologic basis for effects to streams. The subsequent analysis of effects to riparian vegetation appears in the

Effects to Riparian Ecosystems section. These prior analyses are incorporated herein via reference.

Direct Effects to Southwestern Willow Flycatchers

There are no known flycatcher territories or areas anticipated to have or to develop flycatcher breeding habitat within the proposed footprint of the Rosemont Mine; the project area is predominately uplands and directly affected streams (i.e. Barrel Canyon) are ephemeral and lacking in suitable hydroriparian vegetation. As a result, we do not anticipate that any breeding flycatchers will be directly affected by the construction or operation of the mine.

Migratory flycatchers have been detected along nearby Cienega Creek and Empire Gulch and are known to occur in a wider variety of habitat types and locations than are territorial, breeding individuals. The Rosemont Mine site is situated between the Cienega Creek watershed and, to the south, the Sonoita Creek watershed. Given that flycatchers are a neo-tropical migrant and migrate between North American breeding locales and wintering sites in subtropical and tropical latitudes, it is probable that migratory or dispersing flycatchers will intermittently occur in the area of Rosemont Mine during construction or its operation. Because of the length of time the mine is expected to operate, it is reasonable to anticipate that migratory or dispersing flycatchers will transit the mine site. The mine site (in its pre-, during- and post-operation states) lacks the stopover habitat known to be preferred by migratory or dispersing flycatchers, so it is unlikely that the birds would be harmed or harassed to a greater degree than they would be when crossing other, unsuitable habitats.

Indirect Effects to Southwestern Willow Flycatchers

The Effects to Aquatic Ecosystems section discusses the proposed action's effect to regional groundwater and the volume and linear extent of surface flows in area streams. The relationship between flood flow hydrology, depth to groundwater, and the recruitment, maturation, and retention of the riparian forests in which flycatchers occur was analyzed in the section entitled Effects to Riparian Ecosystems. These prior narratives are incorporated herein via reference.

The drawdown of groundwater can negatively influence the ability for riparian plants to germinate, grow, and persist (Stromberg *et al*. 1996, Scott *et al*. 1999, Horton *et al*. 2001, and Merritt and Bateman 2012) (see Effects to Riparian Ecosystems section). Small reductions in stream flow or ground water levels can cause plants to undergo physiological stress and lose productivity, with possible adverse implications for southwestern willow flycatchers (FWS 2002). Even short-term loss of surface flows may reduce bio-productivity and habitat quality by stressing those insects with aquatic larval forms, a portion of the southwestern willow flycatcher's food base (FWS 2002). Nesting flycatchers do not rely on just the existence of riparian plants, but the persistence of this vegetation in abundant and dense quantities, requiring groundwater near the surface that creates conditions for abundant plant germination, growth, and persistence.

As discussed in the Effects to Aquatic Ecosystems section, the proposed action will appreciably, adversely affect the subsurface and, eventually, the surface hydrology of Empire Gulch at the Upper Empire Gulch Springs site (see Upper Empire Gulch Springs data in Table A-5). Tetra

Tech (2010) modeled the effects at this site to range from 0.1 foot upon cessation of mining to 0.2 foot at 20 years, 0.5 foot at 50 years, 2.5 feet at 150 years, and 6 feet at 1,000 years.

The modeled groundwater drawdowns at upper Cienega Creek (Reaches 1, 2, and 3) are of lesser magnitude than in Empire Gulch. The USGS Cienega Creek stream gage (0948550) is situated near the narrows in the upstream portion of Reach 3 (see Figure A-1). Tetra Tech (2012) modeled drawdowns of <0.1 foot from the end of mining and at 20 and 50 years later. Drawdowns reach 0.25 feet and 0.5 feet at 150 and 1,000 years, respectively.

We caution that the distance of these areas from the mine site, the present lack of definitive information regarding the regional aquifer, and the precision (or lack thereof) of the models used, mean there is no reasonable certainty regarding the exact magnitude of the drawdowns or of the exact manner in which groundwater declines will affect riparian ecosystems in either the near or long terms. Groundwater models are more useful in determining the magnitude of trends rather than absolute groundwater elevations. Regardless, the combined result of the effects to regional groundwater, changes in the baseflow hydrology of streams, decreases in stream length, and reduced riparian ET is a likely decrease in the quality of the flycatcher's Environmental Baseline along Empire Gulch and upper Cienega Creek.

Moreover, we have highlighted the aforementioned trends in increasing groundwater drawdown specifically because Merritt and Bateman (2012), modeling hydrology and riparian vegetation relationships on Cherry Creek in Central Arizona, found that a 0.33-foot drop in groundwater translated into a 4% loss of riparian forest in that location.

Brand *et al*. (2010) examined the upper San Pedro River and found that canopy nesting and insectivorous birds reached their highest densities and levels of nesting success in cottonwood stands along intermittent and perennial reaches. While southwestern willow flycatchers are insectivorous, the species is rare on the upper San Pedro River and was not specifically investigated.

Brand *et al*. (2011) conducted analyses intended to determine changes in riparian condition class as described in Leenhouts *et al*. (2005) under varying groundwater scanarios. Scenarios involving groundwater depletion were found to result in reduced abundance of cootonwood/willow vegetation and increased abuyndance of less phraetophytic species such as tamarisk. While southwestern willow flycatchers are known to occur in high densities in salt tamarisk in the southwesteren U.S., the sites are generally associwted with perennial river reaches maintained by releases from dams. We also note that Brand *et al*. (2010, 2011) found that densities of brown-headed cowbirds – a nest parasite of the southwestern willow flycatcher, increased in abundance under decreasing groundwater levels, increasing flow intermittency, and increasing density of tamarisk.

The streams studied by these investigators differ from Cienega Creek in myriad ways, but the findings all document that depletions of groundwater are likely to result in reductions in the quality and quantity of habitat for the southwestern willow flycatcher.

Approximately 3,572 acres of hydroriparian habitat were mapped within Empire Gulch and Reaches 1, 2, and 3 of Cienega Creek by Pima County; some or all of this acreage will be affected by the proposed action (see Table C-1). It is likely that the single 2001 Cienega Creek flycatcher territory and the presumed 2011 Empire Gulch territory were situated within areas mapped as hydroriparian habitat. The anticipated effects to these hydroriparian sites may reduce their suitability to serve as nesting substrates in the future. Conversely, the erratic occurrence of southwestern willow flycatchers in these sites means that we cannot be reasonably certain that birds will be incidentally taken if and when the anticipated effects occur.

It is likely that some fraction of the approximately 1,763 acres of Class A though D xeroriparian habitat mapped by Pima County in Empire Gulch and Reaches 1, 2, and 3 of Cienega Creek are important for flycatchers, providing either: (1) marginal nesting substrate (especially where cottonwoods are interspersed within a mesquite bosque) or foraging and dispersal habitat; or (2) a buffer between more hydric sites and the adjacent, xeric uplands, which decreases the edge/interior ratio of a given hydroriparian patch. Again, the sporadic use of Empire Gulch and upper Cienega Creek by flycatchers for breeding does not support a reasonable certainty that birds will be incidentally taken. Moreover, xeroripariuan vegetation may increase in extent if and as hydroriparian communities diminish.

Effect to Southwestern Willow Flycatcher Critical Habitat

The analyses contained in the Effects to Aquatic Ecosystems and Effects to Riparian Ecosystems sections as well as the preceding analysis of adverse effects to the flycatcher inform the analysis of the effects to critical habitat, and are incorporated herein by reference.

To summarize the prior analyses, the proposed action will adversely affect critical habitat via small, future declines in groundwater elevation which, in turn, will decrease the wetted length of stream, and reduce the vigor and extent of riparian vegetation. These effects would be in addition to relatively larger effects of natural variation. Alternately, if natural conditions recover (i.e. drought ceases), the effects of the proposed action would slightly reduce the magnitude of the improvement. The former scenario, which is more likely given climate change, represents effects to the PCEs of critical habitat: (1) riparian vegetation; and (2) insect prey population.

Within Pima and Santa Cruz Counties, Arizona, we designated flycatcher critical habitat along Cienega Creek, Empire Gulch, and the Santa Cruz River; only the former two sites are within the action area. The Cienega Creek designation includes a 17.9-km (11.1-mi) segment of Cienega Creek above the Narrows within the Las Cienega NCA. There are two segments of critical habitat in Empire Gulch; an isolated 0.4-km (0.3-mi) upper segment of Empire Gulch and a second 1.3-km (0.8-mi) lower segment of Empire Gulch that connects to Cienega Creek. The "Gardner/Cienega Confluence", "Upper Empire Gulch Springs", and "Cienega near Stream Gage 09484550" groundwater drawdown modeling points in Table X and the Upper Cienega and the Narrows impact summaries in Table H1 are informative.

As stated in prior analyses, the effects to riparian and aquatic ecosystems are appreciable and, to the extent that the available models permit, have been quantified (see Tables A-2, A-3, A-5, and SWF-1). Table SWF-2, below, is an excerpt from Table X, and includes the 20 to 1,000-year modeled groundwater drawdowns for Empire Gulch and Cienega Creek within critical habitat. The data for the time of mine closure (0 years) are omitted because modeled drawdowns are 0.1 feet or less. Table SWF-2 shows that from the cessation of mining to 150 years, many groundwater drawdowns are <0.1 foot, though Tetra Tech (2010) consistently predicts larger drawdowns than either Montgomery (2010) or Myers (2010). The most extreme effects are at the 1,000-year timeframe, where Tetra Tech (2010) has modeled a 6-foot drawdown at Upper Empire Gulch Springs. Our prior analyses have characterized this relatively large drawdown as having a limited effect to individual southwestern willow flycatchers; the sporadic use of the reach for nesting means that even large effects are unlikely to harm birds. This represents, however, an appreciable adverse effect to critical habitat. The drawdown is likely to result in the loss of riparian vegetation for nesting and foraging and a reduction in wetted stream, which, in turn, will reduce the export of aquatic insects.

The Effects to Riparian Ecosystems sections describes the work of Merritt and Bateman (2012) at Cherry Creek in central Arizona, where it was found that a simulated groundwater decline of 6.6 feet (2 meters) below base level resulted in a nearly complete loss of riparian forest and conversion of the valley bottom to shrubland. We cannot directly compare Cherry Creek and Empire Gulch using the hydrology, geomorphology, or riparian mapping data that are available to us, nor do we know the current, drought-affected groundwater elevations in Empire Gulch, but the effects noted at the former site indicate that relatively small drawdowns can cause appreciable reductions in riparian vegetation. The 2.5-foot and 6-foot modeled decline that has been predicted at Upper Empire Gulch Springs at 150 and 1,000 years, respectively (Tetra Tech 2010) - given uncertainties regarding ongoing drought, climate change and altered mountain front recharge – could result in an appreciable loss of riparian vegetation (PCE 1) within some portion of the 0.4-km (0.3-mi) upper segment and 1.3-km (0.8- mi) lower segment of Empire Gulch, with lesser effects in the 17.9-km (11.1-mi) segment of mainstem Cienega Creek.

Table SWF-2. Modeled groundwater drawdowns within flycatcher critical habitat.

20 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	<0.1	0
Upper Empire Gulch Springs	<0.1	0.2	0
Cienega near stream gage 09484550 (perennial reach)	<0.1	<0.1	0
50 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	<0.1	0
Upper Empire Gulch Springs	<0.1	0.5	0.2
Cienega near stream gage 09484550 (perennial reach)	<0.1	<0.1	0
150 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	0.2	0.1
Upper Empire Gulch Springs	0.3	2.5	0.3
Cienega near stream gage 09484550 (perennial reach)	<0.1	0.25	0
1,000 years after mine closure			
Location	**Montgomery (2010)**	**Tetra Tech (2010)**	**Myers (2010)**
Gardner/Cienega Confluence	<0.1	0.5	2.2
Upper Empire Gulch Springs	3.3	6	4.3
Cienega near stream gage 09484550 (perennial reach)	<0.1	0.5	0.2

Table SWF-3, below, repeats the content of Table A-2, above; both are based on SWCA (2012).

Table SWF-3 includes only the sites within critical habitat. There are anticipated to be no drawdowns, decreases in the wetted length of stream, decreases in baseflow, or decreases in riparian ET within the vicinity of flycatcher critical habitat at up to 150 years. At 1,000 years, drawdown is modeled to reach 0.01 foot, 0.16 mile (845 feet) of stream will be lost, baseflow will be diminished by 0.02 cfs, and riparian ET will decrease by 51afa. The loss of 845 feet of stream length and 51 afa of riparian ET will result in losses of riparian vegetation within and both up- and downstream from the affected reach.

The predictions found in Table SWF-3, which were performed by Montgomery (2010) and referenced in SWCA (2012) , are not as severe as those that might be expected to result from the worst-case, 1,000-year scenario associated with Tetra Tech's (2010) modeling, and they do provide spatial information regarding the affected stream length. If it is assumed that the 0.16 mile of lost stream length represents the maximum extent of impacts to PCE 1 (riparian vegetation), then that loss represents 1.3 percent of the 12.2 miles of critical habitat in the Cienega Creek watershed, 0.56 percent of the critical habitat in the 28.8-mile Santa Cruz Management Unit, and immeasurably small fractions of both the Gila Recovery Unit (of which the Santa Cruz Management Area is a subdivision) and the rangewide critical habitat designation. These small-scale effects are incapable of diminishing the Management Unit, Recovery Unit, or the critical habitat's respective abilities to contribute to the recovery of the species.

Table SWF-3. Summary of effects to streams within southwestern willow flycatcher critical habitat

	Upper Cienega Creek and the Narrows			
Years after mining	**Drawdown at perennial reach**	**Decrease in stream length (miles)**	**Decrease in baseflow (cfs)**	**Decrease in ET (afa)**
0	0	0	0	0
20	0	0	0	0
150	0	0	0	0
1,000	0.01	0.16	0.02	51

CONCLUSION

After reviewing the current status of the flycatcher and its critical habitat, the environmental baseline for the action area, the effects of the Rosemont Copper Mine, and the cumulative effects, it is the FWS's biological opinion that the Rosemont Mine, as proposed, is not likely to jeopardize the continued existence of the flycatcher, and is not likely to destroy or adversely modify designated flycatcher critical habitat. We present this conclusion for the flycatcher for the following reasons:

- We anticipate that the proposed action may result in immeasurably small losses of riparian vegetation in Empire Gulch and upper Cienega Creek from the conclusion of mining until 150 years later. We anticipate, however, that there will be appreciable losses of hydroriparian vegetation in Empire Gulch and lesser losses in upper Cienega Creek by 1,000 years after the conclusion of mining. Empire Gulch supported a likely southwestern willow flycatcher territory in 2011; upper Cienega Creek hosted a definitively-known territory in 2001. The low frequency of flycatcher breeding in the affected reaches makes it unlikely birds will be harmed or harassed by riparian vegetation losses resulting from implementation of the proposed action.

- The low number, infrequent detections, and lack of persistent flycatcher territories along Empire Gulch and upper Cienega Creek can be contrasted with the population numbers for the greater Gila Recovery Unit, which contained 659 territories as of 2008 (the last year for which comprehensive, area-wide surveys were conducted) (Durst *et al*. 2008, p. 12).
- Southwestern willow flycatcher critical habitat exists in Empire Gulch and along Cienega Creek; effects to the critical habitat parallel the effects to the species. The proposed action will likely result in a significant loss of riparian vegetation (PCE 1) within some portion of the 0.4-km (0.3-mi) upper segment and 1.3-km (0.8- mi) lower segment of Empire Gulch, with lesser effects in the 17.9-km (11.1-mi) segment of mainstem Cienega Creek.
- If the 0.16 mile of lost stream length at 1,000 years after mining calculated by Montgomery (2010) represents the maximum extent of impacts to PCE 1 (riparian vegetation), then it represents 1.3 percent of the 12.2 miles of critical habitat in the Cienega Creek watershed, 0.56 percent of the critical habitat in the 28.8-mile Santa Cruz Management Unit, and immeasurably small fractions of both the Gila Recovery Unit (of which the Santa Cruz Management Area is a subdivision) and the rangewide critical habitat designation. These small-scale, long-delayed effects are incapable of diminishing the recovery value of the Management Unit, Recovery Unit, or the total area designated as critical habitat. The proposed action therefore will not adversely modify or destroy southwestern willow flycatcher critical habitat.

The conclusions of this biological opinion are based on full implementation of the project as described in the Description of the Proposed Action and Description of the Proposed Conservation Measures sections of this document.

INCIDENTAL TAKE STATEMENT – SOUTHWESTERN WILLOW FLYCATCHER

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take – Southwestern Willow Flycatcher

As demonstrated in the Environmental Baseline and Effects of the Proposed Action sections, above, southwestern willow flycatchers are unlikely to be directly or indirectly affected by implementation of the proposed action. We, therefore, do not anticipate that implementation of the proposed action will result in the incidental take of any individuals of the species.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the Forest Service and Rosemont Copper Company facilitate implementing more consistent flycatcher presence/absence surveys, including nest searching and monitoring along lower Empire Gulch, upper Cienega Creek, and the Santa Cruz Management Unit using the latest accepted protocols to better understand the status of the flycatcher within the overall action area and the Management Unit.

2. We recommend implementing long-term monitoring of groundwater resources in the Action Area, especially areas where the groundwater models were less than certain in their conclusions. We recommend employing a third party entity that has experience designing, collecting, and analyzing these types of data which can be held to high scientific scrutiny, such as the U.S. Geologic Survey. At a minimum, we recommend establishing baseline information to better understand how groundwater moves through the watershed, existing groundwater elevations, and other groundwater and surface water uses in the watershed, and subsequently tracking the Rosemont Copper Mine's use of water and its comparative impact to the watershed.

3. If impacts from Rosemont Mine are different from that those anticipated in this biological opinion, we recommend implementing measures to offset those impacts such as acquiring and retiring other water diversion or groundwater stressors.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the FWS's Law Enforcement Office (FWS OLE, Resident Agent In Charge, 4901 Paseo del Norte NE, Suite D, Albuquerque, New Mexico 87113; telephone: (505) 248-7889) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve the biological material in the best possible state.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in your request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have questions or concerns about this consultation or the consultation process in general, feel free to contact Jean Calhoun (520) 670-6150 (x223). Please refer to consultation number 22410-2009-F-0389 in future correspondence concerning this project.

Sincerely,

Steven L. Spangle
Field Supervisor

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LITERATURE CITED

Description of the Proposed Action and Description of the Proposed Conservation Measures

Ayres, J.E. 1984. Rosemont: The History and Archaeology of Post-1880 Sites in the Rosemont Area, Santa Rita Mountains, Arizona. Archaeological Series No. 147, Vol. 3. Tucson, Arizona: Cultural Resource Management Division, Arizona State Museum, University of Arizona.

Brown, D.E. (ed.). 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. Salt Lake City: University of Utah Press.

CDM Smith. 2012. Preliminary Reclamation and Closure Plan for the Preferred Alternative. Prepared for the Rosemont Copper Company, Tucson, Arizona.

Council on Environmental Quality (CEQ). 2011. Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact. Prepared by N.H. Sutley. Washington, D.C.: Executive Office of the President, Council on Environmental Quality. January 14.

Fehmi, J.S. 2007. Final Report for Phase I. Prepared for Augusta Resource Corporation. Tucson: School of Natural Resources, University of Arizona. July 6.

Fehmi, J.S., T.M. Kong, and L. Wood. 2008. Phase II—Final Project Report. Prepared for August Resource Corporation. Tucson: School of Natural Resources, University of Arizona. December 17.

McLaughlin, S., and W. Van Asdall. n.d. [1977]. Flora and vegetation of the Rosemont area. In An Environmental Inventory of the Rosemont Area in Southern Arizona, Vol. 1: The Present Environment, edited by R. Davis and J.R. Callahan, pp. 64–98. Tucson: University of Arizona.

Monrad, C.K., J. Benya, and D.L. Crawford. 2012. Rosemont Copper Project Light Pollution Mitigation Recommendation Report. Tucson, Arizona: Monrad Electrical Engineering Inc. January 24.

Robbie, W. 2009. Supervisory Soil Scientist, U.S. Forest Service. Record of contact regarding ephemeral channels that support upland vegetation. Robert L. Fefevre, Soil Scientist, Coronado National Forest, Tucson, Arizona. September 8.

SWCA Environmental Consultants (SWCA). 2011. Draft Biological Evaluation, Rosemont Copper Project, Santa Rita Mountains, Nogales Ranger District. Prepared for U.S. Forest Service, Coronado National Forest. Tucson, Arizona: SWCA Environmental Consultants. September.

Tetra Tech. 2009b. Geotechnical Addendum. 3 vols. Project No. 320795. Prepared for

Rosemont Copper Company. Tucson, Arizona: Tetra Tech. February.

Tetra Tech.2010a. Reclamation Concept Update: Rosemont Copper Project. Project No. 114-320832. Prepared for Rosemont Copper. Tucson, Arizona: Tetra Tech. March.

Tetra Tech. 2010b. Site Water Management Update. Project No. 114-320828. 5 vols. Prepared for Rosemont Copper Company. Tucson, Arizona: Tetra Tech. April.

Tetra Tech and Schafer. 2007. Baseline Geochemical Characterization. Project No. 320614. Prepared for Augusta Resource Corporation. Golden, Colorado: Tetra Tech; Bozeman, Montana: Schafer, Ltd. June.

U.S. Forest Service (USFS). 2009b. Coronado National Forest Ecological Sustainability Report. Southwestern Region. February.

U.S. Forest Service (USFS). 2012a, Biological Assessment, Rosemont Copper Company Project, Santa Rita Mountains, Nogales Ranger District. Prepared by SWCA Environmental Consultants and Coronado National Forest. June. 140 pp. plus appendices.

U.S. Forest Service (USFS). 2012b. Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest. Prepared by SWCA Environmental Consultants and Coronado National Forest. October. 36 pp. plus appendices.

U.S. Forest Service (USFS). 2012b. [Second] Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest. Prepared by SWCA Environmental Consultants and Coronado National Forest. October. 65 pp.

United States Department of Agriculture, Forest Service (USFS). 2013a. Supplement to the Biological Assessment Proposed Rosemont Copper Mine, Santa Rita Mountains, Pima County, Arizona, Nogales Ranger District. February 2013. 65 pp.

United States Department of Agriculture, Forest Service (USFS). 2013b. Comments on Preliminary, Administrative Draft of the Description of the Proposed Action and Description of the Proposed Conservation Measures. Transmitted to U.S. Fish and Wildlife Service via Electronic Mail.

Water and Earth Technologies, Inc. 2012. Davidson Canyon Conceptual Surface-Water Monitoring Plan. March 2012. 49 pp.

Western Regional Climate Center. 2009. Santa Rita Experimental Range, Arizona. Available at: http://www.wrcc.dri.edu/cgi-bin/cliNORMNCDC2000.pl?azsant. Accessed by SWCA during the preparation of the Draft Environmental Impact Statement. November 22, 2010.

WestLand Resources, Inc. (WestLand). 2007. Mine Plan of Operations. Project No. 1049.05.B.700. Prepared for Augusta Resource Corporation. Tucson, Arizona: WestLand Resources, Inc. July 11.

WestLand Resources, Inc. (WestLand). 2009a. Lesser Long-nosed Bat Survey of the Rosemont Holdings and Vicinity. Project No. 1049.10 330 330A. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources, Inc. March 11.

WestLand Resources, Inc. (WestLand). 2010a. Onsite Riparian Habitat Assessment, Rosemont Project. Project No. 1049.14. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources, Inc. April.

WestLand Resources, Inc. (WestLand). 2011a. Rosemont Copper Project: July 2011 Seeps and Springs Survey. Project No. 1049.14. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources Inc. August 19.

WestLand Resources, Inc. (WestLand). 2012a. Conservation Measures – Water Features. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources, Inc November 12. 12 pp. plus figures.

WestLand Resources, Inc. (WestLand). 2012b. Biological Assessment Supplement Lesser Long-Nosed Bat Forage and Roost Conservation Measures. 7 pp. plus figures.

WestLand Resources, Inc. (WestLand). 2013a. Conservation Measures Summary. February 6. 36 pp.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Lesser Long-nosed Bat

Arends, A., F. J. Bonaccorso, and M. Genoud. 1995. Basal rates of metabolism of nectarivorous bats (Phyllostomidae) from semiarid thorn forest in Venezuela. Journal of Mammalogy 76:947–956.

Arizona Game and Fish Department (AGFD). 2009. Lesser long-nosed bat roost count summary data (2005 – 2009) provided by Angela McIntire, AGFD Bat Program Manager, to Scott Richardson, USFWS, on August 13, 2009. Arizona Game and Fish Department, Phoenix, AZ.

Arizona Game and Fish Department (AGFD). 2009. Update on the lesser long-nosed bat hummingbird feeder and telemetry project given to the City of Tucson's Habitat Conservation Plan Technical Advisory Committee on June 17, 2009.

Arizona Game and Fish Department (AGFD). 2005. Comments submitted 5/3/05 and 5/12/05, in response to Federal Register Notice of Review (70 FR 5460) for the lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*).

Bat Conservation Trust. 2008. Bats and lighting in the United Kingdom. *In* Bats and the Built Environment Series. 10 pp.

Benson, L., and R.A. Darrow. 1982. Trees and shrubs of the Southwestern Deserts. University of Arizona Press, Tucson.

Boldogh, S., D. Dobrosi, and P. Samu. 2007. The effects of illumination of buildings on house-dwelling bats and its conservation consequences. Acta Chiropterologica 9 (2): 527 – 534.

Brown, D. E. 1982a. Madrean Evergreen Woodland. Pp. 59-65 *in* Brown, D. E., ed. Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4). University of Arizona, Boyce Thompson Southwestern Arboretum.

Brown, D. E. 1982b. Plains and Great Basin Grasslands. Pp. 115-121 *in* Brown, D. E., ed. Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4). University of Arizona, Boyce Thompson Southwestern Arboretum.

Brown, D. E. 1982c. Semidesert Grassland. Pp. 137-141 *in* Brown, D. E., ed. Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4). University of Arizona, Boyce Thompson Southwestern Arboretum.

Brown, D. E. and C. H. Lowe. 1994. Biotic Communities of the Southwest. University of Utah Press. Map.

Burger, W. P. 2009. Grand Canyon Bat Survey, January 22-28. Arizona Game and Fish Department Inter-office Memo, February 3, 2009.

Burghardt, J. E. 2000. Bat-compatible closures of abandoned underground mines in national park system units. *In* Vories, K. C., and D. Throgmorton, eds. Bat conservation and mining: a technical interactive forum (2000: St. Louis, MS), US Dept. Interior, Office of Surface Mining, Southern Illinois Univ., Carbondale, Illinois. Available at internet site: http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Conservation/2f.pdf.

Cockrum, E.L., and Y. Petryszyn. 1991. The lesser long-nosed bat. Leptonycteris: An endangered species in the Southwest? Texas Tech Univ., Occas. Pap. Mus., Number 142.

Corbett, J. 2009. Survey data forms from internal mine surveys in the Agua Dulce Mountains, Cabeza Preita National Wildlife Refuge, Ajo, Arizona.

Dalton, V.M., D.C. Dalton, and S.L. Schmidt. 1994. Roosting and foraging use of a proposed military training site by the long-nosed bat, *Leptonycteris curasoae*. Report to the Luke Air Force Natural Resources Program, Contract Nos. DACA65-94-M-0831 and DACA65-94-M-0753. 34pp.

Downs, N.C., V. Beaton, J. Guest, J. Polanski, S.L. Robinson, and P.A. Racey. 2003. The effects of illuminating the roost entrance on the emergence behavior of *Pipistrellus pygmaeus*. Biological Conservation 111: 247 – 252.

Fure, A. 2006. Bats and lighting. The London Naturalist 85: 1 – 20.

Gentry, H.S. 1982. Agaves of continental North America. Pages 443-447 and 538-545, University of Arizona Press, Tucson, Arizona.

Hoffmeister, D.F. 1986. Mammals of Arizona. University of Arizona Press, Tucson.

Holsbeek, L. 2008. Draft assessment of critical points – IWG on light pollution. *In* 13th Meeting of the Advisory Council of Eurobats. Doc. EUROBATS.AC13.13.

Horner, M.A., T.H. Fleming, and M.D. Tuttle. 1990. Foraging and movement patterns of a nectar feeding bat: *Leptonycteris curasoae*. Bat Research News 31:81.

Longcore, T. and C. Rich. 2004. Ecological light pollution. Front. Ecol. Environ. 2 (4): 191 – 198.

Lowery, S.F., S.T.Blackman, and D. Abbate. 2009. Urban movement patterns of lesser long-nosed bats (*Leptonycteris curasoae*): management implications for the Habitat Conservation Plan within the City of Tucson and the Town of Marana. AGFD Final Report. 21 pp.

Ludlow, M.E. and J.A. Gore. 2000. Effects of a cave gate on emergence patterns of colonial bats. Wildlife Society Bulletin 28:191-196.

Nabhan, G.P. and T.H. Fleming. 1993. The conservation of new world mutualisms. Conservation Biology 7(3): 457 – 459.

Ober, H.K. and R.J. Steidl. 2004. Foraging rates of *Leptonycteris curasoae* vary with characteristics of Agave Palmeri. The Southwestern Naturalist 49(1): 68 – 74.

Ober, H.K., R.J. Steidl, and V.M. Dalton. 2000. Foraging ecology of lesser long-nosed bats. Final Report. University of Arizona, Tucson, AZ. 25 pp.

Powell, B. F., W. L. Halvorson, and C. A. Schmidt. 2006. Vascular Plant and Vertebrate Inventory of Saguaro National Park, Rincon Mountain District. OFR 2006-1075. U.S. Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.

Powell, B. F., W. L. Halvorson, and C. A. Schmidt. 2007. Vascular Plant and Vertebrate Inventory of Saguaro National Park, Tucson Mountain District. OFR 2007-1296. U.S. Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.

Rogers, G.F. 1985. Mortality of burned *Cereus giganteus*. Ecology 66 (2): 630 – 632.

Rydell, J. 1992. Exploitation of insects around streetlamps by bats in Sweden. Functional Ecology 6: 744 – 750.

Sahley, C.T., M.A. Horner, and T.H. Fleming. 1993. Flight speeds and mechanical power outputs of the nectar-feeding bat, *Leptonycteris curasoae* (Phyllostomidae: Glossophaginae. Journal of Mammalogy 74(3): 594 – 600.

Scanlon, A.T. and S. Petit. 2008. Effects of site, time, weather, and light on urban bat activity and richness: considerations for survey effort. Wildlife Research 35 (8): 821 – 834.

Sherwin, RE., J.S. Altenbach and DL. Waldien. 2009. Managing abandoned mines for bats. Bat Conservation International, Austin, TX. 103 pp.

Sidner, R. 2000. Report of activities under permit TE-821369-0. Report to the US Fish and Wildlife Service, Albuquerque, New Mexico.

Sidner, R. 2005. Fifteen years of monitoring the endangered lesser long-nosed bat (*Leptonycteris curasoae*) and other bat species on the Fort Huachuca Military Installation, Cochise County, Arizona. June-November 2004. EEC Project Report to Commander, U.S. Army Garrison, Fort Huachuca, AZ. 105 pp.

Sidner, R. 2009. Nineteenth annual monitoring of the endangered lesser long-nosed bat (*Leptonycteris curasoae*) and other bat species on the Fort Huachuca Military Installation, Cochise County, Arizona, February – November 2008. Report to Commander, U.S. Army Garrison, Fort Huachuca, Arizona. 92pp.

Sidner, R. and F. Houser. 1990. Lunarphilia in nectar-feeding bats in Arizona. Bat Research News 31(4):15.

Stone, E.L., G. Jones, and S. Harris. 2009. Street lighting disturbs commuting bats. Current Biology (2009), doi:10.1016/j.cub.2009.05.058.

Tibbitts, T. 2006. Annual report for threatened and endangered species permit No. TE19458. Resources Management Division. Organ Pipe Cactus National Monument, Ajo, Ariozna.

Tibbitts, Tim. 2005. Annual report for threatened and endangered species permit No. TE19458-1. Resources Management Division, Organ Pipe Cactus National Monument, Ajo, Arizona.

Turner, R. M. and D. E. Brown. 1982. Sonoran Desertscrub. Pp. 181-221 *in* Brown, D. E., ed. Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4). University of Arizona, Boyce Thompson Southwestern Arboretum.

U.S. Fish and Wildlife Service. 1988. Endangered and threatened wildlife and plants;

determination of endangered status for two long-nosed bats. Federal Register 53(190):38456-3860.

U.S. Fish and Wildlife Service. 1997. Lesser long-nosed bat recovery plan. Albuquerque, New Mexico. 49pp.

U.S. Fish and Wildlife Service. 2005. Endangered and threatened wildlife and plants: 5-year review of lesser long-nosed bat, black-capped vireo, Yuma clapper rail, Pima pineapple cactus, gypsum wild-buckwheat, Mesa Verde cactus, and Zuni fleabane. Federal Register 70(21):5460-5463.

U.S. Fish and Wildlife Service. 2007a. Biological Opinion for Ongoing and Future Military Operations on Fort Huachuca. Consultation 22410-2007-F-0132. Arizona Ecological Services Office, Phoenix.

U.S. Fish and Wildlife Service. 2007b. Final 5-Year Review Summary and Evaluation for the Lesser Long-Nosed Bat. Arizona Ecological Services Office, Phoenix. 43 pp.

U.S. Fish and Wildlife Service. 2007c. Biological Opinion for Installation of One 600 Kilowatt Wind Turbine and One 50KW Mass Megawatts Wind Machine on Fort Huachuca. Arizona Ecological Services Office, Phoenix.

Weiss, J.L., and J.T. Overpeck. 2005. Is the Sonoran Desert losing its cool? Global Change Biology 11:2065-2077.

Winter, Y., J. Lopez, and O. von Helversen. 2003. Ultraviolet vision in a bat. Nature 425: 612 – 614.

Wolf, S. and D. Dalton. 2005. Comments submitted 4/20/05 and 5/2/05, in response to Federal Register Notice of Review (70 FR 5460) for the lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*).

Ocelot

Avila-Villegas, S. and J.A. Lamberton-Moreno. 2012. "Wildlife Survey and Monitoring in the Sky Island Region with an Emphasis on Neotropical Felids" in Gottfried, Gerald J.; Ffolliott, Peter F.; Gebow, Brooke S.; and Eskew, Lane G., compilers. 2012. Merging science and management in a rapidly changing world: biodiversity and management of the Madrean Archipelago III. 2012 May 1-5, Tucson, AZ. Proceedings RMRS-P-67. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59:228–237.

Bisbal, F.J. 1986. Food habits of some neotropical carnivores in Venezuela (Mammalia, Carnivora). Mammalia 50: 330-339.

Booth-Binczik, S.D. 2007. Report from the field: monitoring Ocelot Dispersal with Satellite telemetry. Endangered Species Update 24(4): 110-112.

Casariego Madorell, M. A. 1998. Estimacion del tamaño poblacional del ocelote (*Leopardus pardalis*) en una selva baja caducifolia de la costa de Jalisco, Mexico. Bachelor's Thesis ENEP-UNAM Iztacala, Mexico.

Caso, A. 1994. Home range and habitat use of three neotropical carnivores in northeast Mexico. Unpublished M.S. thesis, Texas A&M University, Kingsville, TX, 78 pp.

Caso, A., Lopez-Gonzalez, C., Payan, E., Eizirik, E., de Oliveira, T., Leite-Pitman, R., Kelly, M. & Valderrama, C. 2008. *Leopardus pardalis*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 07 March 2013.

Crawshaw, Jr. P.G. 1995. Comparative ecology of ocelot (*Felis pardalis*) and jaguar (*Panthera onca*) in a protected subtropical forest in Brazil and Argentina. PhD thesis. University of Florida.

Crawshaw, P. G., Jr. 1995. Comparative ecology of ocelot (*Felis pardalis*) and jaguar (*Panthera onca*) in a protected subtropical forest in Brazil and Argentina. Ph.D. dissertation, University of Florida, Gainesville, Florida.

Crashaw, P.G., Jr., and H.B. Quigley. 1989. Notes on ocelot movement and activity in the Pantanal Region, Brazil. Biotropica 21:377-379.

de Villa Meza, A., E. Martinez Meyer, C.A. López González. 2002. Ocelot (*Leopardus pardalis*) food habits in a tropical deciduous forest of Jalisco, Mexico. American Midland Naturalist 148: 146-154.

Dillon, A. and M.J. Kelly. 2008. Ocelot home range, overlap and density: comparing radio telemetry with camera trapping. Journal of Zoology 275 (2008) 391-398.

Eaton, R. 1977. Breeding biology and propagation of the ocelot (*Leopardus* [*Felis*] *pardalis*). Zool. Garten Jena 47:9-23.

Emmons, L.H. 1987. Comparative feeding ecology of felids in a neotropical forest. Behavioral Ecology and Sociobiology 20:271-283.

Emmons, L.H. 1988. A field study of ocelots (*Felis pardalis*) in Peru. Review of Ecology (*Terre Vie*) 43:133-157.

Emmons, L.H, P. Sherman, D. Bolster, A. Goldizen, and J. Terborgh. 1989. Ocelot behavior in moonlight. Pp. 233–242 in Redford, K. H. & Eisenberg, J. F. (eds.). Advances in Neotropical mammalogy. Sandhill Crane Press, Inc., Gainesville.

Fernandez, E. C. 2002. Ocelot (*Leopardus pardalis*) ecology in the Chamela-Cuixmala Biosphere Reserve, Jalisco, Mexico. M.S. thesis. University of Wyoming, Laramie, WY.

Grigione, M.M., K. Menke, C. Lopez-Gonzalez, R. List, A. Banda, J. Carrera, R. Carrera, A.J. Giordano, J. Morrison, M. Sternberg, R. Thomas, and B. Van Pelt. 2009. Identifying potential conservation areas for felids in the USA and Mexico: integrating reliable knowledge across an international border. Oryx, 43, 78-86.

Grigione, M. M. and R. Mrykalo. 2004. Effects of artificial night lighting on endangered ocelots (*Leopardus paradalis*) and nocturnal prey along the United States-Mexico border: A literature review and hypotheses of potential impacts. Urban Ecosystems 7: 65-77.

Hall, E.R. 1981. The mammals of North America. Vol. II. John Wiley and Sons, NY.

Holbrook, J.D., R.W. DeYoung, M.E. Tewes, J.H. Young, J.L. Mays, and E. Meyers. 2011. Natural dispersal or illegal pets? Limitations on assigning origin to road-killed ocelots in the southwestern United States. Wildlife Society Bulletin 35: 504–507.

Horne, J.S. 1998. Habitat partitioning of sympatric ocelot and bobcat in southern Texas. Thesis, Texas A & M University-Kingsville, Kingsville, TX.

Jackson, V.L., L.L. Laack, and E.G. Zimmerman. 2005. Landscape metrics associated with habitat use by ocelots in south Texas. Journal of Wildlife Management 69:733-738.

Konecny, M.J. 1989. Movement patterns and food habits of four sympatric carnivore species in Belize, Central America. Pages 243-264 *in* K.H. Redford and J.F. Eisenberg, editors. Advances in neotropical mammalogy. Sandhill Crane Press, Gainesville, FL.

Laack, L.L. 1991. Ecology of the ocelot (*Felis pardalis*) in south Texas. M.S. thesis, Texas A&I University, Kingsville, TX. 113 pp.

Laack, L. L., M. E. Tewes, A. H. Haines, J. H. Rappole. 2005. Reproductive ecology of ocelot (*Leopardus pardalis*) in southern Texas. Acta Theriologica 50:505-514.

López González, C. A., D. E. Brown, and J. P. Gallo-Reynoso. 2003. The ocelot *Leopardus pardalis* in north-western Mexico: ecology, distribution and conservation status. Oryx 37:358-364.

Lomolino, M.V., and R. Channell. 1995. Splendid isolation: Patterns of geographic range collapse in endangered mammals. Journal of Mammalogy 76:335-347.

Longcore, T. and C. Rich. 2004. Ecological Light Pollution. Frontiers in Ecology and the Environment 2(4):191-198.

Ludlow, M. 1986. Home range activity patterns of ocelot (*Felis pardalis*) in Venezuela. M.S. thesis, Department of Wildlife and Range Sciences, University of Florida.

Ludlow, M. E., and M. E. Sunquist. 1987. Ecology and behavior of ocelots in Venezuela. National Geographic Research and Exploration 3:447-461

Maffei, L., A. J. Noss, E. Cuellar, and D. I. Rumiz. 2005. Ocelot (*Felis pardalis*) population densities, activity, and ranging behavior in the dry forests of eastern Bolivia: data from camera trapping. Journal of Tropical Ecology 21:1-6.

Mora, M.A., L.L Laack, M.C/ Lee, J. Sericano, R. Presley, P.R. Gardinali, L.R. Gamble, S. Robertson, and D. Frank. 2000. Environmental contaminants in blood, hair, and tissues of ocelots from the Lower Rio Grande Valley, Texas, 1986-1997. Environmental Monitoring and Assessment 64:447-492.

Murray, J. L. and G. L. Gardner. 1997. *Leopardus pardalis*. Mammalian Species 548:1-10.

Navarro-Lopez, D. 1985. Status and distribution of the ocelot in South Texas. M.S. thesis, Texas A & I University, Kingsville, TX. 92 pp.

NoiseQuest. 2013. What does noise affect? Available at: http://www.noisequest.psu.edu/NoiseAffect.Introduction.html Accessed April 10, 2013.

Nowell, K., and P. Jackson. 1996. Wild cats, status survey and conservation action plan. IUCN/SSC cat Specialist Group. 382 pp.

Pater, L.L., T.G. Grubb, and D.K. Delaney. 2009. Recommendations for Improved Assessment of Noise Impacts on Wildlife. The Journal of Wildlife Management 73(5):788-795.

SEMARNAT. 2002. NORMA Oficial Mexicana (NOM-059-ECOL-2001) - Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la Federación.

Sky Island Alliance. 2013. Northern Mexico Conservation Program. http://www.skyislandalliance.org/jaguars.htm. Accessed 20 March 2013.

Tewes, M. E. 1986. Ecological and behavioral correlates of ocelot spatial patterns. Unpublished Ph.D. dissertation, University of Idaho, Moscow, ID. 128 pp.

Tewes, M.E., and D.J. Schmidly. 1987. The neotropical felids: jaguar, ocelot, margay, and jaguarundi. Pp 695-712 *in* M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada. 1150 pp.

U.S. Fish and Wildlife Service (FWS). 1972. List of Endangered Foreign Fish and Wildlife. 37 FR:2589, March 28, 1972.

U.S. Fish and Wildlife Service (FWS). 1974. Endangered foreign wildlife. 39 FR:1171, January 4, 1974.

U.S. Fish and Wildlife Service (FWS). 1982. Endangered Status for the U.S. Population of the Ocelot. 47 FR:31670, July 21, 1982.

U.S. Fish and Wildlife Service (FWS). 1990. Listed cats of Texas and Arizona recovery plan (with emphasis on the ocelot). FWS, Albuquerque, NM. 131 pp.

U.S. Fish and Wildlife Service (FWS). 2003. Endangered and threatened wildlife. Code of Federal Regulations, Title 50, Section 17.11.

U.S. Fish and Wildlife Service (FWS). 2010. Draft Ocelot *(Leopardus pardalis*) Recovery Plan (revised). FWS, Southwest Region, Albuquerque, NM. 170 pp.

Villa Meza, A., E.M. Meyer, and C.A. Lopez-Gonzalez. 2002. Ocelot (*Leopardus pardalis*) food habits in a tropical deciduous forest of Jalisco, Mexico. American Midland Naturalist 148:146-15.

WestLand Resources, Inc. 2012. Rosemont Copper Project: Potential Effects of Lighting Associated with the Rosemont Project on Endangered Species. Project number 1049.21, December 07, 2012.

Jaguar

Arizona Game and Fish Department. 2012 Rosemont Game/Hunter Effects table. Attachment to Jnauary 18, 2012, comments on the Draft Environmental Impact Statement. Phoenix, Arizona.

Jesse R. Barber, J.R., K.R. Crooks, and K.M. Fristrup. 2009. The costs of chronic noise exposure for terrestrial organisms. Trends in Ecology and Evolution 25(3): 180-189.

Beier, P. 2006. Effects of artificial night lighting on terrestrial mammals. Pages 19-42. *In* Rich, C., and T. Longcore, eds. 2006. Ecological Consequences of Artificial Night Lighting. Island Press, Washington.

Beier P. and R. Barrett, 1993, The cougar in the Santa Ana mountain range, California. Berkeley, California, 104 pp.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59:228–237.

Boydston, E.E. and C.A. López-González. 2005. Sexual differentiation in the distribution potential of northern jaguars (*Panthera onca*). Pp. 51-56 *in* Gottfried, G.J., B.S. Gebow, L.G. Eskew, and C.B. Edminster, comp., Connecting Mountain Islands and Desert Seas: Biodiversity and Management of the Madrean Archipelago II, RMRS-P-36, Rocky Mountain Research Station, Forest Service, Fort Collins, CO.

Brown, D.E. 1983. On the status of the jaguar in the Southwest. Southwestern Nat. 28:459-460.

Brown DE. 1989. Cat fever. Game Country (May/June 1989):63-72.

Brown, D.E. and C.A. López-González. 2001. Borderland jaguars: tigres de la frontera. University of Utah Press. 170 pp.

Carroll, C., R. F. Noss, and P. C. Paquet. 2001. Carnivores as focal species for conservation planning in the Rocky Mountain region. Ecological Applications 11:961-980.

Caso, A. 1994. Home range and habitat use of three neotropical carnivores in northeast Mexico. Unpublished M.S. thesis, Texas A&M University, Kingsville, TX, 78 pp.

Caso, A., C. Lopez-Gonzalez, E. Payan, E. Eizirik, T. de Oliveira, R. Leite-Pitman, M. Kelly, and C. Valderrama. 2008. *Panthera onca*. *In*: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 31 May 2011.

Cavalcanti, S.M.C. and E.M. Gese. 2009. Spatial ecology and social interactions of jaguars (*Panthera onca*) in the southern Pantanal, Brazil. Journal of Mammalogy 90(4):935-945.

Channell, R. and M.V. Lomolino. 2000. Dynamic biogeography and conservation of endangered species. Nature 403:84-86.

Chávez, C., and G. Ceballos. 2006. Memorias del Primer Simposio. El Jaguar Mexicano en el Siglo XXI: Situación Actual y Manejo. CONABIO-Alianza WWF Telcel-Universidad Nacional Autónoma de México. México D.F.

Chávez, C., G. Ceballos, R. Medellin, and H. Zarza. 2007. Primer censo nacional del jaguar. Pp. 133-141 *in* Ceballos, G, C. Chávez, R. List y H. Zarza (editores). 2007. Conservación y manejo del jaguar en México: estudios de caso y perspectivas. Conabio - Alianza WWF- Telcel – Universidad Nacional Autónoma de México. México.

Childs, J. L. 1998. Tracking the felids of the borderlands. Printing Corner Press, El Paso, TX. 77 pp.

Colchero, F., D.A. Conde, C. Manterola, C. Chávez, A. Rivera, and G. Ceballos. 2010. Jaguars on the move: modeling movement to mitigate fragmentation from road expansion in the Mayan Forest. Animal Conservation 14: 158-166.

Conde, D.A., F. Colchero, H. Zarza, N.L. Christensen Jr, J. Sexton, C. Manterola, A. Rivera, C. Chavez, D. Azuara, and G. Ceballos. 2010. Sex matters: modeling male and female jaguar habitat for conservation. Biological Conservation 143, 1980–1988.

Crawshaw, P.G. and H.B. Quigley. 1991. Jaguar spacing, activity and habitat use in a seasonally flooded environment in Brazil. Journal of Zoology 223: 357-370.

Dickson, B.G., J.S. Jenness, and P. Beier. 2005. Influence of Vegetation, Topography, and Roads on Cougar Movement in Southern California. Journal of Wildlife Management 69(1): 264-276.

Glenn, W. 1996. Eyes of fire: encounter with a borderlands jaguar. Printing Corner Press, El Paso, Texas. 28 pp.

Green Valley Recreation Hiking Club. 2013. http://www.gvrhc.org/, accessed May 23, 2013

Grigione, M.M., K. Menke, C. Lopez-Gonzalez, R. List, A. Banda, J. Carrera, R. Carrera, A.J. Giordano, J. Morrison, M. Sternberg, R. Thomas, and B. Van Pelt. 2009. Identifying potential conservation areas for felids in the USA and Mexico: integrating reliable knowledge across an international border. Oryx, 43, 78-86.

Haag, T., A.S. Santos, D.A. Sana, R.G. Morato, L. Cullen Jr., P.G. Crawshaw Jr., C. de Angelo, M.S. Di Bitetti, F.M. Salzano, and E. Eizirik. 2010. The effect of habitat fragmentation on the genetic structure of a top predator: loss of diversity and high differentiation among remnant populations of Atlantic Forest jaguars (*Panthera onca*). Molecular Ecology 2010: 1-16.

Hass, C.C. 2002. Home range dynamics of white-nosed coatis in southeastern Arizona. Journal of Mammalogy 83:934–946.

Hatten, J.R., A. Averill-Murray, and W.E. Van Pelt. 2002. Characterizing and mapping potential jaguar habitat in Arizona. Technical Report 203, Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix. 32pp.

Hatten, J.R., A. Averill-Murray, and W.E. Van Pelt. 2005. A spatial model of potential jaguar habitat in Arizona. Journal of Wildlife Management 69(3):1024-1033.

Hoogesteijn R. and A. Hoogesteijn. 2010 Conserving Wild Felids in Humanized Landscapes: Strategies for Reducing Conflicts between Jaguars and Cattle. Wild Felid Monitor: Publication of the Wild Felid Research and Management Association 3(2): 1-13.

International Union for Conservation of Nature and Natural Resources (IUCN). 2007. Jaguar. http://lynx.uio.no/lynx/catsgportal/cat-website/20_cat-website/home/index_en.htm/. Accessed April, 2007.

Johnson, T.B., W.E. Van Pelt, and J.N. Stuart. 2011. Jaguar conservation assessment for Arizona, New Mexico and Northern Mexico. Nongame and Endangered Wildlife Program, AGFD, Phoenix. 81pp.

Kerley, L.L., J.M. Goodrich, D.G. Miquelle, E.N. Smirnov, H.B. Quigley, and M.G. Hornocker. 2002. Effects of roads and human disturbance on Amur tigers. Conservation Biology 16:97–108.

Lange, K. I. 1960. The jaguar in Arizona. Transactions of the Kansas Academy of Sciences 63:96-101.

Lesica, P., and F. W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9: 753–760.

Longcore, T. and C. Rich. 2004. Ecological Light Pollution. Frontiers in Ecology and the Environment 2(4):191-198.

López-González, C. A. and B. J. Miller. 2002. Do jaguars (*Panthera onca*) depend on large prey? Western North American Naturalist 62(2): 218–222.

López-Gónzalez, C.A. and D. Brown. 2002. Pp. 379-391 *in* Medellin, R.A., C. Equihua, C.L.B. Chetkiewicz, P.G. Crawshaw, Jr., A. Rabinowitz, K.H. Redord, J.G. Robinson, E.W. Sanderson, and A.B. Taber, comps. 2002. El jaguar en el nuevo millenio. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, México. 647pp.

López-González 2011, pers. comm.

Manriquez 2011 (July 15, 2011, email to FWS)

McCain, E.B. and J.L. Childs. 2008. Evidence of resident jaguars (*Panthera onca*) in the southwestern United States and the implications for conservation. Journal of Mammology, 89(1):1-10.

Medellin, R.A. 2009. The conservation of jaguars: A top priority for Latin America. Jaguar News 35: 2.

Medellin, R.A., C. Equihua, C.L.B. Chetkiewicz, P.G. Crawshaw, Jr., A. Rabinowitz, K.H. Redord, J.G. Robinson, E.W. Sanderson, and A.B. Taber, comps. 2002. El jaguar en el nuevo millenio. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, México. 647pp.

Menke, K.A., and C.L. Hayes. 2003. Evaluation of the relative suitability of potential jaguar habitat in New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico. 31pp.

Monroy-Vichis, O., C. Rodríguez-Soto, M. Zarco-González, and V. Urios. 2007. Distribución, uso de hábitat y patrones de actividad el puma y jaguar en el estado de México. Pp 59-69 *in* Ceballos, G, C. Chávez, R. List, y H. Zarza (editores). 2007. Conservación y manejo del jaguar en México: estudios de caso y perspectivas. Conabio - Alianza WWF- Telcel – Universidad Nacional Autónoma de México. México.

Montgomery and Associates Inc. 2010. Revised Report: Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-closure, Vol. 1: Text and Tables. Prepared for Rosemont Copper. Tucson, Arizona: Montgomery and Associates Inc. August 30.

Murphy, K. M. 1983. Relationships between a mountain lion population and hunting pressure. M. S. thesis. University of Montana, Missoula.

Ngoprasert, D., A.J. Lynam, and G.A. Gale. 2007. Human disturbance affects habitat use and behaviour of Asiatic leopard *Panthera pardus* in Kaeng Krachan National Park, Thailand. Oryx 41(3): 343-351

NoiseQuest. 2013. What does noise affect? Available at: http://www.noisequest.psu.edu/NoiseAffect.Introduction.html Accessed April 10, 2013.

Noss, R.F., H.B. Quigley, M.G. Hornocker, T. Merril, and P.C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. Conservation Biology 10:949–963.

Nowak, R.M. 1975. Retreat of the jaguar. National Parks Conservation Magazine 49:10-13.

Nowell, K., and P. Jackson. 1996. Wild cats: status survey and conservation action plan. IUCN/SSC Cat Specialist Group, Gland, Switzerland and Cambridge, United Kingdom.

Núñez, R., B. Miller, and F. Lindzey. 2002. Ecología del jaguar en la reserva de la biosfera de Chamela-Cuixmala, Jalisco, México. Pp. 99-118 in Medellin, R.A.,C. Equihua, C.L.B. Chetkiewicz, P.G. Crawshaw, Jr., A. Rabinowitz, K.H. Redord, J.G. Robinson, E.W. Sanderson, and A.B. Taber, comps. 2002. El jaguar en el nuevo millenio. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, México. 647pp.

Núñez, R., B. Miller, and F. Lindzey. 2000. Food habits of jaguars and pumas in Jalisco, Mexico. Journal of Zoology, London, 252: 373-379.

.

Núñez, R., B. Miller, and F. Lindzey. 2002. Ecología del jaguar en la reserva de la biosfera de Chamela-Cuixmala, Jalisco, México. Pp. 99-118 *in* Medellin, R.A.,C. Equihua, C.L.B. Chetkiewicz, P.G. Crawshaw, Jr., A. Rabinowitz, K.H. Redord, J.G. Robinson, E.W. Sanderson, and A.B. Taber, comps. 2002. El jaguar en el nuevo millenio. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, México. 647pp.

Núñez-Pérez, R. 2006. Área de actividad, patrones de actividad y movimiento del jaguar (*Panthera onca*) y del puma (*Puma concolor*), en la Reserva de la Biosfera “Chamela – Cuixmala”, Jalisco. M.S. Thesis, Universidad Nacional Autónoma de México, México, D.F.

Núñez-Pérez 2011 (August 2, 2011, email to FWS)

Núñez-Pérez, R. 2011. Estimating jaguar population density using camera-traps: a comparison with radio-telemetry estimates. Journal of Zoology (2011) 1-7.

Panthera. 2011. Jaguars. http://www.panthera.org/species/jaguar, accessed on June 13, 2011.

Pater, L.L., T.G. Grubb, and D.K. Delaney. 2009. Recommendations for Improved Assessment of Noise Impacts on Wildlife. The Journal of Wildlife Management 73(5):788-795.

Quigley, H. B., and P. G. Crawshaw, Jr. 1992. A conservation plan for the jaguar *Panthera onca* in the Pantanal region of Brazil. Biological Conservation 61(3):149-157.

Rabinowitz, A. 1999. Present status of jaguars (*Panthera onca*) in the southwestern United States. The Southwestern Naturalist 44(1):96-100.

Rabinowitz A.R and B. G. Nottingham Jr. 1986. Ecology and behaviour of the jaguar (*Panthera onca*) in Belize, Central America. Journal of Zoology 210:149-159.
Rabinowitz and Zeller 2010

Robinson, M.J., C. Bradley, and J. Boyd. 2006. Potential habitat for jaguars in New Mexico. Report to AGFD (AGFD) from Center for Biological Diversity, Silver City, New Mexico.

Rosas-Rosas O.C. 2006. Ecological status and conservation of jaguars (*Panthera onca*) in northeastern Sonora, Mexico. Ph.D. Dissertation, New Mexico State University, Las Cruces, New Mexico.

Rosas-Rosas 2011 (August 6, 2011, email to FWS)

Rosas-Rosas, O. C., and L. C. Bender. 2012. Population status of jaguars (*Panthera onca*) and pumas (*Puma concolor*) in northeastern Sonora, Mexico. Acta Zoológica Mexicana 28: 86-101.

Rosas-Rosas O.C., L.C. Bender, and R. Valdez. 2008. Jaguar and puma predations on cattle calves in northeastern Sonora, Mexico. Rangeland Ecology and Management 61(5):554-560.

Rosas-Rosas O.C., L.C. Bender, R. Valdez. 2010. Habitat correlates of jaguar kill-sites of cattle in northeastern Sonora, Mexico. Human-Wildlife Interactions 4(1):103-111.

Sanderson, E. W., and K. Fisher. 2011. Digital mapping in support of recovery planning for the northern jaguar. Final report under agreement F11AC00036 (and modification #0001) between the U.S. Fish and Wildlife Service and the Wildlife Conservation Society. Pp. 1-11 of 20.

Sanderson, E. W., and K. Fisher. 2013. Jaguar Habitat Modeling and Database Update. Wildlife Conservation Society. Bronx, New York. 10 pp. plus appendices.

Sanderson, E.W., K.H. Redford, C.B. Chetkiewicz, R.A. Medellin, A.R. Rabinowitz, J.G. Robinson, and A.B. Taber. 2002. Planning to save a species: the jaguar as a model. Conservation Biology 16(1):58-72.

Sawyer, H. R.M. Nielson, F. Lindzey, and L.L. McDonald. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. Journal of Wildlife Management. 70(2): 396–403.

Seymour, K.L. 1989. *Panthera onca*. Mammalian Species 340:1-9.

Sierra Institute Field Studies Program in Arizona. 2000. Jaguar habitat in southern Arizona and New Mexico. Unpublished report, University of California Extension, Santa Cruz.

Swank, W.G. and J.G. Teer. 1989. Status of the jaguar - 1987. Oryx 23:14-21.

Tetra Tech. 2008. Background Ambient Noise Study. Project No. 114-320776 (100-SFO-T22436). Prepared for Rosemont Copper Company. Tucson, Arizona: Tetra Tech. October.

Tetra Tech. 2009d. Supplemental Noise Study, Rosemont Copper Project. Project No. 114-320794 (100-SFO-T22436; 100-SFO-T23373). Prepared for Rosemont Copper Company. Tucson, Arizona: Tetra Tech. April.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874. Prepared for Rosemont Copper. Tucson, Arizona. November.

U.S. Fish and Wildlife Service (FWS). 1990. Listed Cats of Texas and Arizona Recovery Plan (with Emphasis on the Ocelot. U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico. 131pp.

U.S. Fish and Wildlife Service (FWS). 2004. Memorandum from the Director to the Regional Directors of Regions 1, 2, 3, 4, 5, 6, and 7 and the California-Nevada Operations Office regarding Application of the “Destruction or Adverse Modification” Standard under Section 7(a)(2) of the Endangered Species Act. 3pp.

U.S. Fish and Wildlife Service. 2010. Ocelot Recovery Plan (*Leopardus pardalis*) - Draft First Revision. Southwest Region, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 99 pp. plus appendices.

U.S. Fish and Wildlife Service (FWS). 2012a. Recovery outline for the jaguar (*Panthera onca*). April 2012. 59 pp.

U.S. Fish and Wildlife Service (FWS). 2012b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Jaguar: Proposed Rule 77 FR 50214-50242

U.S. Fish and Wildlife Service (FWS) 2012c. Memorandum from the Field Supervisor to Industrial Economics, Inc. regarding Incremental Effects Memorandum for the Economic Analysis for the Proposed Rule to Designate Critical Habitat for the Jaguar. 16 pp.

U.S. Forest Service (USFS). 2011. Draft Environmental Impact Statement for the Rosemont Copper Project. A Proposed Mining Operation in Coronado National Forest, Pima County, Arizona: U.S. Forest Service, Southwestern Region. September.

U.S. Forest Service (USFS). 2012. Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Pima County, Arizona, Nogales Ranger District. February. 65 pp.

U.S. Forest Service (USFS). 2013a. [Second] Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest. Coronado National Forest, Tucson, AZ. 65pp.

U.S. Forest Service (USFS). 2013b. Comments submitted in response to the U.S. Fish and Wildlife Service preliminary, administrative draft Effects analysis for the jaguar.

Valdez, R., A. Martínez-Mendoza, O.C. Rosas-Rosas. 2002. Componentes históricos y actuales del hábitat del jaguar en el noroeste de Sonora, México. Pp. 367-377 *in* Medellin, R.A., C. Equihua, C.L.B. Chetkiewicz, P.G. Crawshaw, Jr., A. Rabinowitz, K.H. Redord, J.G. Robinson, E.W. Sanderson, and A.B. Taber, comps. 2002. El jaguar en el nuevo millenio. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, México. 647pp.

WestLand Resources, Inc. November 9, 2012. Rosemont Copper Project: Potential Effects of the Rosemont Project to Jaguar and Proposed Jaguar Critical Habitat Prepared for: Rosemont Copper CompanyWildlife Conservation Society 2007

Young, A. and G. Clarke. 2000. Genetics, Demography and Viability of Fragmented Populations. Cambridge University Press, Cambridge, UK.

Zarza, H., C. Chávez, and G. Ceballos. 2007. Uso de hábitat del jaguar a escala regional en un paisaje dominado por actividades humanas en el sur de la península de Yucatán. Pp 101-110 in Ceballos, G, C. Chávez, R. List y H. Zarza (editores). 2007. Conservación y manejo del jaguar en México: estudios de caso y perspectivas. Conabio - Alianza WWF-Telcel – Universidad Nacional Autónoma de México. México.

Zarza, H., C. Chávez, and G. Ceballos. 2010. Asesoría para la coordinación e integración de los trabajos realizados sobre las poblaciones de jaguar en México. Instituto de Ecología, Universidad Nacional Autónoma de México. México.

Zeller, K. 2007. Jaguars in the New Millenium Data Set Update: The State of the Jaguar in 2006. Unpublished Report. Wildlife Conservation Society, Bronx, New York, USA.

Pima Pineapple Cactus

Anable, M.E., M. P. McClaran, and G.B. Ruyle. 1992. Spread of introduced Lehmann lovegrass (*Eragrostis lehmanniana* Nee.) in southern Arizona, USA. Biological Conservation 61:181-188.

Baker, M. 2004. Phenetic analysis of *Coryphantha*, section *Robustispina* (Cactaceae), part 1: stem characters. Final report submitted to U.S. Fish and Wildlife Service under contract with the Arizona Board of Regents, University of Arizona, Tucson. 21 pp.

Baker, M. 2005. Geographic distribution and DNA analysis of *Coryphantha robustispina* ssp. *robustispina*, part 1: geographic distribution. Final report submitted to the Department of Agriculture on 7 July 2005. 7 pp. + appendices.

Baker, M. 2006. 2005 demographic study of *Coryphantha robustispina* ssp. *robustispina*. Status report prepared for Bureau of Reclamation. 17 pp.

Baker, M. 2011. A demographic study of *Coryphantha robustisipina* ssp. *robustispina* – report to BOR. Phoenix Area Office. 51 pp.

Benson, L. 1982. The Cacti of the United States and Canada. Stanford University Press, Stanford, CA. Page 820.

Brown, D. E. 1982. Biotic communities of the American Southwest – United States and Mexico. Desert Plants (4)1-4: 1-342.

Buffelgrass Working Group. 2007. Buffelgrass invasion in the Sonoran Desert: Imminent risks and unavoidable mitigation. 4 pp. http://www.buffelgrass.org/pdf/invasion.pdf, accessed May 19, 2009.

Ecosphere Environmental Services Inc. 1992. Final Report: A survey for threatened and endangered plant species at three proposed reservoir sites and associated pipelines. Bureau of Reclamation contract 0-CS-32-1950. Farmington, NM. 69 pp.

Gori, D. F. and C. A. F. Enquist. 2003. An assessment of the spatial extent and condition of grasslands in Central and Southern Arizona, Southwestern New Mexico and Northern Mexico. Prepared by the Nature Conservancy, Arizona Chapter. 28 pp.

Johnson, M. B. 2004. Cacti, other succulents, and unusual xerophytes of southern Arizona. Boyce Thompson Southwestern Arboretum, Superior, AZ. 96 pp.

McDonald, C. J. 2005. Conservation of the rare Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*): recruitment after fires and pollination in the Altar Valley of southern Arizona. Master of Science Thesis, School of Natural Resource, The University of Arizona. 82 pp.

McPherson, G. R. 2002. Relationship of ecological variables in the field with the presence of

Pima pineapple cactus. Report to USFWS under agreement 1448-20181-01-J818. 4 pp.

Paredes-Aguilar, R., T. R. Van Devender, and R. S. Felger. 2000. Cactáceas de Sonora, México: Su diversidad, uso, y conservación. Instituto del Medio Ambiente y el Desarrollo Sustenable del Estado de Sonora (IMADES), Hermosillo, Sonora y Arizona-Sonora Desert Museum, Tucson, AZ. 143 pp.

Phillips, A. M. III, B. G. Phillips, and N. Brian. 1981. Status report for *Coryphantha scheeri* var. *robustispina*. Unpublished Report. U.S. Fish and Wildlife Service, Office of Endangered Species, Albuquerque, NM.

Pima County. 1998. Native Plant Preservation. Chapter 18.72.

RECON Environmental, Inc. 2006. Draft Pima County Multi-Species Conservation Plan, Pima County, Arizona and Attachments.

Roller, P. S. and W. L. Halvorson. 1997. Fire and Pima pineapple cactus (*Coryphantha scheeri* Kuntze var. *robustispina* Schott) in southern Arizona. *In* Proceedings of Fire Effects on Rare and Endangered Species and Habitats Conference, Coeur d'Alene, Idaho. Pp. 267-274.

Routson, R., M. Dimmitt, and R. C. Brusca. 2004. A demographic study of *Coryphantha scheeri* var. *robustispina*. Final report to USFWS. NFWF contract # 2000-0015. 18 pp.

Ruyle, G. B., B. A. Roundy, and J. R. Cox. 1988. Effects of burning on germinability of Lehmanns lovegrass. Journal of Range Management 41:404-406.

Schmalzel, R. J., R. T. Nixon, A. L. Best, and J. A. Tress. 2004. Morphometric variation in *Coryphantha robustispina* (Cactaceae). Systematic Botany 29:553-568.

SWCA, Inc. 2001. September 12, 2001 Technical Memorandum regarding the PPC mitigation program at Las Campanas.

U.S. Fish and Wildlife Service. 1993. Determination of endangered status for the plant PPC (*Coryphantha scheeri* var. *robustispina*). Federal Register 58(158):49875-49880.

U.S. Fish and Wildlife Service. 2005. Biological Opinion on the Buenos Aires National Wildlife Refuge Fire Management Plan for the 2005-2008 Burn Seasons. Arizona Ecological Services Office, Phoenix, Arizona. 56 pp.

U.S. Fish and Wildlife Service. 2007. 5-year review for Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). Arizona Ecological Services Office, Phoenix, Arizona. 17 pp. Available at: http://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/PimaPineappleCactus/PPC_5yrReview.pdf

University of Arizona. 2009. Cactus, agave, yucca, and ocotillo. Arizona Cooperative

Extension, College of Agriculture and Life Sciences. Publication AZ1125. Available at: http://ag.arizona.edu/pubs/garden/az1225.pdf.

Vasek, F.C., H.B. Johnson, and D.H. Eslinger. 1975. Effects of pipeline construction on creosote bush scrub vegetation of the Mojave Desert. Madroño 23: 1-13.

WestLand Resources, Inc. 2004. January 26, 2004, Technical Memorandum regarding the transplanted PPC at the Madera Highland Reserve.

WestLand Resources, Inc. 2008. May 22, 2008, Technical Memorandum regarding the survival of transplanted Pima pineapple cactus on the Sycamore Highland Property.

Chiricahua Leopard Frog

Berger L., R. Speare, P. Daszak, D.E. Green, A.A. Cunningham, C.L. Goggins, R. Slocombe, M.A. Ragan, A.D. Hyatt, K.R. McDonald, H.B. Hines, K.R. Lips, G. Marantelli, and H. Parkes. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proceedings of the National Academy of Science, USA 95:9031-9036.

Blaustein, A.R, and P. T. J. Johnson. 2010. When an infection turns lethal. Nature 465:881-882.

Bradford, D.F. 1989. Allotopic distribution of native frogs and introduced fishes in high Sierra Nevada lakes of California; Implications of the negative effect of fish introductions. Copeia 1898:775-778.

Bradford, D.F., F. Tabatabai, and D.M. Graber. 1993. Isolation of remaining ppopulations of the native frog, *Rana muscosa*, by introduced fishes in Sequioa and Kings Canyon national Parks, California. Conservation Biology 7(4):882-888.

Bradley, G.A., P.C. Rosen, M.J. Sredl, T.R. Jones, and J.E. Longcore. 2002. Chytridomycosis in native Arizona frogs. Journal of Wildlife Diseases 38(1):206-212.

Campbell, J.A. 1998. Amphibians and Reptiles of northern Guatemala, the Yucatan, and Belize. University of Oklahoma Press, Norman, Oklahoma.

Carey, C., N. Cohen, and L. Rollins-Smith. 1999. Amphibian declines: an immunological perspective. Developmental and Comparative Immunology 23:459-472.

Carey, C., W.R. Heyer, J. Wilkinson, R.A. Alford, J.W. Arntzen, T. Halliday, L. Hungerford, K.R. Lips, E.M. Middleton, S.A. Orchard, and A.S. Rand. 2001. Amphibian declines and environmental change: use of remote sensing data to identify environmental correlates. Conservation Biology 15(4):903-913.

Collins, J.P., J.L. Brunner, V. Miera, M.J. Parris, D.M. Schock, and A. Storfer. 2003. Ecology and evolution of infectious disease. Pages 137-151 *in* R.D. Semlitsch, Amphibian Conservation. Smithsonian Books, Washington D.C.

Clarkson, R.W., and J.C. Rorabaugh. 1989. Status of leopard frogs (*Rana pipiens* Complex) in Arizona and southeastern California. Southwestern Naturalist 34(4):531-538.

Crother, B.I. (ed.). 2008. Scientific and Common Names for Amphibians and Reptiles of North America North of México. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 37:1-84

Dahms, C.W., and B.W. Geils (tech. eds). 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO, US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Danzer, S.R., C.H. Baisan, and T.W. Swetnam. 1997. The influence of fire and land-use history on stand dynamics in the Huachuca Mountains of southeastern Arizona. Appendix D in Robinett, D., R.A. Abolt, and R. Anderson, Fort Huachuca Fire Management Plan. Report to Fort Huachuca, AZ.

Daszak, P. 2000. Frog decline and epidemic disease. International Society for Infectious Diseases. Http://www.promedmail.org.

Davidson, C. 1996. Frog and toad calls of the Rocky Mountains. Library of Natural Sounds, Cornell Laboratory of Ornithology, Ithaca, NY.

Davidson, D., Pessier, A.P., J.E. Longcore, M. Parris, J. Jancovich, J. Brunner, D. Schock, and J.P. Collins. 2000. Chytridiomycosis in Arizona (USA) tiger salamanders. Page 23 *in* Conference and Workshop Compendium: Getting the Jump! On amphibian diseas. Cairns, Australia, August 2000.

DeBano, L.F., and D.G. Neary. 1996. Effects of fire on riparian systems. Pages 69-76 *in* P.F. Ffolliott, L.F. DeBano, M.B. Baker, G.J. Gottfried, G. Solis-Garza, C.B. Edminster, D.G Neary, L.S. Allen, and R.H Hamre (tech. coords.). Effects of fire on Madrean province ecosystems, a symposium proceedings. USDA Forest Service, General Technical Report RM-GTR-289.

Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque.

Diaz, J.V., and G.E.Q. Diaz. 1997. Anfibios y reptiles de Aguascalientes. Grupo Impressor Mexico, Aguascalientes, Aguascalientes, MX.

Dole, J.W. 1968. Homing in leopard frogs, *Rana pipiens*. Ecology 49:386-399.

Dole, J.W. 1971. Dispersal of recently metamorphosed leopard frogs, *Rana pipiens*. Copeia 1971:221-228.

Dole, J.W. 1972. Evidence of celestial orientation in newly-metamorphosed *Rana pipiens*. Herpetologica 28:273-276.

Fellers, G.M., D.E. Green, and J.E. Longcore. 2001. Oral chytridiomycosis in the mountain yellow-legged frog (*Rana muscosa*). Copeia 2000(4):945-953.

Fellers, G.M., L.L. McConnell, D. Pratt, and S. Datta. 2004. Pesticides in mountain yellow-legged frogs (*Rana muscosa*) from the Sierra Nevada Mountains of California, USA. Environmental Toxicology and Chemistry 23(9):2170-2177.

Fellers, G.M., K.L. Pope, J.E. Stead, M.S. Koo, and H.H. Welsh, Jr. 2007. Turning population trend monitoring into active conservation: Can we save the Cascades frog (*Rana cascadae*) in the Lassen region of California. Herpetological Conservation and Biology 3(1):28-39.

Fernandez, P.J., and J.T. Bagnara. 1995. Recent changes in leopard frog distribution in the White Mountains of east central Arizona. Page 4 in abstracts of the First Annual Meeting of the Southwestern Working Group of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Fernandez, P.J., and P.C. Rosen. 1996. Effects of the introduced crayfish *Oronectes virilis* on the native aquatic herpetofauna in Arizona. Report to the Arizona Game and Fish Department, Heritage Program, IIPAM Project No. I94054.

Fernandez, P.J. and P.C. Rosen. 1998. Effects of introduced crayfish on the Chiricahua leopard frog and its stream habitat in the White Mountains, Arizona. Page 5 *in* abstracts of the Fourth Annual Meeting of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Frost, J.S., and J.T. Bagnara. 1977. Sympatry between *Rana blairi* and the southern form of leopard frog in southeastern Arizona (Anura: Ranidae). The Southwestern Naturalist 22(4):443-453.

Gingrich, R.W. 2003. The political ecology of deforestation in the Sierra Madre Occidental of Chihuahua. Online publication.

Green, D.E., and C.K. Dodd, Jr. 2007. Presence of amphibian chytrid fungus *Batrochochytrium dendrobatidis* and other amphibian pathogens at warm-water fish hatcheries in southeastern North Ameroca. Herpetological Conservation and Biology 2(1):43-47.

Hale, S.F. 2001. The status of the Tarahumara frog in Sonora, Mexico based on a re-survey of selected localities, and search for additional populations. Report to the U.S. Fish and Wildlife Service, Phoenix, Arizona.

Halliday, T.R. 1998. A declining amphibian conundrum. Nature 394:418-419.

Jennings, R.D. 1987. The status of *Rana berlandieri*, the Rio Grande leopard frog, and *Rana* *yavapaiensis*, the lowland leopard frog, in New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Jennings, R.D. 1995. Investigations of recently viable leopard frog populations in New Mexico: *Rana chiricahuensis* and *Rana yavapaiensis*. New Mexico Game and Fish Department, Santa Fe.

Knapp, R.A., and K.R. Mathews. 2000. Nonnative fish introductions and the decline of the Mountain yellow-legged frog from within protected areas. Conservation Biology 14(2):428-438.

Lemos-Espinal, J.A., and H.M. Smith. 2007. Anfibios y Reptiles del Estado de Chihuahua, México/Amphibians and Reptiles of the State of Chihuahua, México. Universidad Nacional Autonoma de México y CONABIO, México D.F.

Longcore, J.E., A.P. Pessier, and D.K. Nichols. 1999. *Batracytrium dendrobatidis* gen. Et sp. Nov., a chytrid pathogenic to amphibians. Mycologia 91(2):219-227.

Mazzoni, R., A.A. Cunninghan, P. Daszak, A. Apolo, E. Perdomo, and G. Speranza. 2003. Emerging pathogen of wild amphibians in frogs (*Rana catesbeiana*) farmed for international trade. Emerging Infectious Diseases 9(8):3-30.

Morehouse, E.A., T.Y. James, A.R.D. Ganley, R. Vilgalys, L. Berger, P.J. Murphys, and J.E. Longcore. 2003. Multilocus sequence typing suggests the chytrid pathogen of amphibians is a recently emerged clone. Molecular Ecology 12:395-403.

Morell, V. 1999. Are pathogens felling frogs? Science 284:728-731.

Painter, C.W. 2000. Status of listed and category herpetofauna. Report to US Fish and Wildlife Service, Albuquerque, NM. Completion report for E-31/1-5.

Picco, A.M., and J.P. Collins. 2008. Amphibian commerce as a likely source of pathogen pollution. Conservation Biology 22(6):1582-1589.

Platz, J.E., and J.S. Mecham. 1979. *Rana chiricahuensis*, a new species of leopard frog (*Rana pipiens* Complex) from Arizona. Copeia 1979(3):383-390.

Platz, J.E., and J.S. Mecham. 1984. *Rana chiricahuensis*. Catalogue of American Amphibians and Reptiles 347.1.

Pounds, J.A., and M.L. Crump. 1994. Amphibian declines and climate disturbance: the case of the golden toad and the harlequin frog. Conservation Biology 8(1)72-85.

Reaser, J.K., and D.S. Pilliod. 2005. *Rana luteiventris* Thompson 1913. Columbia spotted frog. Pp. 559-563 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Rorabaugh, J.C. 2005. *Rana berlandieri* Baird, 1854(a), Rio Grande leopard frog. Pages 530-

532 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Rorabaugh, J.C. 2008. An introduction to the herpetofauna of mainland Sonora, México, with comments on conservation and management. Journal of the Arizona-Nevada Academy of Science 40(1):20-65.

Rosen, P.C., and C. Melendez. 2006. Observations on the status of aquatic turtles and ranid frogs in northwestern Mexico. Pp. 104-106 *in* Extended Abstracts, Proceedings of the Sizth Conference on Research and Resource Management in the Southwestern Deserts. USGS Southwest Biological Science Center, Sonoran Desert Research Station, Tucson, AZ.

Rosen, P.C., and C.R. Schwalbe. 1998. Using managed waters for conservation of threatened frogs. Pages 180-202 *in* Proceedings of Symposium on Environmental, Economic, and Legal Issues Related to Rangeland Water Developments. November 13-15, 1997, Tempe, AZ.

Rosen, P.C., C.R. Schwalbe, D.A. Parizek, P.A. Holm, and C.H. Lowe. 1994. Introduced aquatic vertebrates in the Chiricahua region: effects on declining native ranid frogs. Pages 251-261 *in* L.F. DeBano, G.J. Gottfried, R.H. Hamre, C.B. Edminster, P.F. Ffolliott, and A. Ortega-Rubio (tech. coords.), Biodiversity and management of the Madrean Archipelago. USDA Forest Service, General Technical Report RM-GTR-264.

Rosen, P.C., C.R. Schwalbe, and S.S. Sartorius. 1996. Decline of the Chiricahua leopard frog in Arizona mediated by introduced species. Report to Heritage program, Arizona Game and Fish Department, Phoenix, AZ. IIPAM Project No. I92052.

Seburn, C.N.L., D.C. Seburn, and C.A. Paszkowski. 1997. Northern leopard frog (*Rana pipiens*) dispersal in relation to habitat. Herpetological Conservation 1:64-72.

Sinsch, U. 1991. Mini-review: the orientation behaviour of amphibians. Herpetological Journal 1:541-544.

Skerratt, L.F., L. Berger, and R. Speare. 2007. Natural history of Bd. Abstract in Program for the Conference, Amphibian Declines and Chytridomycosis: Translating Science into Urgent Action, Tempe, AZ.

Snyder, J., T. Maret, and J.P. Collins. 1996. Exotic species and the distribution of native amphibians in the San Rafael Valley, AZ. Page 6 *in* abstracts of the Second Annual Meeting of the Southwestern United States Working Group of the Declining Amphibian Populations Task Force, Tucson, AZ.

Speare, R., and L. Berger. 2000. Global distribution of chytridiomycosis in amphibians. Http://www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm.11 November 2000.

Sredl, M.J., and D. Caldwell. 2000. Wintertime populations surveys - call for volunteers.

Sonoran Herpetologist 13:1.

Sredl, M.J., and J.M. Howland. 1994. Conservation and management of Madrean populations of the Chiricahua leopard frog, *Rana chiricahuensis*. Arizona Game and Fish Department, Nongame Branch, Phoenix, AZ.

Sredl, M.J., J.M. Howland, J.E. Wallace, and L.S. Saylor. 1997. Status and distribution of Arizona's native ranid frogs. Pages 45-101 *in* M.J. Sredl (ed). Ranid frog conservation and management. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program, Technical Report 121.

Sredl, M.J., and R.D. Jennings. 2005. *Rana chiricahuensis*: Chiricahua leopard frogs. Pages 546-549 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Company, Boston, MA.

Swetnam, T.W., and C.H. Baisan. 1996. Fire histories of montane forests in the Madrean Borderlands. Pages 15-36 *in* P.F. Ffolliott *et al.* (Tech. Coord.), Effects of fire on Madrean Province ecosystems. USDA Forest Service, General Technical Report, RM-GTR-289.

U.S. Fish and Wildlife Service (FWS). 2007. Chiricahua leopard frog (*Rana chiricahuensis*) recovery plan. Region 2, U.S. Fish and Wildlife Service, Albuquerque, NM.

U.S. Fish and Wildlife Service (FWS). 2009. Endangered and threatened wildlife and plants; partial 90-day finding on a petition to list 475 species in the Southwestern United States as threatened or endangered with critical habitat; proposed rule. Federal Register 74(240):66866-66905.

Vredenburg, V., G.M. Fellers, and C. Davidson. 2005. *Rana muscosa* Camp 1917b. Mountain yellow-legged frog. Pp. 563-566 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Vredenburg, V. T., Knapp, R. A., Tunstall, T. S. & Briggs, C. J. 2010. Dynamics of an emerging disease drive large-scale amphibian population extinctions. Proc. Natl Acad. Sci. USA 107:9689–9694.

Wallace, E. 2003. Status assessment of lowland leopard frogs in mountains of Coronado National Forest – Santa Catalina Ranger District. Purchase Order 43-8197-3-0058. Coronado national Forest, Tucson, AZ.

Weldon, C., L.H. du Preez, A.D. Hyatt, R. Muller, and R. Speare. 2004. Origin of the amphibian chytrid fungus. Emerging Infectious Diseases 10(12):3-8.

Witte, C.L., M.J. Sredl, A.S. Kane, and L.L. Hungerford. 2008. Epidemiological analysis of factors associated with local disappearances of native ranid frogs in Arizona. Conservation Biology 22:375-383.

Effects to Aquatic Ecosystems

Bodner, G. and K. Simms. 2008. State of the Las Ciénegas NCA, Part III: Condition of Riparian Habitats and Channel Geomorphology. The Nature Conservancy in Arizona and the Bureau of Land Management, Tucson, Arizona. XX pp. 69 pp.

Cosgrove, D.M. and G.S. Johnson. 2005. Aquifer Management Zones Based on Simulated Surface-Water Response Functions. Journal of Water Resources Planning and Management. 131(2): 89-100.

Huth, H. 1996. Personal Communication with E.L. Knight, Cienega Creek Group Thesis Practicum, Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona

Knight, E.L. 1996. A water budget and land management recommendations for upper Cienega Creek basin. Master's Thesis, University of Arizona, Department of Hydrology and Water Resources. 119 pp.

Leake, S.A. 2011. Capture—Rates and Directions of Groundwater Flow Don't Matter! Ground Water 49(4): 456-458.

Leake, S.A., D.R. Pool, and J.M. Leenhouts. 2008, Simulated effects of ground-water withdrawals and artificial recharge on discharge to streams, springs, and riparian vegetation in the Sierra Vista Subwatershed of the Upper San Pedro Basin, southeastern Arizona: U.S. Geological Survey Scientific Investigations Report 2008-5207, 14 p.

Montgomery and Associates Inc. 2010. Revised Report: Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-closure, Vol. 1: Text and Tables. Prepared for Rosemont Copper. Tucson, Arizona: Montgomery and Associates Inc. August 30.

Myers, T. 2010. Technical Memorandum: Updated Groundwater Modeling Report Proposed Rosemont Open Pit Mining Project. Prepared for Pima County and Pima County Regional Flood Control District. Reno, Nevada. April 21.

Pima County. 2012. Agency Review of the Internal Working Draft of the Rosemont Copper Project DEIS: Special Expertise Required Comment Form. 9 pp.

Port, P.S. 2012. United States Department of the Interior, Office of the Secretary, Office of Environmental Policy and Compliance Comments on the Draft EIS, US Forest Service, Rosemont Copper Project, Proposed Construction, Operation with Concurrent Reclamation and Closure of an Open-Pit Copper Mine, Coronado National Forest, Pima County, AZ. 12 pp.

Propst. L. 2012. Comments on Draft Environmental Impact Statement for Proposed Rosemont Mine Plan of Operations. Letter from Jim Upchurch, Coronado National Forest Supervisor. 16 pp, plus Postscript.

SRK Consulting. 2012. Memorandum to Chris Garrett of SWCA regarding Pt. 3 SWCA Questions 1 through 3 - Professional Opinions to Assess Impacts to Distant Surface Waters and Modeling Certainty. Pp 22-28 *in* SWCA, Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process.

SWCA. 2012. Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process. November 12, 2012. 65 pp.

Tetra Tech. 2010c. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874. Prepared for Rosemont Copper. Tucson, Arizona. November.

U.S. Forest Service (USFS). 2011a. Draft Environmental Impact Statement for the Rosemont Copper Project. A Proposed Mining Operation in Coronado National Forest, Pima County, Arizona: U.S. Forest Service, Southwestern Region. September.

U.S. Forest Service (USFS). 2012. Letter from Jim Upchurch, Coronado National Forest Supervisor to Jean Calhoun, Arizona Ecological Services Office Assistant Field Supervisor Documenting the Conclusions of an October 18, 2012, groundwater modeling forum. 2 pp.

U.S. Forest Service (USFS). 2013a. Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Pima County, Arizona, Nogales Ranger District. February. 65 pp.

U.S. Forest Service (USFS). 2013b. Transmittal of Comments on the U.S. Fish and Wildlife Service Preliminary Draft Effects to Aquatic Ecosystems, Effects to Riparian Ecosystems, and Effects to the Southwestern Willow Flycatcher sections.

Gila Chub

Aquatic Nuisance Species Task Force. 1994. Report to Congress: Findings, conclusions, and recommendations of the intentional introductions policy review.

Arthington, A. H., S. Hamlet, and D. R. Bluhdorn. 1990. The role of habitat disturbance in the establishment of introduced warm-water fishes in Australia. Pages 61-66 in Pollard, D. A., ed., Proceedings Australian Society for Fish Biology, Workshop on Introduced and Translocated Fishes and their Ecological Effects, Bureau of Rural Resources Proc. No. 8.

Bagley, B. E. 2002. Survey of Verde River drainage, Arizona, for loach minnow (*Tiaroga cobitis*). Final Report to U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Contract No. 22410-0-M525, Phoenix, AZ.

Bagley, B. E., D. A. Hendrickson, F. J. Abarca, and S. D. Hart. 1991. Status of the Sonoran topminnow (*Poeciliopsis occidentalis*) and desert pupfish (*Cyprinodon macularius*) in Arizona. Report on Project E5-2, Job 9, Title VI of the ESA, AGFD, Phoenix, AZ. 64pp.

Bahre, C. J. 1991. A legacy of change: Historic land use and vegetation in the Arizona borderlands. University of Arizona Press, Tucson, AZ. 231pp.

Bahre, C. J., and C. F. Hutchinson. 1985. The impact of historic fuelwood cutting on the semidesert woodlands of southeastern Arizona. J. Forest History Oct.:175-186.

Belsky, A. J. 1986. Does herbivory benefit plants? A review of the evidence. American Naturalist 127(6):870-892.

Belsky, A. J., and D. M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior west. Conservation Biology 11(2):315-327.

Bestgen, K. R. 1985. Distribution, biology and status of the roundtail chub, Gila robusta, in the Gila River basin, New Mexico. MS Thesis, Colorado State Univ., Fort Collins, CO. 104pp.

Bodner, G., J. Simms, and D. Gori. 2007. State of the Las Cienegas National Conservation Area: Gila Topminnow population status and trends 1989–2005. The Nature Conservancy, Tucson, AZ.

Bodner, G., and K. Simms. 2008. State of the Las Cienegas National Conservation Area; Part 3: Condition and trend of riparian target species, vegetation and channel geomorphology. The Nature Conservancy, Tucson, Arizona, and Bureau of Land Management, Tucson Field Office, Tucson, AZ.

Bogan, M.T., and D.A. Lytle. 2011. Severe drought drives novel community trajectories in desert stream pools. Freshwater Biology 56(10):2070–2081.

Bonar, S. A., C. J. Carveth, A. M. Widmer, and J. Simms. 2005. Upper temperature tolerance of loach minnow and spikedace under acute, chronic, and fluctuating thermal regimes. Fisheries research report 04-05, Arizona Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, University of Arizona, Tucson, AZ. 58pp.

Bota, L. 1996. Modeling of groundwater flow and surface/groundwater interaction for upper Cienega Creek Basin. MS. Thesis, University of Arizona, Tucson, AZ.

Bozek, M. A., and M. K. Young. 1994. Fish mortality resulting from delayed effects of fire in the Greater Yellowstone Ecosystem. Great Basin Naturalist 54:91-95.

Brown, D. E., C. H. Lowe, and J. F. Hausler. 1977. Southwestern riparian communities:

their biotic importance and management in Arizona. Johnson, R. R., and D.A. Jones, eds., Importance, Preservation, and Management of Riparian Habitats: a Symposium. USDA Forest Service, Gen. Tech. Rep. Rm-43, Rocky Mt. Forest and Range Experiment Station, Denver, CO.

Brown, D. K., A. A. Echelle, D. L. Propst, J. E. Brooks, and W. L. Fisher. 2001. Catastrophic wildfire and number of populations as factors influencing risk of extinction for Gila trout (Oncorhynchus gilae). Western North American Naturalist 61:139–148.

Brown, D. P., and A. C. Comrie. 2004. A winter precipitation 'dipole' in the western United States associated with multidecadal ENSO variability. Geophysical Research Letters 31.

Brown, T. J., B. L. Hall, and A. L. Westerling. 2004. The impact of twenty-first century climate change on wildlife fire danger in the western United States: An applications perspective. Climatic Change 62:365-388.

Bryan, K. 1925. Date of channel trenching (arroyo cutting) in the arid southwest. Science 62:338-344.

Burns, D. C. 1991. Cumulative effect of small modifications to habitat. Fisheries 16:12–17.

Caldwell, D., D. Hall, and P. Rosen. 2011. F.R.O.G. Project, Las Cienegas National Conservation Area. Regional Enhancement Work Sites Evaluation Proposal for Conservation of Native Aquatic Vertebrates. Review Draft. March.

California Department of Water Resources. 2008. Water and Border Area Climate Change: An Introduction. Special report prepared for the 26th Border Governors Conference. Sacramento, California: California Department of Water Resources. July.

Carlson, C. A., and R. T. Muth. 1989. The Colorado River: lifeline of the American Southwest. Pages 220-239 in Dodge, D.P., ed., Proceedings of the International Large River symposium, Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Carveth, C. J., A. M. Widmar, and S. A. Bonar. 2006. Comparisons of upper thermal tolerances of native and nonnative fish in Arizona. Trans. American Fisheries Soc. 135(6):1433–1440.

Christensen, N. S., A. W. Wood, N. Voisin, D. P. Lettenmaier, and R. N. Palmer. 2004. The effects of climate change on the hydrology and water resources of the Colorado River Basin. Climatic Change 62:337–363.

City of Tucson and Pima County, Arizona. 2009. Chuck Huckelberry and Mike Letcher, Riparian Protection Technical Paper, Water and Wastewater Infrastructure, Supply and Planning Study, Phase II. Prepared for City/County Waste and Wastewater Study Oversight Committee.

Claudi, R., and J. H. Leach. 2000. Nonindigenous freshwater organisms. Vectors, biology, and impacts. Lewis Publishers, Boca Raton, FL. 464 pp.

CLIMAS. 2013. Southwest climate outlook, March 27, 2013. Climate Assessment for the Southwest (CLIMAS) project, the University of Arizona Cooperative Extension, and the Arizona State Climate Office, 2(3)1-18.

Colorado River Basin Water Supply and Demand Study Team. 2011. Reclamation: Managing Water in the West. Interim Report No. 1; Colorado River Basin Water Supply and Demand Study. Technical Report C - Water Demand Assessment. U.S. Department of the Interior, Bureau of Reclamation. June.

Cooper, C. F. 1960. Changes in vegetation, structure and growth of Southwestern pine forests since white settlement. Ecological Monographs 30: 129-164.

Courtenay, W. R., Jr. 1993. Biological pollution through fish introductions. Pages 35-61 in B. N. McKnight, ed., Biological Pollution, The Control and Impact of Invasive Exotic Species, Indiana Academy of Science, Indianapolis.

Courtenay, W. R., Jr., and J. R. Stauffer. 1984. Distribution, biology and management of exotic fishes. Johns Hopkins University Press, Baltimore, Maryland.

Cushing, C. E., Jr., and P. A. Olson. 1963. Effects of weed burning on stream conditions. Transactions of the American Fisheries Society 92:303–305.

Davies, B. R., M. Thoms, and M. R. Meador. 1992. An assessment of the ecological impacts of inter-basin water transfers, and their threats to river basin integrity and conservation. Aquatic Conservation: Marine and Freshwater Ecosystems 2:235-349.

Davis, G. P., Jr. 1982. Man and wildlife in Arizona: The American exploration period 1824-1865. Carmony, N. B., and D. E. Brown, eds., Ariz. Game and Fish Dept. and Ariz. Coop. Wildl. Res. Unit, Somers Graphics, Inc., Scottsdale. 232pp.

de la Torre, A. C. 1970. Streamflow in the upper Santa Cruz River basin, Santa Cruz and Pima Counties, Arizona. U.S. Geological Survey, City of Tucson, Univ. of Ariz., Geol. Surv. Supply Paper 1939-A. U.S. Gov. Printing Office, Washington, D.C. 26pp. + 6 maps.

Deacon, J. E., C. Hubbs, and B. J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of southern Nevada. Copeia 1964(2):384-388.

DeMarais, B. D. 1986. Morphological variation in *Gila* (Pisces: Cyprinidae) and geologic history: Lower Colorado River basin. MS Thesis, Arizona State University, Tempe, AZ. 85pp.

DeMarais, B. D. 1995. Taxonomic history and status of the Gila chub, *Gila intermedia* (Girard). A Report to Arizona Game and Fish Department.

Desert Fishes Team. 2003. Status of federal and state listed warm water fishes of the Gila River basin, with recommendations for management. Desert Fishes Team Report 1, Phoenix, AZ.

Desert Fishes Team. 2006. Analysis of recovery plan implementation for threatened and endangered warm water fishes of the Gila River basin. Desert Fishes Team Report 3, Phoenix, AZ.

Dobyns, H. R. 1981. From fire to flood: Historic human destruction of Sonoran Desert riverine oases. Ballena Press, Anthropological Papers No. 20. 222pp.

Duce, J. T. 1918. The effect of cattle on the erosion of cañon bottoms. Science 47:450–452.

Dudley, R. K., and W. J. Matter. 2000. Effects of small green sunfish (*Lepomis cyanella*) on recruitment of Gila chub (*Gila intermedia*) in Sabino Creek, Arizona. Southwestern Naturalist 45(1):24-29.

Duncan, D., and G. Garfin. 2006. Native fish conservation and climate variability in southeastern Arizona. Pages 41-43 *in* Halvorson, B., ed., Borders, Boundaries, and Time Scales: Proceedings of the 6th Conference on Research and Resource Management in the Southwestern Deserts; Extended Abstracts, U. S. Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station, Tucson, AZ.

Eddy, F. W., and M. E. Cooley. 1983. Cultural and environmental history of Cienega Valley, southeastern Arizona. University of Arizona Press, Tucson, AZ. 60 pp.

Ehret, S., and J. Simms. n.d. [2009]. Gila chub Monitoring in Cienega Creek in 2005, 2007, and 2008 with notes on Gila topminnow, longfin dace, Sonoran mud turtle, and Huachuca water umbel. Arizona Game and Fish Department and Bureau of Land Management, Tucson, AZ.

Fisheries and Agriculture Organization (FAO). 1998. Database on introductions of aquatic species. U. N. Environment Programme. Http://www.fao.org/fi/statist/fishoft/dias/mainpage.htm.

Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8(3):629-644.

Fonseca, J. 2008. Aquifer monitoring for groundwater-dependent ecosystems, Pima County, Arizona. Office of Conservation Science, Pima County Natural Resources, Parks and Recreation, Tucson, Arizona. 38pp.

Garfin, G. 2005. Climate change in the Colorado River Basin. Pages 36-44 in Colorado River Basin Climate: Paleo, Present, Future, at http://wwa.colorado.edu/resources/colorado_river/Colorado_River_Basin_Climate.pdf

Gilbert, C. H., and N. B. Scofield. 1898. Notes on a collection of fishes from the Colorado Basin in Arizona. Proc. U.S. National Museum 20:487 499.

Gray, S. T., J. L. Betancourt, C. L. Fastie, and S. T. Jackson. 2003. Patterns and sources of multidecadal oscillations in drought-sensitive tree-ring records from the central and southern Rocky Mountains. Geophysical Research Letters 30:10.1029/2002GL016154.

Gresswell, R. E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193–221.

Griffith, J. S., and T. R. Tiersch. 1989. Ecology of fishes in Redfield Canyon, Arizona, with emphasis on Gila robusta intermedia. The Southwestern Naturalist 34:131-134.

Haddock, P. L. 1980. Compendium of water projects: Lower Colorado River basin. (Preliminary edition, excluding the Salton Sea basin). Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Haney, J., M. Robles, D. Majka, and R. MarshalL. 2009. Sustaining river flows in the face of growing water demands in Arizona. The Nature Conservancy Center for Science and Public Policy, Tucson, AZ. 11pp.

Hanson, R., and E. Brott. 2005. Citizens' council protecting Sky Island wildlife corridor. Pages 392-395 in Gottfreid, G. J., B. S. Gebow, L. G. Eskew, and C. B. Edminster, comps., Connecting Mountain Islands and Desert Seas: Biodiversity and Management of the Madrean Archipelago II. USDA Forest Service, RMRS-P-36, Rocky Mtn. Res. Stn., Ft. Collins, CO. 631pp.

Hastings, J. R., and R. M. Turner. 1965. The changing mile. Univ. of Arizona Press, Tucson, AZ.

Hedrick, P. W., T. Kim, and K. M. Parker. 2001a. Parasite resistance and genetic variation in the endangered Gila topminnow. Anim. Cons. 4: 103-109.

Hedrick, P. W., and K. M. Parker. 1998. MHC variation in the endangered Gila topminnow. Evolution 52(1):194-199.

Hedrick, P. W., K. M. Parker, and R. N. Lee. 2001b. Using microsatellite and MHC variation to identify species, ESUs, and MUs in the endangered Sonoran topminnow. Molec. Ecol. 10: 1399-1412.

Hendrickson, D. A., and W. L. Minckley. 1984. Cienegas — vanishing climax communities of the American southwest. Desert Plants 6(3):131-175.

Hereford, R. 1993. Geomorphic evolution of the San Pedro River channel since 1900 in the San Pedro Riparian National Conservation Area, southeast Arizona. USDI, Geological Survey, Open File Report 92-339. 71pp.

Hereford, R., R. H. Webb, and S. Graham. 2002. Precipitation history of the Colorado Plateau Region, 1900-2000. USGS Fact Sheet 119-02 (http://geopubs.wr.usgs.gov/ fact-sheet/fs119-02/).

Hoerling, M., and J. Eischeid. 2007. Past peak water in the southwest. Southwest Hydrology January/February 2007:18–35.

Humphrey, R. R. 1987. 90 years and 535 miles. Vegetation changes along the Mexican border. University of New Mexico Press, Albuquerque. 448pp.

Huth, H. 1996. Personal Communication with E.L. Knight, Cienega Creek Group Thesis Practicum, Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona.

Hynes, H. B. N. 1970. The ecology of running waters. University of Toronto Press, Toronto. 555pp.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate change 2001: The scientific basis. Contribution of Working Group I to the third assessment report of the Intergovernmental Panel on Climate Change. Houghton, J. T.,Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson, eds., Cambridge Univ. Press, Cambridge, United Kingdom and New York, NY.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: The physical science basis summary for policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC Secretariat, Geneva, Switzerland, http://www.ipcc.ch

Jacobs, K. L., G. M. Garfin, and B. J. Morehouse. 2005. Climate science and drought planning: The Arizona experience. J. of the American Water Resources Association 41:437-445.

Jordan, D. S. and B. W. Evermann. 1896. The fishes of North and Middle America. Part 1. Bulletin U.S. National Museum, 47:1-1240.

Kauffman, J. B., and W. C. Krueger. 1984. Livestock impacts on riparian plant communities and streamside management implications...a review. Journal of Range Management 37(5): 430-438.

Kesner, B. R., and P. C. Marsh. 2010. Central Arizona Project fish monitoring, final report: analysis of fish population monitoring data for selected waters of the Gila River Basin, Arizona, for the five-year period 2005-2009. Agreement No. R09PD32013, Submitted to U.S. Bureau of Reclamation, Glendale, AZ, Marsh and Associates, LLC, Tempe, AZ.

Kitzberger, T., P. M. Brown, E. K. Heyerdahl, T. W. Swetnam, and T. T. Veblen. 2006. Contingent Pacific-Atlantic Ocean influence on multicentury wildfire synchrony over western North America. Proceedings of the National Academy of Sciences, published online Dec 29, 2006.

Knight, E. L. 1996. A water budget and land management recommendations for upper Cienega Creek basin. MS Thesis, University of Arizona, Tucson, AZ. 119pp.

Kundzewicz, Z. W., L. J. Mata, N. W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I. A. Shiklomanov. 2007. Freshwater resources and their management. Pages 173–210 *in* Parry, M. L., O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, eds., Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

Lenart, M. 2007. Global Warming in the Southwest: Projections, Observations and Impacts. Tucson, Arizona: The Climate Assessment Project for the Southwest (CLIMAS) Institute for the Study of Planet Earth, the University of Arizona. April.

Leopold, A. 1921. A plea for recognition of artificial works in forest erosion control policy. Journal of Forestry 19:267 273.

Leopold, A. 1924. Grass, brush, timber, and fire in southern Arizona. J. Forestry 22:1 10.

Leopold, A. 1946. Erosion as a menace to the social and economic future of the Southwest. A paper read to the New Mexico Association for Science, 1922. J. of Forestry 44:627 633.

Leopold, L. B. 1997. Water, rivers and creeks. Univ. Sci. Books, Sausalito, California, 185pp.

Logan, M. F. 2002. The lessening stream: an environmental history of the Santa Cruz, River. University of Arizona Press, Tucson, AZ. 311pp.

Lytle, D. A. 2000. Biotic and abiotic effects of flash flooding in a montane desert stream. Archive fur Hydrobiologia 150:85–100.

MacDonald, G.M. 2010. Water, climate change, and sustainability in the southwest. Proceedings of the National Academy of Sciences of the United States 107(50):21256–21262.

MacKenzie, D., Z. Gedalof, D. L. Peterson, and P. Mote. 2004. Climatic change, wildlife, and conservation. Conservation Biology 18(4):890-902.

Madany, M. H., and N .E. West. 1983. Livestock grazing – fire regime interactions with in montane forests for Zion National Park, Utah. Ecology 64:661–667.

Marsh, P. C., and W. L. Minckley. 1982. Fishes of the Phoenix metropolitan area in central Arizona. North American J. Fisheries Management 4:395-402.

Marsh, P. C., and B. R. Kesner. 2011. Central Arizona Project fish monitoring, final annual report: summary of sample year 2010 fish surveys in behalf of a long-term monitoring plan for fish populations in selected waters of the Gila River Basin, Arizona. Agreement No. R09PD32013, Submitted to U.S. Bureau of Reclamation. Glendale, Arizona, Marsh and Associates, LLC, Tempe, AZ.

Martin, S. C. 1975. Ecology and management of southwestern semidesert grass-shrub ranges: The status of our knowledge. USDA Forest Service, Rocky Mtn. For. & Range Exp. Stn., Fort Collins, CO. 39pp.

McCabe, G. J., M. A. Palecki, and J. L. Betancourt. 2004. Pacific and Atlantic Ocean influences on multidecadal drought frequency in the United States. Proceedings of the National Academy of Sciences 101(12):4136-4141.

McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. EPA 910-R-99-010, U.S. Environmental Protection Agency, Seattle, Washington.

McKenzie, D., Z. Gedalof, D. L. Peterson, and P. Mote. 2004. Climatic change, wildfire, and conservation. Conservation Biology 18:890–902.

Meador, M. R. 1992. Inter-basin water transfer: Ecological concerns. Fisheries 17(2):17-22.

Meador, M. R. 1996. Water transfer projects and the role of fisheries biologists. Fisheries 21(9):18-23.

Meador M. R., L. R. Brown, and T. Short. 2003. Relations between introduced fish and environmental conditions at large geographic scales. Ecological Indicators 3:81–92.

Meehan, W. R., and W. S. Platts. 1978. Livestock grazing and the aquatic environment. Journal of Soil and Water Conservation 33:274–278.

Meffe, G. K. 1985. Predation and species replacement in American Southwestern stream fishes: A case study. Southwest Nat. 30:173-187.

Meffe, G. K., D. A. Hendrickson, W. L. Minckley, and J. N. Rinne. 1983. Factors resulting in decline of the endangered Sonoran topminnow *Poeciliopsis occidentalis* (Atheriniformes: Poeciliidae) in the United States. Biological Conservation 25:135-159.

Meisner, J. D. 1990. Potential loss of thermal habitat for brook trout, due to climatic warming, in two southern Ontario streams. Transactions of the American Fisheries Society 119:282–291.

Miller, R. R. 1945. A new cyprinid fish from southern Arizona, and Sonora, Mexico, with the description of a new subgenus of *Gila* and a review of related species. Copeia 1945 (no. 2): 104-110, Pl. 1.

Miller, R. R. 1946. Gila cypha, a remarkable new species of cyprinid fish from the lower

Colorado River basin, Arizona. Journal Washington Academy Science, 36: 206-212.

Miller, R. R. 1950. Notes on the cutthroat and rainbow trouts with the description of a new species from the Gila River, New Mexico. Occasional Papers of the Museum of Zoology, University of Michigan, Ann Arbor, Michigan. 529:1-43.

Miller, R. R. 1961. Man and the changing fish fauna of the American Southwest. Pap. Michigan Acad. Sci., Arts, Lett. 46:365-404.

Miller, R. R., and C. H. Lowe. 1967. Fishes of Arizona, Part 2. Pages 133-151 *in* Lowe, C. H., ed., The Vertebrates of Arizona, 2d printing, University of Arizona Press, Tucson, AZ.

Miller, R. R., J. D. Williams, and J. E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14:22 38.

Minckley, W.L. 1969. Aquatic biota of the Bonita Creek Basin, Santa Cruz County, Arizona. The Nature Conservancy, Ecological Studies Leaflet, 15:1-8.

Minckley, W. L. 1973. Fishes of Arizona. Ariz. Fish and Game Dept. Sims Printing Company, Inc., Phoenix, AZ. 293pp.

Minckley, W. L. 1985. Native fishes and natural aquatic habitats in U.S. Fish and Wildlife Region II west of the Continental Divide. Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico, Department of Zoology, Ariz. State Univ., Tempe, AZ. 158pp.

Minckley, W. L. 1999. Ecological review and management recommendations for recovery of the endangered Gila topminnow. Great Basin Naturalist 59(3): 230-244.

Minckley, W. L., and J. E. Deacon. 1991. Battle against extinction: Native fish management in the American west. University of Arizona Press, Tucson, AZ. 517pp.

Minckley, W. L., and B. D. DeMarais. 2000. Taxonomy of chubs (Teleostei, Cyprinidae, Genus *Gila*) in the American Southwest with comments on conservation. Copeia 2000(1):251-256.

Minckley, W. L., and P. C. Marsh. 2009. Inland fishes of the greater Southwest, chronicle of a vanishing biota. The University of Arizona Press, Tucson, Arizona.

Minckley, W. L., and G. K. Meffe. 1987. Differential selection by flooding in stream fish communities of the arid American Southwest. Pages 93- 104 *in* Matthews W. J,. and D. C. Heins, eds., Community and Evolutionary Ecology of North American Stream Fishes, University of Oklahoma Press, Norman.

Minckley, W. L., J. N. Rinne, and J. E. Johnson. 1977. Status of the Gila topminnow and its co-occurrence with mosquitofish. USDA Forest Service, Research Paper RM-198, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO. 8pp.

Minshall, G. W., J. T. Brock, and J.D. Varley. 1989. Wildfires and Yellowstone's stream ecosystems. BioScience 39:707-715.

Molles, M. C. Jr. 1985. Recovery of a stream invertebrate community from a flash flood in Tesuque Creek, New Mexico. Southwestern Naturalist 30:279–287.

Montgomery and Associates Inc. 2010. Revised report: groundwater flow modeling conducted for simulation of proposed Rosemont Pit dewatering and post-closure, vol. 1: text and tables. Prepared for Rosemont Copper, Tucson, Arizona.

Moore, R. H., R. A. Garrett, and P. J. Wingate. 1976. Occurrence of the red shiner, *Notropis lutrensis*, in North Carolina: A probable aquarium release. Trans. Am. Fish. Soc. 105(2):220-221.

Moyle, P. B. 1976a. Fish introductions in California: history and impact on native fishes. Biological Conservation 9:101-118.

Moyle, P. B. 1976a. Inland fishes of California. Univ. California Press, Berkeley, California. 405pp.

Moyle, P. B., H. W. Li, and B. A. Barton. 1986. The Frankenstein effect: impact of introduced fishes on native fishes in North America. Pages 415-426 *in* Stroud, R. H., ed., Fish Culture in Fisheries Management, American Fisheries Society, Bethesda, MD.

Myers, T. 2010. Technical Memorandum: updated groundwater modeling report proposed Rosemont open pit mining project. Prepared for Pima County and Pima County Regional Flood Control District, Reno, Nevada.

Naiman, R. J., and D. L. Soltz, eds. 1981. Fishes in North American deserts. John Wiley & Sons, New York.

Nash, L. L., and P. H. Gleick. 1993. The Colorado River Basin and climatic change. EPA 230-R-93-009, U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation, Climate Change Division. Oakland, California.

Nelson, B. 1993. Spawning characteristics of Gila chub (*Gila intermedia*) in Cienega Creek, Pima County, Arizona. Report for USDI Bureau of Land Management, Tucson Resource Area, Tucson, Arizona.

Ohmart, R. D. 1996. Historical and present impacts of livestock grazing on fish and wildlife resources in western riparian habitats. Society for Range Management, Denver, CO. 245-279pp.

Organ Pipe Cactus National Monument. 2008. Quitobaquito berm stabilization chronological summary, project field activities April-May 2008. U.S. National Park Service, Ajo, AZ.

36pp.

Overpeck, J., G. Garfin, A. Jardine, D. Busch, D. Cayan, M. Dettinger, E. Fleishman, A. Gershunov, G. MacDonald, K. Redmond, W. Travis, and B. Udall. 2012. Chapter 1: summary for decision makers. In Garfin, G., A. Jardine, R. Merideth, M. Black, and J. Overpeck, eds., Assessment of Climate Change in the Southwest United States: a Technical Report Prepared for the U.S. National Climate Assessment. A report by the Southwest Climate Alliance, Southwest Climate Summit Draft, Tucson, AZ.

Parker, K. M., R. J. Sheffer, and P. W. Hedrick. 1999. Molecular variation and evolutionarily significant units in the endangered Gila topminnow. Conservation Biology 13(1):108-116.

Parmesan, C., and J. Matthews. 2006. Biological impacts of climate change. Pages 333–374 in Groom, M. J., G. K. Meffe, and C. R. Carroll, eds., Principles of Conservation Biology. Sinauer Associates, Inc. Sunderland, Massachusetts.

Pearsons, T. N., H. W. Li, and G. A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Transactions of the American Fisheries Society 121:427–436.

Pima Association of Governments. 2003. Contribution of Davidson Canyon to Base Flows in Cienega Creek. November. 49pp.

Pima Association of Governments. 2010. Evaluation of Riparian Habitat and Headcutting along Lower Cienega Creek. Arizona Water Protection Fund Grant #07-144. Tucson, AZ. 53pp.

Pima Association of Governments. 2012a. Cienega Creek Natural Preserve surface water and groundwater monitoring: annual report for the 2009-2010 fiscal year. Pima Association of Governments, Tucson, AZ. 80pp.

Pima Association of Governments. 2012b. Shallow groundwater areas in Eastern Pima County, Arizona: water well inventory and pumping trend analysis. Tucson, AZ. 117pp.

Pima County. 2000. Resources of the Cienega-Rincon Valley. Pima County, Tucons, AZ. 135pp.

Pima County. 2012a. Multi-species conservation plan for Pima County, Arizona: public draft. Submitted to the Arizona Ecological Services office of the U.S. Fish and Wildlife Service, Tucson, Arizona. 137pp.

Pima County. 2012b. Multi-species conservation plan appendices for Pima County, Arizona: public draft. Submitted to the Arizona Ecological Services office of the U.S. Fish and Wildlife Service, Tucson, Arizona. 318pp.

Pima County Flood Control District. 2013. Cienega Creek Natural Preserve. Accessed 21

March, 2013. http://rfcd.pima.gov/wrd/landmgt/cienegapreserve/#overview

Platts, W. S. 1991. Livestock grazing. Pages 389-424 *in* Meehan, W. R., ed., Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats, American Fisheries Society Special Publication 19: 389-423, Bethesda, MD.

Platz, J. E., R. W. Clarkson, J. C. Rorabaugh, and D. M. Hillis. 1990. *Rana berlandieri*: Recently introduced populations in Arizona and southeastern California. Copeia 1990(2):324-333.

Pollard, K., and M. Mather. 2010. Census counts nearly 309 Million Americans. http://www.prb.org/Articles/2010/2010-unitedstates-census.aspx?p=1, Accessed November 15, 2011.

Pool, D. R., and A. L. Coes. 1999. Hydro-geologic Investigations of the Sierra Vista subwatershed of the Upper San Pedro Basin, Cochise County, Southeast Arizona. US Geological Survey, Water-Resources Investigations Report 99-4197.

Propst, D. L., K. R. Bestgen, and C. W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (*Meda fulgida*) in New Mexico. Endangered Species Report No. 15, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, 93pp.

Rauscher, S. A., J. S. Pal, N. S. Diffenbaugh, and M. M. Benedetti. 2008. Future changes in snowmelt-driven runoff timing over the western US. Geophysical Research Letters 35L16703:1–5.

Rea, A. M. 1983. Once a river. Bird life and habitat changes on the Middle Gila River. University of Arizona Press, Tucson, AZ. 285pp.

Regonda, S. K., B. Rajagopalan, M. Clark, and J. Pitlick. 2005. Seasonal shifts in hydroclimatology over the Western United States. Journal of Climate 18:372–384.

Reinthal, P. 2009. Fish collection curator, University of Arizona. Written communication to K. Kertell, SWCA. June 23.

Rhodes, J. J. 2007. Watershed impacts of forest treatments to reduce fuels and modify fire behavior. Prepared for: Pacific Rivers Council, Eugene, Oregon.

Rich, J. L. 1911. Recent stream trenching in the semi-arid portion of southwestern New Mexico, a result of removal of vegetation cover. American J. of Science 32:237–245.

Rieman, B.E., and D.J. Isaak. 2010. Climate Change, Aquatic Ecosystems, and Fishes in the Rocky Mountain West: Implications and Alternatives for Management. General Technical Report RMRS-GTR-250. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Rinne J. N. 1969. Cyprinid fishes of the genus *Gila* from the lower Colorado River Basin.

M.S. thesis, Arizona State University, Tempe Arizona.

Rinne, J. N. 1975. Changes in minnow populations in a small desert stream resulting from natural and artificially induced factors. Southwestern Naturalist 202(2): 185-195.

Rinne, J. N. 1976. Cyprinid fishes of the genus *Gila* from the lower Colorado River basin. Wasmann Journal Biology 34(1):65 107.

Rinne, J. N. 1996. Short-term effects of wildfire on fishes and aquatic macroinvertebrates in the southwestern United States. North American J. of Fisheries Management 16:653-658.

Rinne, J. N. 2004. Forests, Fish and Fire: Relationships and Management Implications for Fishes in the Southwestern USA. Pages 151-156 *in* Scrimgeour, G. J., G. Eisler, B. McCulloch, U. Silins and M. Monita, eds., Forest Land–Fish Conference II – Ecosystem Stewardship through Collaboration, Proceedings of the Forest-Land-Fish Conference II, April 26-28, 2004, Edmonton, Alberta.

Rinne, J. N., and A. L. Medina. 1992. Fire, fish, floods: The Dude Fire, Arizona, 1990. Proc. Desert Fishes Council Ann. Symp. 26:30.

Rinne, J. N., and D. Miller. 2006. Hydrology, geomorphology and management: Implications for sustainability of southwestern native fishes. Reviews in Fisheries Biology.

Rinne, J. N., and W. L. Minckley. 1970. Native Arizona fishes, Part III the minnows called chubs. Arizona Wildlife Views 17(5):12 19.

Rinne, J. N., and W. L. Minckley. 1991. Native fishes of arid lands: A dwindling resource of the desert Southwest. USDA Forest Service, Gen. Tech. Rep. RM 206, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 45pp.

Rixon, T. F. 1905. Forest conditions in the Gila River Forest Reserve, New Mexico. U.S. Geological Survey Professional Paper No. 39.

Robinson, A. 2010. Arizona native fish recovery and nonnative fish control, final report. USFWS Agreement No 201816J808, Arizona Game and Fish Department, Phoenix, AZ. 34pp.

Robinson, A. 2011. Gila River Basin Native Fishes Conservation Program: Cooperative Agreement 201819J853 Final Semi-Annual Report for the Period May 1, 2010--October 31, 2010 Arizona Game and Fish Department, Phoenix, AZ.

Robinson, A. 2012. Gila River Basin Native Fishes Conservation Program: Cooperative Agreement 201819J853 Semi-Annual Report for the Period May 1 thru October 31, 2011. Arizona Game and Fish Department, Phoenix, AZ. 19pp.

Robinson, A. T., P. P. Hines, J. A. Sorensen, and S. D. Bryan. 1998. Parasites and fish health in a desert stream, and management implications for two endangered fishes. North American Journal of Fisheries Management 18:599-608.

Rosen, P. C., C. R. Schwalbe, D. A. Parizek, Jr., P. A. Holm, and C. H. Lowe. 1995. Introduced aquatic vertebrates in the Chiricahua region: Effects on declining native ranid frogs. Pages 251-261 *in* DeBano, L. F., P. F. Ffolliott, A. Ortega-Rubio, G. J. Gottfried, R. H. Hamre, and C. B. Edminster, tech. coords., Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Mexico, USDA Forest Service, Gen. Tech. Rept. RM-GTR-264, Rocky Mtn. For. & Range Exp. Stn., Ft. Collins, Colorado. 669pp.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Inc., Pagosa Springs, CO.

Rutman, S. 1997. Dirt is not cheap: livestock grazing and a legacy of accelerated soil erosion on Organ Pipe Cactus National Monument, Arizona. Pages 360 375 *in* Environmental, Economic, and Legal Issues Related to Rangeland Water Developments, Proceedings of a Symposium, Tempe, Arizona, Center for the Study of Law, Arizona State Univ., Tempe.

Savage, M., and T. W. Swetnam. 1990. Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. Ecology 71:2374-2378.

Schneider, N., and B. D. Cornuelle. 2005. The forcing of the Pacific Decadal Oscillation. Journal of Climate 18:4355-4373.

Schrank, A. J., F. J. Rahel, and H. C. Johnstone. 2003. Evaluating laboratory-derived thermal criteria in the field: An example involving Bonneville cutthroat trout. Transactions of the American Fisheries Society 132:100–109.

Schultz, A. A. 2009. Selected aspects of the natural history and culture of Gila chub. PhD. Diss., University of Arizona, Tucson, AZ. 138pp.

Schultz, A. A., and Bonar, S.A. 2006. Spawning and culture of Gila chub. Final Report to the Arizona Game and Fish Department. Fisheries Research Report 02-07, AZ Cooperative Fish and Wildlife Research Unit, USGS, Univ. of AZ, Tucson, AZ.

Schulz, T. T., and W. C. Leininger. 1990. Differences in riparian vegetation structure between grazed areas and exclosures. Journal of Range Management 43(4): 295-299.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H.-P. Huang, N. Harnik, A. Leetmaa, N.-C. Lau, C. Li, J. Velex, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316:1181–1184.

Shelton, W. L., and R. O. Smitherman. 1984. Exotic fishes in warmwater aquaculture. Pages 262-301 *in* Courtenay, Jr., W. R., and J. R. Stauffer, Jr., eds., Distribution, Biology, and Management of Exotic Fishes, Johns Hopkins University Press, Baltimore, Maryland.

Sheppard, P. R., A. C. Comrie, G. D. Packin, K. Angersbach, and M. K. Hughes. 2002. The climate of the US southwest. Climate Research 21:219–238.

Sheridan, T. E. 1986. Los Tucsonenses: The Mexican community in Tucson, 1854-1941. University of Arizona Press, Tucson, AZ. 327pp.

Simms, J. R. 2001. Cienega Creek stream restoration project. Hendrickson, D. A., and L. T. Findley, eds, Proc. of the Desert Fishes Council 32:13-14.

Simms, J. R. 2009. Fishery Biologist, Bureau of Land Management. Email communication to K. Kertell, SWCA. June 10.

Simms, J. 2013. Chub in Empire Gulch and Rosemont. Electronic mail communication to Doug Duncan, USFWS, 2 April, 2013.

Simms, J. R. and K. M. Simms. 1992. What constitutes high quality habitat for Gila topminnow (*Poeciliopsis occidentalis occidentalis*)? An overview of habitat parameters supporting a robust population at Cienega Creek, Pima Co., AZ. Proc. Desert Fishes Council 24:22-23.

Smith, K., and M. E. Lavis. 1975. Environmental influences on the temperature of a small upland stream. Oikos 26:228–236.

Soule, M. E. 1990. The onslaught of alien species, and other challenges in the coming decades. Conservation Biology 4(3):233-239.

Spencer, C. N., and F. R. Hauer. 1991. Phosphorus and nitrogen dynamics in streams during a wildfire. Journal of the North American Benthological Society 10(1):24-30.

SRK. 2012. Memorandum: Pt. 3, SWCA Questions 1 through 3 – professional opinions to assess impacts to distant surface waters and modeling certainty. July 31, 2012.

State of New Mexico: New Mexico Office of the State Engineer. 2005. Potential effects of climate change on New Mexico. Agency Technical Workgroup. Santa Fe, New Mexico. http://www.nmenv.state.nm.us/aqb/cc/Potential_Effects_Climate_Change_NM.pdf. Accessed October 30, 2011.

Stefferud, S. E., and M. R. Meador. 1998. Interbasin water transfers and nonnative aquatic species movement: a brief case history review. Proc. of the Desert Fishes Council 47.

Stewart, I. T., D. R. Cayan, M. D. Dettinger. 2004. Changes in snowmelt runoff timing in western North American under a 'business as usual' climate change scenario. Climatic Change 62: 217-32.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across Western North America. Journal of Climate 18:1136–1155.

Stine, S. 1994. Extreme and persistent drought in California and Patagonia during mediaeval time. Nature 369:546-549.

Stout, G.G., E.C. Bloom, and J.K. Glass. 1970. The Fishes of Cave Creek, Maricopa County, Arizona. Journal Arizona Academy Science, 6(2): 109-113.

Sublette, J. E., M. D. Hatch, and M. Sublette. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque. 347 pp.

Swanston, D. N. 1991. Natural processes. Pages 139-179 *in* Meehan, W. R., ed., Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland.

SWCA. 2012. Agenda Rosemont-FWS-USFS consultation meeting. 16 November, 2012, unpublished white paper.

Swetnam, T. W. 1990. Fire history and climate in the southwestern United States. Pages 6-17 *in* J. S. Krammes, tech. coord., Effects of Fire in Manage. of Southwestern Natural Resources. USDA Forest Service, GTR RM-191 Rocky Mtn. For. & Range Exp. Stn., Ft. Collins, Colorado.

Swetnam, T. W., and C. H. Baisan. 1996. Fire histories of montane forests in the Madrean Borderlands. Pages 15-36 *in* Ffolliott, P. F., et al., tech. coord., Effects of Fire on Madrean Province Ecosystems, USDA Forest Service, General Technical Report, RM-GTR-289, Rocky Mtn. For. & Range Exp. Stn., Ft. Collins, CO.

Swetnam, T. W., and J. Dieterich. 1985. Fire history of ponderosa pine forests in the Gila Wilderness, New Mexico. Pages 390-397 *in* Lotan, J. E., B. M. Kilgore, W. M. Fischer, and R. W. Mutch, tech. coords., Wilderness Fire: Proc. Symp. & Workshop. USDA FS, GTR INT 182, Res. Stn., Ogden, UT.

Tellman, B., R. Yarde, and M. G. Wallace. 1997. Arizona's changing rivers: How people have affected the rivers. Issue Paper 19, Water Resources Research Center, University of Arizona, Tucson, AZ. 198pp.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874, Prepared for Rosemont Copper. Tucson, Arizona.

Tetra Tech. 2012. Baseline & Post Mine Hydrology and Sediment Delivery at USGS Gage for Barrel Alternative. Technical Memorandum.

Touchan, R., T. W. Swetnam, and H. D. Grissino-Mayer. 1995. Effects of livestock grazing on pre-settlement fire regimes in New Mexico. Pages 268-272 *in* Brown, J. K., R. W. Mutch, C. W. Spoon, and R. H. Wakimoto, tech. coords., Proc.: Symp. on Fire in Wilderness and Park Management, March 30 - April 1, 1993, Missoula, MT, USDA Forest Service, General Technical Report INT-GTR-320, Intermountain Research Station, Ogden, UT.

Turner, R. M., R. H. Webb., J. E. Bowers, and J. R. Hastings. 2003. The changing mile revisited. University of Arizona Press, Tucson, AZ 334pp.

U.S. Bureau of Land Management (BLM). 1998. Gila Box Management Plan, environmental assessment, and decision record. Bureau of Land Management, Safford Field Office, Safford, Arizona. 90pp.

U.S. Bureau of Land Management (BLM). 2002. Biological evaluation for the Las Cienegas Resource Management plan. U.S. Department of the Interior, BLM, Tucson Field Office, Tucson, AZ.

U.S. Bureau of Reclamation and U.S. Forest Service (USFS). 2008. Final Environmental Assessment, native fish restoration project, Redrock Canyon, Santa Cruz County, Arizona. U.S. Bureau of Reclamation, Phoenix Area Office, Glendale, AZ. 198pp.

U.S. Census Bureau. 2005. Florida, California and Texas to dominate future population growth, Census Bureau reports. Web page: http://www.census.gov/Press-Release/www/releases/archives/population/004704.html Accessed 12 October 2005.

U.S. Environmental Protection Agency (EPA). 2011. Ecological Toxicity Information. Available at: http://www.epa.gov/region5superfund/ecology/toxprofiles.htm. Accessed June 5, 2012.

U.S. Fish and Wildlife Service (FWS), and National Marine Fisheries Service (NMFS). 1998. Endangered Species consultation handbook: procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act.

U.S. Fish and Wildlife Service (FWS). 1983. Central Arizona water control study - Formal consultation under section 7 of the Endangered Species Act, biological opinion. 2-21-83-F-10. March 8, 1983. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 13pp.

U.S. Fish and Wildlife Service (FWS). 1994. Final biological opinion on the transportation and delivery of Central Arizona Project water to the Gila River Basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers, and associated tributaries) in Arizona and New Mexico. 2-21-90-F-119, USFWS, Albuquerque, NM. 41pp.

U.S. Fish and Wildlife Service (FWS). 1998. Biological opinion on reintroduction of beaver into the San Pedro Riparian National Conservation Area. Memorandum, June 17, 1998 (2-21-97-F-097) from Acting Field Supervisor, AESO, USFWS, to Field Manager, BLM, Tucson, Phoenix, AZ. 48pp.

U.S. Fish and Wildlife Service (FWS). 1998a. Biological opinion on the Cienega Creek stream restoration project. Memorandum, June 3 (2-21-98-F-373) from Acting Field Supervisor, Arizona Ecological Services Field Office, USFWS, to Manager, Tucson Field Office, BLM, Phoeninx, AZ. 51pp.

U.S. Fish and Wildlife Service (FWS). 2002. Biological opinion: Effects of the proposed Las Cienegas National Conservation Area Resource Management Plan in Pima and Santa Cruz Counties, Arizona. October 4 Memo (02-21-02-F-162) from Field Supervisor, AESO, USFWS, to Field Manager, Tucson Field Office, Bureau of Land Management, Tucson, AZ. 198pp.

U.S. Fish and Wildlife Service (FWS). 2005. Endangered and threatened wildlife and plants; Final rule listing the Gila chub as endangered with critical habitat. Federal Register 67(154): 51948-51985.

U.S. Fish and Wildlife Service (FWS). 2008. Reinitiated biological opinion on transportation and delivery of Central Arizona Project water to the Gila River Basin in Arizona and New Mexico and its potential to introduce and spread nonindigenous aquatic species. Memorandum May 15 (02-21-90-F-119, 02-21-91-F-406, 22410-2007-F-0081) from Field Supervisor, AESO, USFWS, to Area Manager, Bureau of Reclamation, Phoenix, Arizona. 162pp.

U.S. Fish and Wildlife Service (FWS). 2012. Reinitiation of Biological Opinion on the Las Cienegas National Conservation Area Resources Management Plan (22410-2002-F-0162) in Pima and Santa Cruz Counties, Arizona. Memorandum from Field Supervisor, AESO, USFWS, to Field Manager, Tucson Field Office, Bureau of Land Management, Tucson, AZ.

U.S. Forest Service (USFS). 2012a. Biological Assessment, Rosemont Copper Company Project, Santa Rita Mountains, Nogales Ranger District. Coronado National Forest, Tucson, AZ. 194pp.

U.S. Forest Service (USFS). 2012b. Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest. Coronado National Forest, Tucson, AZ. 73pp.

U.S. Forest Service (USFS). 2013. [Second] Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest. Coronado National Forest, Tucson, AZ. 65pp.

U.S. Global Change Research Program (USGCRP). 2001. Preparing for a changing climate: the potential consequences of climate variability and change – Southwest. A Report of the Southwest Regional Assessment Group for the U.S. Global Change Research Program. Institute for the Study of Planet Earth, University of Arizona, Tucson, AZ. 60pp.

Varela-Romero, A., C. Galindo-Duarte, E. Saucedo-Monarque, L.S. Anderson, P. Warren, S. Stefferud, J. Stefferud, S. Rutman, T. Tibbets, and J. Malusa. 1992. Re-discovery of Gila intermedia and Gila purpurea in the north of Sonora, Mexico. Proceedings of the Desert Fishes Council Vol. 22 (1990).

Voeltz, J. B., and R. H. Bettaso. 2003. 2003 Status of the Gila topminnow and desert pupfish in Arizona. Nongame and Endangered Wildlife Program Technical Report 226, Arizona

Game and Fish Department, Phoenix, AZ. 124pp.

Wang, B., J. Liuc, H. Kim, P. J. Webster, S. Yim, and B. Xiang. 2013. Northern Hemisphere summer monsoon intensified by mega-El Niño/southern oscillation and Atlantic multidecadal oscillation. Proceedings of the National Academy of Sciences 110(14):5347-5352 .

Webb, R. H., and J. L. Betancourt. 1992. Climatic variability and flood frequency of the Santa Cruz River, Pima County, Arizona. USGS, Water-Supply Paper 2379. 40pp.

Weedman, D. A. 1999. Gila topminnow, *Poeciliopsis occidentalis occidentalis,* revised recovery plan. Draft. U.S. Fish and Wildlife Service, Albuquerque, NM. 86pp.

Weedman, D. A., A. L. Girmendonk, and K. L. Young. 1996. Status review of Gila chub, *Gila intermedia,* in the United States and Mexico. Arizona Game and Fish Department, Nongame Technical Report 91, Phoenix, AZ. 111pp.

Welcomme, R. L. 1988. International introductions of inland aquatic species. Food and Agriculture Organization of the United Nations (FAO), FAO Fisheries Tech. Paper 294, Rome. 318pp.

Westerling, A. L., H. G. Hidalgo, D. R. Cyan, and T. W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313:940–943.

Wetzel, R. G. 1983. Limnology, second edition. Sanders College Publishing, Philadelphia, PA. 760+pp.

Wilson, B. L., J. D. Deason, and W. G. Bradley. 1996. Parasitism in the fishes of the Moapa River, Clark County, Nevada. Trans. California-Nevada Sect. Wildlife Soc. 1966:12-23.

York, J. C,. and W. A. Dick Peddie. 1969. Vegetation changes in southern New Mexico during the past hundred years. Pages 157-166 *in* McGinnies, W. G., and B. J. Goldman, eds., Arid Lands in Perspective, University of Arizona Press, Tucson, AZ.

Gila Topminnow

Bestgen, K. R., and D. L. Propst. 1989. Red shiner vs. native fishes: Replacement or displacement? Proc. of the Desert Fishes Council 18:209.

Brooks, J. E. 1986. Status of natural and introduced Sonoran topminnow (*Poeciliopsis o. occidentalis*) populations in Arizona through 1985. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 19+pp.

Chamberlain, F. M. 1904. Notes on fishes collected in Arizona, 1904. Unpublished manuscript, U.S. National Museum, Washington D.C.

Duncan, D. K. In press. Gila topminnow interactions with western mosquitofish: an update. Pages to be determined *in* Biodiversity and Management of the Madrean Archipelago III: Merging Science and Management in a Rapidly Changing World. USDA Forest Service, RMRS-P-x, Rocky Mtn. Res. Stn., Ft. Collins, CO.

Fernandez, P. J., and P. C. Rosen. 1996. Effects of the introduced crayfish *Orconectes virilis* on native aquatic herpetofauna in Arizona. Report to Heritage Program, Ariz. Game and Fish Dept., Phoenix, AZ. IIPAM Proj. No. I94054. 57+pp.

Hedrick, P. W., and C. R. Hurt. 2012. Conservation genetics and evolution in an endangered species: research in Sonoran topminnows. Evolutionary Applications 5(2012):806-819.

Hubbs, C. L., and R. R. Miller. 1941. Studies of the fishes of the order Cyprinodonts. XVII: Genera and species of the Colorado River system. Occas. Papers Mus. Zool., Univ. Mich. 433:1-9.

Johnson, J. E., and C. Hubbs. 1989. Status and conservation of poeciliid fishes. Pages 301-331 *in* Meffe, G. K., and F. F. Snelson, eds., Ecology and Evolution of Livebearing Fishes (Poeciliidae), Prentice Hall, Englewood Cliffs, New Jersey. 453pp.

Laurenson, L. B. J., and C. H. Hocutt. 1985. Colonization theory and invasive biota: The Great Fish River, a case history. Environmental Monitoring and Assessment 6(1985):71-90.

MacArthur, R. H., and E. O. Wilson. 1967. The theory of island biogeography. Princeton University Press, Princeton, New Jersey.

Marsh, P. C., and W. L. Minckley. 1990. Management of endangered Sonoran topminnow at Bylas Springs, Arizona: description, critique, and recommendations. Great Basin Naturalist 50(3):265-272.

Meffe, G. K. 1983. Attempted chemical renovation of an Arizona spring brook for management of the endangered Sonoran topminnow. N. American J. Fisheries Management 3:315 321.

Meffe, G. K. 1984. Effects of abiotic disturbance on coexistence of predator prey fish species. Ecology 65(5):1525 1534.

Meffe, G. K., D. A., Hendrickson, and J. N. Rinne. 1982. Description of a new topminnow population in Arizona, with observations on topminnow/mosquitofish co occurrence. Southwestern Naturalist 27(2):226 228.

Minckley, W. L. 1969. Native Arizona fishes, part I— livebearers. Arizona Wildlife Views 16:6-8.

Minckley, W. L., G. K. Meffe, and D. L. Soltz. 1991. Conservation and management of short-lived fishes: the cyprinodontoids. Pages 247-282 *in* Minckley, W. L., and J. E.

Deacon, eds., Battle Against Extinction Native Fish Management in the American West, University of Arizona Press, Tucson, AZ.

Moyle, P. B., and J. E. Williams. 1990. Biodiversity loss in the temperate zone: Decline of the native fish fauna of California. Conservation Biology 4(3):275-284.

Nelson, J. S., E. J. Crossman, H. Espinosa-Perez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society, Special Publication 29, Bethesda, Maryland. 386pp.

Quattro, J. M., and R. C. Vrijenhoek. 1989. Fitness differences among remnant populations of the endangered Sonoran topminnow. Science 245:976 978.

Robinson, A. 2013. Gila River Basin Native Fishes Conservation Program: Cooperative Agreement F09AC00084, Annual Report for the Period Nov. 1, 2011 thru October 31, 2012. Arizona Game and Fish Department, Phoenix, AZ. 27pp.

Schoenherr, A. A. 1974. Life history of the topminnow, *Poeciliopsis occidentalis* (Baird and Girard) in Arizona, and an analysis of its interaction with the mosquitofish *Gambusia affinis* (Baird and Girard). Ph.D. Dissertation, Arizona State University, Tempe, AZ.

Simms, J. 2010. Empire Gulch monitoring and frog transfer field report. Bureau of Land Management, Tucson Field Office, Tucson, AZ. 2pp.

Stefferud, J. A., and S. E. Stefferud. 1994. Status of Gila topminnow and results of monitoring of the fish community in Redrock Canyon, Coronado National Forest, Santa Cruz County, Arizona, 1979-1993. Pages 361-369 *in* DeBano, L. F., P. F. Ffolliott, A. Ortega-Rubio, G. J. Gottfried, R. H. Hamre, and C. B. Edminster, tech. coords., Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Mexico. USDA Forest Service, Gen. Tech. Rept. RM-GTR-264, Rocky Mtn. For. & Range Exp. Stn., Ft. Collins, Colorado. 669pp.

Stefferud, S. E., and J. A. Stefferud. 2008. Report of activities in calendar year 2008 under Permit number TE053109-0. Phoenix, AZ. 4pp.

U.S. Bureau of Land Management. 2007. Biological evaluation for the proposed construction of aquatic habitat and stocking of Gila topminnow (*Poeciliopsis occidentalis*), desert pupfish (*Cyprinodon macularius*), Chiricahua leopard frog (Rana chiricahuensis), and Huachuca water umbel (*Liliaeopsis schaffneriana* var. *recurva*) into waters on the San Pedro Riparian National Conservation Area and Las Cienegas National Conservation Area, Cochise and Pima Counties, Arizona. Bureau of Land Management, Tucson Field Office, Tucson, AZ. 71pp.

U.S. Fish and Wildlife Service. 1967. Native Fish and Wildlife. Endangered Species. Federal Register 32(48):4001.

U.S. Fish and Wildlife Service. 1984. Sonoran topminnow recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 56pp.

U.S. Fish and Wildlife Service. 1995. Yaqui fishes recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Voeltz, J. B. 2004. New location for Gila topminnow in Cienega Creek. Memorandum to Doug Duncan, U.S. Fish and Wildlife Service, March 18, Arizona Game and Fish Department, Phoenix, AZ.

Weedman, D. A., and K. L. Young. 1997. Status of the Gila topminnow and desert pupfish in Arizona. Ariz. Game and Fish Dept., Nongame and Endangered Wildl. Prog. Tech. Rept. 118, Phoenix, AZ. 141pp.

Huachuca Water Umbel

Affolter, J.M. 1985. A Monograph of the Genus *Lilaeopsis* (Umbelliferae). Systematic Botany Monographs Volume 6: 1-140.

Arizona Game and Fish Department (AGFD). 2011. Special Status Species within the Rosemont Mine Study Area. AGFD # M11-08150947. Heritage Data Management System. Tucson, Arizona: Arizona Game and Fish Department. August 15.

Anderson, G. 2006. Huachuca water umbel in the Upper San Pedro watershed of Sonora, Mexico. Report to the U.S. Fish and Wildlife Service, Tucson, AZ.

Arizona Department of Water Resources. 1991. Preliminary hydrographic survey report for the San Pedro River watershed. Volume 1: General Assessment. Phoenix, Arizona. 548 pp.

Arizona Game and Fish Department 1993. Arizona Riparian Inventory and Mapping Project. Phoenix, Arizona.

Arizona Game and Fish Department. 1997. *Lilaeopsis schaffneriana* var. *recurva*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

Bahre, C.J. 1991. A legacy of change: Historic human impact on vegetation of the Arizona borderlands. University of Arizona Press, Tucson, Arizona. 231pp.

Bryan, K. 1925. Date of channel trenching (arroyo cutting) in the arid southwest. Science 62:338-344.

Bureau of Land Management (BML). 2011. Survey data for Huachuca water umbel within Cienega Creek and Mattie Canyon.

Dobyns, H.F. 1981. From fire to flood: historic human destruction of Sonoran Desert riverine oases. Ballena Press, Socorro, New Mexico. 222pp.

Engineering and Environmental Consultants, Inc. (EEC). 2001. Final Report Huachuca Water Umbel Surveys, Cienega Creek Preserve, Bingham Cienega Preserve, La Cebadilla Property, Pima County, Arizona. Prepared for Pima County Flood Control District, Tucson, Arizona.

Falk, D. and P.L. Warren. 1994. Rare plants of the Coronado National Forest: Population studies and monitoring recommendations. Report to the Coronado National Forest, Tucson, Arizona.

Geraghty and Miller, Inc. 1995. Historical flows and conditions in the San Pedro River. Report to the Water Action Task Force, Sierra Vista Economic Development Foundation, Project No. AZ0473.001. 33pp +figures.

Gori, D.F., P.L. Warren, and L.S. Anderson. 1990. Population studies of sensitive plants of the Huachuca, Patagonia, and Atascosa Mountains, Arizona. Unpublished report. Coronado National Forest, Tucson. 114pp.

Haas, S.K, and R.J. Frye. 1997. Hydrology and water quality effects on *Lilaeopsis schaffneriana* ssp. *recurva*. Report to Arizona Dept. of Agriculture and Fort Huachuca.

Hastings, J.R.and R.M. Turner. 1980. The changing mile. University of Arizona Press, Tucson. 327pp.

Hendrickson, D.A., and W.L. Minckley. 1984. Ciénagas - vanishing climax communities of the American Southwest. Desert Plants 6(3):131-175.

Hereford, R. 1993. Geomorphic evolution of the San Pedro River channel since 1900 in the San Pedro Riparian National Conservation Area, southeast Arizona. US Geological Survey, Open File Report 92-339. 71pp.

Johnson, K., P.L. Warren, D.F. Gori, and E.S. Monarque. 1992. Species management evaluation, cienega false rush (*Lilaeopsis schaffneriana* ssp. *recurva*). Unpublished report. The Nature Conservancy, Tucson, Arizona.

Leenhouts, J. M., Stromberg, J. C., and R. L. Scott. 2006. Hydrologic requirements of and consumptive ground-water use by riparian vegetation along the San Pedro River, Arizona. Reston, VA. U.S. Geological Survey Scientific Investigations Report 2005–5163, 154 pp.

Martin, S.C. 1975. Ecology and management of southwestern semidesert grass-shrub ranges: the status of our knowledge. US Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 39pp.

Mier, M. 2012. Personal communication via electronic mail between Mead Mier of the Pima Association of Governments and Jeff Simms of the Bureau of Land Management regarding drought conditions in Cienega Creek.

Pima County. 2001. Huachuca Water Umbel Report: Sonoran Desert Conservation and Comprehensive Land Use Plan Summer 2001. Tucson, Arizona.

Saucedo-Monarque, E. 1990. Proyecto: Prospeccion de plantas raras en el Norte de Sonora. Centro Ecologico de Sonora, Subdireccion de Investigacion, Area de Ecologia Terrestre, Hermosillo, Sonora, Mexico. 65pp.

Shafer, C.L. 1990. Nature reserves, island theory and conservation practice. Smithsonian Institution Press, Washington D.C. 189pp.

Sheridan, T.E. 1986. Los Tucsonenses: the Mexican community in Tucson, 1854-1941. University of Arizona Press, Tucson. 327pp.

State of Arizona. 1990. Final report and recommendations of the Governor's riparian habitat task force. Executive Order 89-16. Streams and riparian resources. Phoenix, Arizona. October 1990. 28 pp.

Stromberg, J.C., K.J. Bagstad, J.M. Leenhouts, S.L. Lite, and E Makings. 2005. Effects of Stream Flow Intermittency on Riparian Vegetation of a Semiarid Region River (San Pedro River, Arizona). River Research and Applications 21: 925-938.

SRK Consulting. 2012. Memorandum to Chris Garrett of SWCA regarding Pt. 3 SWCA Questions 1 through 3 - Professional Opinions to Assess Impacts to Distant Surface Waters and Modeling Certainty. Pp 22-28 *in* SWCA, Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process.

SWCA. 2012. Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process. November 12, 2012. 65 pp.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874. Prepared for Rosemont Copper. Tucson, Arizona. November.

Titus, P., A. Zuhlke, S. Scott, K. Sovenyhazy, and J. Titus. 2002. Huachuca water umbel - endangered wetland plant in Arizona. Poster paper presented at Fourth Conf. on Research and Resource Management in the Southwestern Deserts: Meeting Resource Management Information Needs, May 15-17, Tucson.

U.S. Fish and Wildlife Service (FWS). 1997. Endangered and threatened wildlife and plants; determination of endangered status for three wetland species found in southern Arizona and Northern Sonora, Mexico. Federal Register 62(3):665-689.

U.S. Fish and Wildlife Service (FWS). 1999. Endangered and threatened wildlife plants;

Designation of Critical Habitat for Huachuca Water Umbel. A plant. Final rule. 50 CFR Part 17. July 12, 1999. Federal Register 64 (132); 37441-37453.

Vernadero Group, Inc. 2011. 2010 Huachuca Water Umbel (*Lilaeopsis schaffneriana* ssp. *recurva*) San Pedro Riparian National Conservation Area Inventory Report, Cochise County, Arizona. Prepared for Environment and Natural Resource Division, Directorate of Public Works, U.S. Army Garrison, Fort Huachuca, Arizona, 30 pp. plus appendices.

Warren, P.L., D.F. Gori, L.S. Anderson, and B.S. Gebow. 1991. Status report for *Lilaeopsis schaffneriana* ssp. *recurva*. U.S. Fish and Wildlife Service, Arizona Ecological Services State Office, Phoenix, Arizona. 30 pp.

Warren, P.L., and F.W. Reichenbacher. 1991. Sensitive plant survey of Fort Huachuca, Arizona. Report to U.S. Army, Fort Huachuca, AZ. Purchase Order DAEA1889P4546.

Warren, P.L., L.S. Anderson, and P.B. Shaffroth. 1989. Population studies of sensitive plants of the Huachuca and Patagonia Mountains, Arizona. Unpublished Report, Coronado National Forest, Tucson. 99pp.

Webb, R.H. and J.L. Betancourt. 1992. Climatic variability and flood frequency of the Santa Cruz River, Pima County, Arizona. U.S. Geological Survey Water-supply Paper 2379.

Wilcox, B.A., and D.D. Murphy. 1985. Conservation strategy: the effects of fragmentation on extinction. American Naturalist 125:879-887.

Effects to Riparian Ecosystems

Amlin, N.M., and S.B. Rood, 2002, Comparative tolerances of riparian willows and cottonwoods to water-table decline: Wetlands 22: 338–346.

Brown, D. E. 1982. Warm-Temperate Wetlands. Pp. 248-262 *in* Brown, D. E., ed. Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4). University of Arizona, Boyce Thompson Southwestern Arboretum.

Fenner, P., W.W. Brady, and D.R. Patton. 1984. Observations on seeds and seedlings of Fremont cottonwood: Desert Plants 6:55-58.

Horton, J.L., and J.L. Clark. 2001. Water table decline alters growth and survival of *Salix gooddingii* and *Tamarix chinensis* seedlings: Forest Ecology and Management 140:239–247.

Horton, J.L., T.E. Kolb, and S.C. Hart. 2001a. Physiological response to groundwater depth varies among species and with river flow regulation: Ecological Applications 11: 1046-1059.

Horton, J.L., Kolb, T.E., and Hart, S.C. 2001b. Responses of riparian trees to interannual variation in ground water depth in a semi-arid river basin: Plant, Cell and Environment:

24: 293-304.

Kalischuk, A.R., Rood, S.B., and Mahoney, J.M., 2001, Environmental influences on seedling growth of cottonwood species following a major flood: Forest Ecology and Management, v 144 , p. 75–89.

Leenhouts, J. M., Stromberg, J. C., and R. L. Scott. 2006. Hydrologic requirements of and consumptive ground-water use by riparian vegetation along the San Pedro River, Arizona. Reston, VA. U.S. Geological Survey Scientific Investigations Report 2005–5163, 154 pp.

Lite, S.J., and J.C. Stromberg. 2005. Surface water and ground-water thresholds for maintaining *Populus-Salix* forests, San Pedro River, Arizona: Biological Conservation 125:153-167.

Mahoney, J.M., and S.B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment - An integrative model. Wetlands 18: 634-645 .

Merritt, D.M. and H.L. Bateman. 2012. Linking stream flow and groundwater to avian habitat in a desert riparian system. Ecological Applications 22(7): 1973–1988.

National Wetlands Inventory. 2013. National Wetlands Inventory. Data Limitations, Exclusions and Precautions. Accessed on-line on June 19, 2013 at http://www.fws.gov/wetlands/Data/Limitations.html.

Parametrix. 2008. Restoration analysis and recommendations for the San Acacia reach of the Middle Rio Grande, NM. Albuquerque, NM.

Pima County Regional Flood Control District (PCRFCD). 2011. Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines. Supplement to Title 16, Chapter 16.30 of the Watercourse and Riparian Habitat Protection and Mitigation Requirements Ordinance No. 2010 FC5. November. 15 pp, plus appendices.

Pima County Geographic Information Systems. 2012. Pima County MagGuide Maps. Available at: http://gis.pima.gov/maps/mapguide/. Accessed during the preparation of the Rosemont Copper Project Biological Assessment June 5, 2012.

Rood S.B. and J.M. Mahoney. 1990. Collapse of riparian poplar forests downstream from dams in western prairies: probable causes and prospects for mitigation. Environmental Management 14: 451-464.

Scott, M.L., P.B. Shafroth, and G.T. Auble. 1999. Responses of riparian cottonwoods to alluvial water table declines. Environmental Management 23: 347-358.

Scott, M.L., G.C. Lines, and G.T. Auble. 2000. Channel incision and patterns of cottonwood stress and mortality along the Mojave River, California. Journal of Arid Environments 44: 399-414 .

Segelquist, C.A., M.L. Scott, and G.T. Auble. 1993. Establishment of Populus deltoides under simulated alluvial groundwater declines. American Midland Naturalist 130:275-285.

Shafroth, P.B., G.T. Auble., J.C. Stromberg, and D.T. Patten. 1998. Establishment of woody riparian vegetation in relation to annual patterns of streamflow, Bill Williams River, Arizona. Wetlands 18: 577-590.

Shafroth, P.B., J.C. Stromberg, and D.T. Patten. 2000. Woody riparian vegetation response to different alluvial water table regimes. Western North American Naturalist 60: 66-76.

Shafroth, P.B., J.C. Stromberg, and D.T. Patten. 2002. Riparian vegetation response to altered disturbance and stress regimes. Ecological Applications 12: 107-123.

Stromberg, J.C., Tiller, R., and Richter, B., 1996, Effects of groundwater decline on riparian vegetation of semi-arid regions—The San Pedro River, Arizona: Ecological Applications, v. 6, p. 113 –131.

Stromberg, J.C., K.J. Bagstad, J.M. Leenhouts, S.L. Lite, and E Makings. 2005. Effects of Stream Flow Intermittency on Riparian Vegetation of a Semiarid Region River (San Pedro River, Arizona). River Research and Applications 21: 925-938.

Stromberg, J.C., V.B. Beauchamp, M.D. Dixon, S.J. Lite, and C. Paradzick. 2007a. Importance of low-flow and high- flow characteristics to restoration of riparian vegetation along rivers in arid southwestern United States. Freshwater Biology 52: 651-679.

Stromberg, J.C., S.J. Lite, R. Marler, C. Paradzick, P.B. Shafroth, D. Shorrock, J.M. White, and M.S. White. 2007b. Altered stream-flow regimes and invasive plant species: the Tamarix case. Global Ecology and Biogeography 16(3): 381-393.

SWCA. 2012. Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process. November 12, 2012. 65 pp.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874. Prepared for Rosemont Copper. Tucson, Arizona. November.

Tyree, M.T., K.J. Kolb, S.B. Rood, and S. Patino. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta - A possible factor in the decline of the ecosystem? Tree Physiology 14: 455-466.

WestLand Resources, Inc. (WestLand). 2010. Onsite Riparian Habitat Assessment, Rosemont Project. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources, Inc. April.

WestLand Resources, Inc. (WestLand). 2011g. Rosemont Copper Project: July 2011 Seeps and Springs Survey. Project No. 1049.14. Prepared for Rosemont Copper Company. Tucson, Arizona. August 19.

WestLand Resources, Inc. (WestLand). 2012a. Rosemont Copper Project: Seeps and Springs Survey 2011-2012. Prepared for Rosemont Copper Company. Tucson, Arizona. July 11.

WestLand Resources, Inc. (WestLand). 2012b Potential Effects of the Rosemont Project on Lower Cienega Creek. Prepared for Rosemont Copper Company. Tucson, Arizona. November 14.

Southwestern Willow Flycatcher

Arizona Department of Water Resources. 1994. Arizona riparian protection program legislature report. Arizona Department of Water Resources, Phoenix, AZ.

Bent, A.C. 1960. Life histories of North American flycatchers, larks, swallows and their allies. Dover Press, New York, New York. 555 pp.

Brand, L.A., J.C. Stromberg, and B.R. Noon. 2010. Avian Density and Nest Survival on the San Pedro River: Importance of Vegetation Type and Hydrologic Regime. Journal of Wildlife Management 74(4):739-775.

Brand, L.A., J.C. Stromberg, D.C. Goodrich, M.D. Dixon, K. Lansey, D. Kang, D.S. Brookshire, and D.J. Cerasale. 2011. Projecting Avian Response to Linked Changes in Groundwater and Riparian Floodplain Vegetation along a Dryland River: a Scenario Analysis. Ecohydrology 4: 130–142.

Browning, M.R. 1993. Comments on the taxonomy of Empidonax traillii (willow flycatcher). Western Birds 24:241-257.

Cardinal S.N. and E. H. Paxton. 2005. Home range, movement, and habitat use of the southwestern willow flycatcher at Roosevelt Lake, AZ – 2004. U.S. Geological Survey Report to the U.S. Bureau of Reclamation, Phoenix, AZ.

Drost, C.A., M.K. Sogge, and E. Paxton. 1998. Preliminary Diet Study of the Endangered Southwestern Willow Flycatcher. Report to U.S. Bureau of Reclamation. U.S.G.S. Biological Resources Division/Colorado Plateau Res. Station/N. Arizona University. 26 pp.

Drost, C.A., E.H. Paxton, M.K. Sogge, and M.J. Whitfield. 2003. Food habits of southwestern willow flycatchers during the nesting season *in* M.K. Sogge, B.E. Kus, S.J. Sferra and M.J. Whitfield (eds). Ecology and Conservation of the Willow Flycatcher. Cooper Ornithological Society, Studies in Avian Biology, No. 26.

Durst, S.L. 2004. Southwestern willow flycatcher potential prey base and diet in native and exotic habitat. Masters Thesis. Northern Arizona University, Flagstaff, AZ.

Durst, S.L., M.K. Sogge, H.C. English, H.A. Walker, B.E. Kus, and S.J. Sferra. 2008. Southwestern willow flycatcher breeding site and territory summary – 2007. U.S. Geological Survey, Colorado Plateau Research Station, Flagstaff, AZ.

Ellis, L.A., D.M. Weddle, S.D. Stump, H.C. English, and A.E. Graber. 2008. Southwestern willow flycatcher final survey and monitoring report. Arizona Game and Fish Department, Research Technical Guidance Bulletin #10, Phoenix, Arizona, USA.

English, H.C., A.E. Graber, S.D. Stump, H.E. Telle, and L.A. Ellis. 2006. Southwestern willow flycatcher 2005 survey and nest monitoring report. Nongame and Endangered Wildlife Program Technical Report 248. Arizona Game and Fish Department, Phoenix, AZ.

Finch, D.M. and S.H. Stoleson, eds. 2000. Status, ecology, and conservation of the southwestern willow flycatcher. Gen. Tech. Rep. RMRS-GTR-60. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 131 p.

Graber, A.E., D.W. Weddle, H.C. English, S.D. Stump, H.E. Telle, and L.A Ellis. 2007. Southwestern willow flycatcher 2006 survey and nest monitoring report. Nongame and Endangered Wildlife Program Technical Report 249. Arizona Game and Fish Department, Phoenix, AZ.

Hatten, J.R. and C.E. Paradzick. 2003. A multiscaled model of southwestern willow flycatcher breeding habitat. Journal of Wildlife Management 67:774-788.

Horton, J.L., Kolb, T.E., and Hart, S.C. 2001. Responses of riparian trees to interannual variation in ground water depth in a semi-arid river basin: Plant, Cell and Environment: 24: 293-304.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press, New York, New York. 851 pp.

Hubbard, J.P. 1987. The Status of the Willow Flycatcher in New Mexico. Endangered Species Program, New Mexico Department of Game and Fish, Sante Fe, New Mexico. 29 pp.

Institute for Bird Populations. 2006. MAPS breeding status information. Available at: http://www.birdpop.org/nbii2006/status/statusresults.asp?strStation=12334. Accessed during the preparation of the Rosemont Copper Project Biological Assessment on January 9, 2012.

Johnson, K.L. 1992. Management for water quality on rangelands through best management practices: The Idaho approach. Pages 415-469 in Naiman, R.J. ed. Watershed Management; Balancing Sustainability and Environmental Changes, Springer-Verlag, NY.

Leenhouts, J. M., Stromberg, J. C., and R. L. Scott. 2006. Hydrologic requirements of and consumptive ground-water use by riparian vegetation along the San Pedro River, Arizona. Reston, VA. U.S. Geological Survey Scientific Investigations Report 2005–5163, 154 pp.

Lichivar, R.W. and J.S. Wakely. 2004. Review of ordinary high water make indicators for delineating arid streams in the southwestern United States. Army Corps of Engineers, Engineer Research and Development Center Technical Report 04-1.

McCabe, R.A. 1001. The Little Green Bird. Rusty Rock Press. Madison, WI. 171 pp.

McLeod, M.A., T.J. Koronkiewicz, B.T. Brown, and S.W. Carothers. 2005. Southwestern willow flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries. Annual report submitted U.S. Bureau of Reclamation, Boulder City, NV, by SWCA Environmental Consultants, Flagstaff, AZ.

Merritt, D.M. and H.L. Bateman. 2012. Linking stream flow and groundwater to avian habitat in a desert riparian system. Ecological Applications 22(7): 1973–1988.

Montgomery and Associates Inc. 2010. Revised Report: Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-closure, Vol. 1: Text and Tables. Prepared for Rosemont Copper. Tucson, Arizona: Montgomery and Associates Inc. August 30.

Myers, T. 2010. Technical Memorandum: Updated Groundwater Modeling Report Proposed Rosemont Open Pit Mining Project. Prepared for Pima County and Pima County Regional Flood Control District. Reno, Nevada. April 21.

Owen, J.C. and M.K. Sogge. 2002. Physiological condition of southwestern willow flycatchers in native and saltcedar habitats. U.S. Geological Survey report to the Arizona Department of Transportation.

Paxton, E.H. 2012. Personal Communication via electronic mail with G. Beatty of Arizona Ecological Services Office, U.S. Fish and Wildlife Service regarding the breeding/territorial status of a southwestern willow flycatcher captured in Empire Gulch.

Paxton, E., J. Owen, and M. Sogge. 2010. Southwestern Willow Flycatcher response to catastrophic habitat loss. Report by the USGS Colorado Plateau Research Station, Flagstaff, AZ.

Paxton, E., K. Day, T Olson, P. Wheeler, M. MacLeod, T. Koronkiewicz, and S. O'Meara. 2010. Tamarisk biocontrol impacts occupied breeding habitat of the endangered southwestern willow flycatcher. Poster presentation at Tamarisk Coalition annual conference. Reno, NV.

Paxton, E.H., M.K. Sogge, S.L. Durst, T.C. Theimer, and J.R. Hatten. 2007. The ecology of the southwestern willow flycatcher in central Arizona—a 10-year synthesis report. U.S.

Geological Survey Open-File Report 2007-1381, 143 pp.

Peterson, R.T. 1990. A field guide to western birds. Third edition. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.

Phillips, A.R. 1948. Geographic variation in *Empidonax traillii*. The Auk 65:507-514.

Phillips, A.R.. J. Marshall, and G. Monson. 1964. The Birds of Arizona. University of Arizona Press, Tucson, Arizona. 212 pp.

Prescott, D.R.C. and A.L.A. Middleton. 1988. Feeding-time minimization and the territorial behavior of the willow flycatcher (Empidonax traillii). Auk 105:17-28.

Radke, M. 2011. Southwestern Willow Flycatcher Survey Form: Cienega Creek. Survey results submitted to U.S. Fish and Wildlife Service, Phoenix, AZ.

Ridgely, R.S. and G. Tudor. 1994. The Birds of South America: Suboscine Passerines. University of Texas Press, Austin, Texas.

Rodden, I. 2010. Southwestern Willow Flycatcher Survey Form: Cienega Creek. Survey results submitted to U.S. Fish and Wildlife Service, Phoenix, AZ.

Rodden, I. 2011. Southwestern Willow Flycatcher Survey Form: Cienega Creek. Survey results submitted to U.S. Fish and Wildlife Service, Phoenix, AZ.

Rodden, I. 2012. Southwestern Willow Flycatcher Survey Form: Cienega Creek. Survey results submitted to U.S. Fish and Wildlife Service, Phoenix, AZ.

Rothstein, S.I., J. Verner, S. Ernest. 1984. Radio-tracking confirms a unique diurnal pattern of spatial occurrence in the parasitic brown-headed cowbird. Ecology. 65: 77-88.

Scott, M.L., P.B. Shafroth, and G.T. Auble. 1999. Responses of riparian cottonwoods to alluvial water table declines. Environmental Management 23: 347-358.

Skovlin, J.M. 1984. Impacts of grazing on wetland and riparian habitat: A review of our knowledge. Pages 1001-1103 in Developing Strategies for Rangeland Management, National Research Council/Nat'l. Acad. of Sciences, Westview Press, Boulder, Colorado.

Smith, A.B., C.E. Paradzick, A.A. Woodward, P.E.T. Dockens, and T.D. McCarthey. 2002. Southwestern willow flycatcher 2001 survey and nest monitoring report. Nongame and Endangered Wildlife Program Technical Report #191. Arizona Game and Fish Department, Phoenix, Arizona.

Sogge, M.K. and T.J. Tibbitts. 1994. Distribution and Status of the Southwestern Willow Flycatcher along the Colorado River in the Grand Canyon-1994. Summary Report.

National Biological Survey, Colorado Plateau Research Station/Northern Arizona University and U.S. Fish and Wildlife Service, Phoenix, Arizona. 37 pp.

Sogge, M.K., R. M. Marshall, S. J. Sferra, and T. J. Tibbitts. 1997. A southwestern willow flycatcher survey protocol and breeding ecology summary. National Park Service/Colorado Plateau Res. Station/N. Arizona University, Tech. Rept. NRTR-97/12. 37 pp.

Sogge, M.K. and R.M. Marshall. 2000. A survey of current breeding habitats. Chapter 5 in D. Finch and S. Stoleson (eds.) Status, ecology, and conservation of the southwestern willow flycatcher. U.S. Forest Service, Rocky Mountain Research Station, Albuquerque, NM.

Sogge, M.K., E.H. Paxton, and A.A Tudor. 2005. Saltcedar and southwestern willow flycatchers: lessons from long-term studies in central Arizona. As published on CD ROM in: Aguirre-Bravo, Celedonio, and others. Eds. 2005. Monitoring science and technology symposium: unifying knowledge for sustainability in the Western Hemisphere. 2004 September 20-24; Denver, CO. Proceedings RMRS-P037CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Spencer, J. A., S. J. Sferra, T. E. Corman, J. W. Rourke, and M. W. Sumner. 1996. Arizona Partners In Flight 1995 southwestern willow flycatcher survey. Technical Report 97, March 1996. Arizona Game and Fish Department, Phoenix. 69 pp.

Stiles, F. G., and A. F. Skutch. 1989. A guide to the birds of Costa Rica. Comstock, Ithaca, New York. 364 pp.

Unitt, P. 1987. Empidonax traillii extimus: An endangered subspecies. Western Birds 18:137-162.

Stromberg, J.C., Tiller, R., and Richter, B., 1996, Effects of groundwater decline on riparian vegetation of semi-arid regions—The San Pedro River, Arizona: Ecological Applications, v. 6, p. 113 –131.

SWCA. 2012. Presentation made to U.S. Fish and Wildlife Service and Forest Service to Convey Detailed Information Regarding the Seeps, Springs, and Riparian Impacts Analysis in the Rosemont EIS, in order to inform the USFWS Section 7 consultation process. November 12, 2012. 65 pp.

Tetra Tech. 2010c. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874. Prepared for Rosemont Copper. Tucson, Arizona. November.

United States Army Corps of Engineers (USACE). 2000. Tres Rios Feasibility Study Environmental Impact Statement. Los Angeles District, Phoenix.

U.S. Fish and Wildlife Service (FWS). 1995. Final rule determining endangered status for the southwestern willow flycatcher. Federal Register 60:10694-10715.

U.S. Fish and Wildlife Service (FWS). 1997a. Final determination of critical habitat for the southwestern willow flycatcher. Federal Register 62(140):39129-39146.

U.S. Fish and Wildlife Service (FWS). 1997b. Correction; final determination of critical habitat for the southwestern willow flycatcher. Federal Register 62 (161): 44228.

U.S. Fish and Wildlife Service (FWS). 2002. Southwestern Willow Flycatcher Recovery Plan, Region 2, Albuquerque, NM.

U.S. Fish and Wildlife Service (FWS). 2005. Designation of Critical Habitat for the Southwestern Willow Flycatcher: Final Rule. Federal Register 70 (201): 60886.

U.S. Fish and Wildlife Service (FWS). 2005a. Biological opinion on the Forest Service's continued implementation of the land, resource, and management plans for the 11 southwestern region national forests and grasslands, R2/ES-TE, 02-21-03-F-0366. U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (FWS). 2011. Designation of Revised Critical Habitat for the Southwestern Willow Flycatcher: Proposed Rule. Federal Register 76 (157): 50542.

Yong, W. and D.M. Finch. 1997. Migration of the willow flycatcher along the middle Rio Grande. Wilson Bulletin 109:253-268.

Mexican Spotted Owl (see Appendix A)

U.S. Fish and Wildlife Service (FWS). 2012. Final Recovery Plan for the Mexican Spotted Owl (*Strix occidentalis lucida*), First Revision. U.S. Fish and Wildlife Service. Albuquerque, New Mexico, USA.

Appendix A: Concurrence for the Mexican Spotted Owl

Species Information

A complete description of the biology of the Mexican spotted owl appears in our November 2012 *Mexican Spotted Owl Recovery Plan, First Revision* (FWS 2012). The rangewide status of the species appears in our April 11, 2013, *Biological Opinion on the Aravaipa Ecosystem Management Plan* (File number 02EAAZ00-2012-F-0282).

Background for Determination of Effects:

The action area for this analysis is based on: (1) the area of the mine footprint; (2) areas outside the mine footprint that may be affected by noise, dust, light pollution, and other mining activities; (3) all areas for which mining activity may affect groundwater and surface water; and (4) other areas outside the footprint that are related to mining activity, such as road modifications, power lines, and pipelines (i.e., connected actions). The action area totals approximately 145,513 acres, including the footprints of the Barrel Alternative and utility corridor. The action area is located primarily in Pima County, but also encompasses a small portion of Santa Cruz County; 65,215 acres within the action area are on Forest Service and Bureau of Land Management (BLM) lands, and the remaining 80,298 acres within the action area on Arizona State Land Department State Trust land and private land. The larger action area was drawn to consider the impacts of noise, dust, light pollution, groundwater drawdown, and surface water reduction.

There are three Mexican spotted owl protected activity centers (PACs) adjacent to the larger action area (see Table MSO-1, below). The project area does not contain Mexican spotted owl nest/roost habitat as defined in the Recovery Plan for the Mexican spotted owl (FWS 2012). The Coronado National Forest compiled all known Mexican spotted owl locations from the Santa Rita Mountains, and there are no records of owls within the action area. The closest occupied area is the Ramanote Canyon PAC, which is located approximately 0.7 mile to the west-southwest. The larger action area includes approximately 430 acres of critical habitat unit BR-W-12.

Table MSO-1. Mexican spotted owl PACs near the action area for the Rosemont Project.

PAC Name (Number)	Distance from Project Area	Distance from Action Area
Ramanote Canyon (#0502019)	4.8 miles	0.7 mile
Sawmill Canyon (#0502013)	5.6 miles	1.3 miles
Florida Spring (#0503001)	6.4 miles	2.5 miles

Determination of Effects:

We concur with your determination that the proposed action may affect, but will not likely adversely affect, the Mexican spotted owl. We base our concurrence on the following:

- The proposed action will not directly affect the key habitat components of Mexican spotted owl nest/roost habitat. The project and action areas contain desert, semi-desert grasslands, and Madrean encinal woodlands, which are not habitats used by Mexican spotted owls for nesting and/or roosting (FWS 2012).

- The project area is located approximately 4.8 miles northeast of the nearest PAC and the action area is located approximately 0.7 mile northeast of the nearest PAC. Therefore, the project will not result in noise disturbance to Mexican spotted owls during the breeding season (March 1 through August 31).
- The aforementioned level of effects are insignificant and discountable and will not reduce the potential to achieve recovery of the Mexican spotted owl.
- There is no Mexican spotted owl critical habitat in the action area; therefore, none will be affected.

Appendix B: Mitigation and Monitoring Plan

MITIGATION AND MONITORING PLAN

Introduction

This mitigation and monitoring plan has been developed by the Rosemont ID Team, using information from a number of sources. Since release of the DEIS, mitigation and monitoring has been reviewed and updated to include additional details on: the impacts being mitigated; whether the mitigation measure is meant to avoid, minimize, reduce, rectify, or compensate for impacts; monitoring actions; effectiveness criteria; timing; responsible party; and to which alternatives the items are applicable. In addition, a number of mitigation and monitoring items have been added since release of the DEIS.

As stated in Chapter 2 of the FEIS, the Council of Environmental Quality states that agencies should not commit to mitigation measures absent the authority or expectation of resources to ensure the mitigation is performed (Council on Environmental Quality 2011). This mitigation monitoring plan is designed to clearly disclose which mitigation and monitoring items are within the authority of the Forest Service or other regulatory permitting agency (such as the U.S. Fish and Wildlife Service, U.S Army Corps of Engineers; Arizona Department of Environmental Quality, Arizona State Historic Preservation Office, Arizona Department of Water Resources, etc.). To that end, this mitigation and monitoring plan is organized as follows:

Mitigation and Monitoring - Forest Service – Mitigation and monitoring items under this heading are within the authority of the Forest Service, U.S Fish and Wildlife Service, U.S. Army Corps of Engineers, or Arizona State Historic Preservation Office. They would be specified as a requirement of the Record of Decision, and the final MPO. This category includes mitigation measures and associated monitoring items that would help to minimize impacts to Forest Service surface resources; or are required by the U.S Fish and Wildlife Service Biological Opinion, the Memorandum of Agreement with the Arizona State Historic Preservation Office and associated Historic Properties Treatment Plan (HPTP), or as part of the U.S. Army Corps of Engineers 404 permit. The Forest Service is responsible for overseeing implementation of the mitigation and monitoring in this category. It has the regulatory responsibility to do so for those measures that minimize impacts to Forest Service surface resources; and has a legal obligation to ensure that requirements of the Biological Opinion and Memorandum of Agreement/HTPT are implemented. While the requirements of the U.S. Army Corps of Engineers 404 permit are the responsibility of that agency to oversee, the only mitigation measure that directly mitigates for impacts to waters of the United States is also a requirement of the Biological Opinion. For the purposes of this mitigation and monitoring plan, the U.S. Army Corps of Engineers 404 permit mitigation is also contained in this category.

Mitigation and Monitoring - Other Regulatory and Permitting Agencies - Mitigation and monitoring items under this heading are within the authority of other regulatory permitting agency, including the Arizona Department of Environmental Quality and Arizona Department of Water Resources. These items include permit requirements and stipulations from legally binding permits and authorizations such as the Air Quality Permit, and Aquifer Protection Permit and the groundwater withdrawal permit.

Mitigation and Monitoring Measures - Rosemont Copper - Rosemont has publically agreed to consider or implement the mitigation and monitoring items under this heading. These may include contractual and financial agreements over which the Forest Service and other agencies have no jurisdiction. The items in this category are beyond the authority of the Forest Service or other regulatory and permitting agency. Since the Forest Service and regulatory permitting agencies have no mechanism to require implementation of the mitigation and monitoring items in this category, their implementation is not assured. While the effectiveness of these mitigation measures is included in Chapter 3 of the FEIS, environmental impacts are addressed as measures that may occur, as opposed to measures that would occur, unless otherwise noted.

Potential Future Mitigation Measures – The mitigation and monitoring items listed under this heading have been suggested, and are items in which Rosemont Copper has expressed interest in implementing. However, development of these measures has not progressed to the point that adequate details are available from which to determine their effectiveness in avoiding, reducing or compensating for impacts. While these mitigation and monitoring items may eventually be implemented, they are not considered in determination of mitigation effectiveness disclosed in Chapter 3 of the FEIS.

Monitoring measures described in this plan are primarily addressed as either implementation monitoring or effectiveness monitoring. Implementation monitoring is primarily focused on determining whether a mitigation measure or requirement has been implemented according to the FEIS, ROD, final MPO or pertinent permit. Effectiveness monitoring is primarily focused on determining whether the results of implementing the mitigation measure or requirement achieve the results predicted in the FEIS upon which the ROD and final MPO are based, and comply with applicable laws and regulations.

A number or supporting documents and permits contain detailed information on mitigation or monitoring requirements. In order to avoid repetition, the following documents are incorporated by reference in their entirety:

- Historic Properties Treatment Plan;
- Aquifer Protection Permit (APP, Permit P-106100) issued by the Arizona Department of Environmental Quality;
- Air Quality Class II Synthetic Minor Permit (Air Quality Permit) issued by the Arizona Department of Environmental Quality (Permit 55223);
- Stormwater Pollution Prevention Plan (Permit AZMSG-74939);
- Mineral Extraction and Metallurgical Processing Groundwater Withdrawal Permit (Permit 59-215979.0000)
- Rosemont Copper Project Light Pollution Mitigation Recommendation Report, (Monrad et al, 2012);
- U.S. Fish and Wildlife Service Biological Opinion (contained in Appendix E of this FEIS);
- U.S. Army Corps of Engineers Clean Water Act Habitat Mitigation and Monitoring Plan (included in this appendix);
- Arizona Corporation Commission Certificate of Environmental Compliance issued to TEP for power supply line (Decision No. 73232 and Amendment 1, dated June 12, 2012);
- Memorandum of Agreement with Arizona State Historic Preservation Officer (contained in Appendix D of this FEIS)
- Protection Program Master Agreement, dated December 1, 2009, recorded in the Pima County Recorder's Office January 15, 2012, Recorder's Sequence No. 20100100153, as amended by Amendment No. 1 dated December 17, 2010, recorded in the Pima County Recorder's Office on February 10, 201, Recorder's Sequence No. 20110410243; together with the individual Rosemont Copper Residential Well Protection Program Well Owner Agreements (private, direct contractual agreements with well owners);
- Well Protection Program Master Agreement, dated June 19, 2012, originally recorded in the Pima County Recorder's Office on June 20, 2012, Recorder's Sequence No. 20121720146 and re-recorded to correct a clerical error July 25, 2012, Recorder's Sequence No. 20122070247; together with the individual Rosemont Copper Residential Well Protection Program Well Owner Agreements (private, direct contractual agreements with well owners).

It is important to note that there are a number of plans and permits that would contain additional details pertaining to mitigation and monitoring that have would not be completed until after approval of the ROD. Many of these plans and permits are specific to the alternative that is selected for implementation, and therefore cannot be fully developed prior to approval of the ROD. The mitigation and monitoring items contained in these plans and permits would be required either as a component of the final MPO, or as a permit requirement of a regulatory permitting agency.

Mitigation and Monitoring - Forest Service

The mitigation and monitoring in this section would be required by the Forest Service and included in the Record of Decision and final MPO. The impact analyses are disclosed in Chapter 3 of the FEIS, and final conclusions regarding impacts consider the effectiveness of these mitigation and monitoring measures.

Geology, Minerals and Paleontology

MITIGATION MEASURE	FS-GMP-01 - Upon discovery of paleontological resources, suspend operations pending Forest Service review
Description	Upon discovery of significant paleontological resources, Rosemont Copper would suspend work at that site and the site would be investigated by the appropriate personnel before work resumes. The designated Forest Service representative would promptly coordinate the investigation with appropriate Forest Service or other specialist. Significant fossils may be recovered.
Source	Coronado ID Team.
Impacts Mitigated	Compensates for significant impacts to paleontological resources by allowing data to be gathered and evaluated. Requires investigation and documentation of significant paleontological resources, should they be found during operations.
Location	Includes all areas with surface disturbance on National Forest System lands.
Monitoring / Reporting Action	**Implementation:** Rosemont would conduct visual inspections while implementing ground disturbing activities. Upon discovery of significant paleontological resources, Rosemont Copper would suspend work at that site, notify the Forest Service, and the site would be investigated by the Forest Service before work resumes. **Effectiveness:** Should paleontological resources be discovered, work suspended, and subsequent investigation conducted, the Forest Service would conduct an "after action review" to determine whether any visual inspections, reporting and data collection/evaluation were effective in achieving desired results.
Performance Criteria	**Implementation and Effectiveness:** Upon discovery of significant paleontological resources, Rosemont suspends work at that site and contacts the designated Forest Service representative to investigate the discovery before work is reinitiated.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for monitoring ground disturbing activities for the presence of significant paleontological resources; and for suspending operations at the site of such discovery and notifying the Forest Service. The Forest Service is responsible for investigating significant paleontological resources that are located in a timely manner so that Rosemont operational suspension period is minimized.
Timing	**Implementation and Effectiveness:** Pre-mining through active mining phases when initial ground disturbance would occur.

MITIGATION MEASURE	FS-GMP-02 - Upon discovery of a cave or sinkhole, suspend operations pending Forest Service review
Description	Upon indication or discovery of a cave or sinkhole, Rosemont Copper would suspend work at that site and contact the designated Forest Service representative to investigate the discovery before work is reinitiated. The designated Forest Service representative would promptly coordinate the investigation with appropriate agency resource specialists. Any natural void in rock that is large enough for a human to enter constitutes a cave. Any collapse feature in or over carbonate rock constitutes a sinkhole.
Source	Coronado ID Team.
Impacts Mitigated	May compensate for impacts to cave by allowing data to be gathered and evaluated. Requires investigation and documentation of significant cave or sinkhole, should they be found during operations.
Location	Includes all areas with surface disturbance on National Forest System lands.
Monitoring / Reporting Action	**Implementation:** Visual inspections by Rosemont Copper while implementing ground disturbing activities to determine whether any cave or sinkhole has been discovered. Upon discovery of such resources, Rosemont Copper would suspend work at that site, notify the Forest Service, and the site would be investigated in the same 24-hour period by the Forest Service before work resumes. **Effectiveness:** Should a cave or sinkhole be discovered, work suspended, and subsequent investigation conducted, the Forest Service would conduct an "after action review" to determine whether any visual inspections, reporting and data collection/evaluation were effective in achieving desired results.
Performance Criteria	**Implementation:** Visual inspections by Rosemont Copper are conducted while implementing ground disturbing activities. **Effectiveness:** Upon discovery of cave or sinkhole, Rosemont Copper suspends work at that site and contacts the designated Forest Service representative to investigate the discovery before work is reinitiated.
Responsible Party	**Implementation:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. **Effectiveness:** Rosemont is responsible for suspending operations and notifying the Forest Service should discoveries of a cave or sinkhole occur. Forest Service is responsible for conducting investigation that in a timely manner within the same 24 hour period so that the Rosemont operational suspension period is minimized.
Timing	**Implementation and Effectiveness:** Pre-mining thorough final reclamation and closure phases.

Soils and Revegetation

MITIGATION MEASURE	FS-SR-01 - Growth media salvage and application
Description	Soil would be salvaged in accordance with the Final Reclamation and Closure Plan. This plan would also specify where and how this growth media would be stored, and how and where it would be applied on tailings and waste rock facilities and other disturbed areas in order to facilitate revegetation of mine related disturbance. Hill slopes would be monitored for erosion.
Source	This is a design feature that was contained in the preliminary MPO; and further refined in Preliminary Soil Salvage and Management Plan (CDM Smith, July 2012). Erosion monitoring aspects were subsequently required by Forest. Final specifications would be developed and included in the final MPO for the selected action.
Impacts Mitigated	Provides substrate for improving the success of revegetation efforts; enhances soil function and stability; which in turn would promote revegetation and reduces impacts to surface water quality from potential erosion; and reduce impacts to visual resources.
Location	All disturbed areas except the mine pit. Includes linear features such as utilities and pipelines, and may include the upper benches of the mine pit as well.
Monitoring / Reporting Action	**Implementation:** Weekly visual inspections during soil (growth media) salvage and storage activities to ensure compliance with specifications in final MPO, with results reported quarterly; visual inspections of recently reclaimed areas after significant rainfall events (0.5 inches or greater precipitation within 24-hour period) to determine if there are signs of accelerated erosion and areas in need of stabilization. Rosemont would determine soil texture and soil surface particle size when the area is ready for planting. Rosemont would provide GIS information on reclaimed sites and the location of different types of growth medium. GIS information and monitoring would be provided on a quarterly basis. A Final Reclamation and Closure Plan would be developed by Rosemont and approved by the Forest Service, prior to issuance of the final MPO. An adaptive management approach would be used to set and refine success criteria for the growth medium resource and soil stability. Rosemont and the Forest Service would use National Resource Conservation Service (NRCS) Ecological Site Descriptions (ESD) to identify comparable reference site replications in the vicinity of the mine. Success criteria would be expressed as a percent similarity of revegetated sites compared to reference areas. Success criteria would be based on quantitative monitoring results and statistical analyses/comparisons of results from reference sites, test plots, and ongoing site monitoring of previously reclaimed areas. Texture of growth media would follow established NRCS protocols. Monitoring of growth media, soil stability and site characteristics on reference areas, test plots, and previously revegetated areas would provide quantifiable results and set up a data feedback loop to continually adjust success criteria and objectives; and to determine if changes are needed in growth medium texture, site preparation, soil amendments, soil mycorrhizal inoculation, or other characteristics. **Effectiveness:** Soil stability measurements may include measurements of: soil surface particle size, litter and basal plant cover; rills, waterflow patterns, pedestals/terracettes, gullies, wind-scoured areas, soil surface loss or degradation, plant community distribution relative to infiltration and runoff, soil surface aggregate stability, and soil compaction (USDI and USDA, 2000, *Interpreting Indicators of Rangeland Health Version 3.* Technical Reference 1734-6.) Reclaimed area monitoring results would be statistically compared to reference plot results to determine if objectives are being met. Additional measurements across the reclaimed sites would be required to detect the presence of rills and gullies and to quantify soil movement. Adaptive management adjustments would be assessed to ensure their compliance with the current NEPA decision; supported by monitoring data results; and documented in the project monitoring and evaluation report. This includes monitoring of sediment buildup in flow channels and removal of sediment if necessary to maintain adequate flow capacity.

MITIGATION MEASURE	FS-SR-01 - Growth media salvage and application
Performance Criteria	**Implementation:** Growth media is salvaged, stockpiled and placed in accordance with the final MPO in areas protected from mining operations that are stable, isolated from surface water gently sloping and well drained. Growth media stockpiles are convex in shape and have slopes no steeper than 3:1. Stockpiles are revegetated with native species no later than the first growth season following the pre-mining phase. Sediment control structures are installed and other best management practices implemented as needed to protect growth media from loss (wind or rain run-off). Placement of growth media and revegetation efforts are implemented concurrently with reclamation efforts. Areas to be reclaimed are contoured, graded, prepared, and seeded and/or planted in accordance with the final reclamation plan. Specifications and goals for the salvage, storage, and reuse of growth media from disturbed areas would be developed with the goal of providing sufficient cover on all disturbed areas to be reclaimed. Additional treatments to stabilize soils, soil amendments and/or soil mychorrizal inoculations may be considered pending monitoring results. Monitoring results are used to determine if additional mitigation measures are needed to enhance plant success on growth medium types or to improve soil stability. Revegetated areas would have diverse and permanent vegetative cover composed of species and cover amounts similar to natural vegetation in the area (FSM 2070, 2008). Revegetated shrub and tree plantings would be scattered across the landscape in a random/patchy distribution to mimic natural vegetation patterns on adjacent undisturbed areas. Available, on-site woody debris from clearing of the mine site would be used on the reclaimed growth medium surfaces to provide stability, organic matter, and microhabitats for seed germination, invertebrates and small vertebrate species. Density of woody debris would meet guidelines that are portrayed in the Draft Coronado Forest Plan. Should soil texture, surface particle size or soil stability not meet revegetation objectives of the Final Reclamation and Closure Plan, appropriate, site specific measures are developed by Rosemont in cooperation with the Coronado. Measures may include: additional soil being placed on-site, soil amendments, soil stability measures, or other prescribed treatments. **Effectiveness:** Slopes with growth media placement contain a minimum of 1 foot of cover; are stable and monitoring results show no signs of unacceptable soil movement as determined in comparisons with reference sites, Ecological Site Descriptions, test plots, and previously revegetated reclamation areas. Growth media is sufficient to ensure seeding and planting is successful in establishing desired plant species and communities in location zones specified in the final reclamation plan. Growth media texture, surface particle size and soil stability measurements meet interim and final reclamation and revegetation objectives of the Final Reclamation and Closure Plan. Sediment channels maintain design capacity needed for adequate movement of stormwater.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service on a quarterly basis. Forest Service is responsible for establishing success criteria to determine if the growth media is sufficient to support revegetation objectives of the Final Reclamation and Closure Plan, and soil stability requirements; and to spot check revegetation success and soil stability on National Forest System lands throughout the year. The Forest Service would conduct annual (at a minimum) site inspections to review monitoring results in cooperation with Rosemont to: determine if success criteria have been met and cause/effect for better or worse results than predicted; if data (from reference sites, test plots and revegetated plots) indicates the need for adjustments to growth medium or soil amendments, seed/plant application rates, site preparation; determine if acceptable soil stability has been achieved; and determine the need for additional mitigation measures for more successful revegetation and increased soil stability. The Forest Service would evaluate monitoring results to determine and document compliance with NEPA decision and effectiveness of mitigation.
Timing	**Implementation:** Monitoring would begin when salvage of soil (growth media) begins, and continue until the Forest Service determines that no further reclamation efforts (seeding, planting, site stabilization, etc.) are necessary to meet final objectives to be determined by USFS at the time of the mine closure. **Effectiveness:** Monitoring would begin when salvage of soil (growth media) begins to ensure that storage pile(s) are stable and kept from contributing large quantities of dust during wind events; continuing through placement of growth media to ensure it is stable, placed according to final reclamation plan, and does not erode excessively.

MITIGATION MEASURE	FS-SR-02 - Revegetate disturbed areas with native species
Description	Includes efforts to establish native grasses, forbs, shrubs and trees on areas disturbed my mining and mine related activities. Revegetation would be protected by detecting and treating of invasive weed species. Revegetation efforts would consider use of species important to Native American cultural uses.
Source	This is a design feature that was contained in the preliminary MPO. Further refinements have been made is various reclamation updates, and efforts to further refine revegetation plans are currently ongoing by the Forest Service. The USFWS Biological Opinion provides woody vegetation goals for jaguar habitat.

MITIGATION MEASURE	FS-SR-02 - Revegetate disturbed areas with native species
Impacts Mitigated	Reduces impacts to surface water quality from potential erosion; reduces impacts to visual resources; vegetation enhances soil function and stability. Potentially provides wildlife habitat (including habitat for jaguar, ocelot, lesser long-nosed bat and southwestern willow flycatcher); suitable livestock grazing conditions; establishment of culturally important plant species; and future recreational use.
Location	All disturbed areas except the mine pit. Includes linear features such as utilities and pipelines.
Monitoring / Reporting Action	**Implementation:** Visual inspections of recently reclaimed areas after significant rainfall events (0.5 inches or greater precipitation within 24-hour period) to determine if there are signs of accelerated erosion and areas in need of stabilization to determine if there is sufficient growth medium on-site to ensure revegetation success. A revegetation plan would be developed by Rosemont and approved by the USFS as part of the Final Reclamation and Closure Plan, prior to issuance of the final MPO. The revegetation plan would address how the different plant communities, including woody species, would be dispersed across the landscape. Revegetation efforts, including maps, GIS data, and acreage of initial seeding, seed/plant mix, seeding/planting application rate, propagation, and transplanting reported on an annual basis. The Forest Service would determine revegetation success using an adaptive management approach to set and refine success criteria based on quantitative monitoring results and statistical analyses/comparisons of results from reference sites, test plots, and ongoing revegetation efforts. Revegetation success would be defined as similarity to comparable reference sites. The Biological Assessment calls for 3-40% woody vegetation cover averaged over the reclamation area. Additional tree and shrub cover may be required in order to meet similarity requirements to reference sites. Monitoring vegetation and site characteristics on these three types of plots would provide quantifiable results and set up a data feedback loop to continually adjust success criteria, objectives, species to be used in seed mix/planting, and site preparation techniques. Adaptive management adjustments would be assessed to ensure their compliance with current NEPA decision; supported by monitoring data results; and documented in the project monitoring and evaluation report. Invasive plan control measures comply with the Environmental Assessment for the Invasive Exotic Plant Management Program (Coronado National Forest 2004). GIS data for treatment areas, and description of species treated, and the type and amount of herbicides used would be reported to USFS annually. **Effectiveness:** Annual quantitative monitoring of revegetation and soil stability would be required. Vegetation measurements may include: species richness, canopy cover, basal cover, density/frequency, and plant community structure. Revegetated plot results would be statistically compared to reference plot results to determine if objectives are being met. Disturbed and revegetated areas are surveyed for invasive species twice a year following winter and summer rains; map such locations and take action to prevent, eliminate, or control invasive plants should they occur, in accordance with the final MPO.
Performance Criteria	**Implementation:** Percent similarity to reference sites would be established based on Ecological Site Descriptions, reference plots, test plots, and ongoing monitoring of previously revegetated plots. Placement of growth media and revegetation efforts are implemented concurrently with reclamation efforts. Areas to be revegetated are contoured, graded, prepared, and seeded and/or planted in accordance with the Final Reclamation and Closure Plan. Rosemont and the Forest Service would use NRCS Ecological Site Descriptions to identify comparable reference site replications in the vicinity of the mine. Native species used for revegetation efforts are approved by the Forest Service in advance, and meet those specified in the final reclamation plan. Species are determined from NRCS Ecological Site Descriptions, reference sites, and test plot results. The revegetation plan would include measures to meet the terms and conditions of the Biological Assessment. Species composition on revegetated sites would be similar to those found on reference sites including: grasses, forbs, shrubs and trees. Species considered would be capable of being self-sustaining and would include species with the ability to provide soil stability, achieve desired future conditions, wildlife habitat, and may include species that are culturally important to Tribes. Reference site data would be used to calculate native species' occurrence, density, and cover; and to set revegetation success criteria. Aspect, elevation, and topographic location would be considered when selecting reference sites, and when quantifying comparisons between reference and revegetated sites. **Effectiveness:** Growth medium characteristics and soil stability are sufficient to meet revegetation objectives. Ecological Site Descriptions, test plots, and previously revegetated reclamation areas are used to establish appropriate plant species to be revegetated and set success criteria. Seeding and planting is successful in establishing desired plant species and communities in location zones specified in the final reclamation plan. Vegetation species and density are similar to reference sites as determined by the adaptive management data feedback loop.

MITIGATION MEASURE	FS-SR-02 - Revegetate disturbed areas with native species
Responsible Party	**Implementation and Effectiveness:** The Forest Service is responsible for consultation with U.S. Fish and Wildlife Service and for ensuring the terms and conditions of the Biological Opinion to provide for threatened and endangered species habitats are met (see FS-BR-04). The Forest Service is responsible for consultation with tribes regarding culturally important plant species. Rosemont is responsible for conducting monitoring and reporting to the Forest Service. The Forest Service is responsible for establishing success criteria and revegetation objectives based on similarity to reference sites and the adaptive management process. The Forest Service would spot check revegetation success and site stability on National Forest System lands throughout the year. The Forest Service would conduct annual (at a minimum) site inspections to review monitoring results in cooperation with Rosemont to: determine if success criteria have been met and cause/effect for better or worse results than predicted; if data (from reference sites, test plots and revegetated plots) indicates the need for adjustments to seed/plant mix, seed/plant application rates, site preparation; determine if acceptable soil stability has been achieved; and determine the need for additional mitigation measures for revegetation and soil stability. The Forest Service would evaluate monitoring results to determine and document compliance with NEPA decision and effectiveness of mitigation.
Timing	**Implementation:** Monitoring would begin when salvage of soil (growth media) begins the during pre-mining phase, and continue until the Forest Service determines that no further revegetation efforts (seeding, planting, site stabilization, etc.) are necessary to meet the revegetation plan, and Final Reclamation and Closure Plans' and objectives, during final reclamation and closure or post-closure phases. **Effectiveness:** Revegetation effectiveness monitoring would begin with initial seeding or planting during the active mining phase, and continue until the Forest Service determines that final reclamation objectives for revegetation and site stability have been met during final reclamation and closure or post-closure phases.

MITIGATION MEASURE	FS-SR-03 - Concurrent placement of perimeter buttress
Description	This mitigation involves constructing a buttress formed of waste rock surrounding and encapsulating the compacted tailings.
Source	This is a design feature that was contained in the preliminary MPO and is required by the APP.
Impacts Mitigated	Reduces impacts to surface water due to erosion potential by beginning reclamation and vegetation recovery earlier, and concurrently with mining operations; reduces impacts to visual quality by eventually blocking the view of most of plant site and structures; reduces risk of impacts to groundwater from potential acid generation through proper placement of neutralizing waste rock materials.
Location	Completely surrounding the dry-stack tailings, waste rock facilities
Monitoring / Reporting Action	**Implementation:** Weekly visual inspections and quarterly reporting to ensure (1) placement is within the footprint specified in the FEIS, ROD and final MPO; (2) geometry of facility adheres to specifications in the final MPO; (3) waste rock placement in storage area is placed according to APP and stacking plan from the final MPO; and (4) facilities are stable. Slopes are configured to support successful revegetation. **Effectiveness:** Weekly visual inspections and quarterly reporting of status and condition of perimeter buttress construction, including excessive erosion, if any; and results of acid rock drainage monitoring (see GW-02). Annual monitoring of effectiveness of perimeter buttress in blocking the view of the plant site from selected viewpoints.
Performance Criteria	**Implementation:** Perimeter buttress is located within the footprint depicted in the FEIS, ROD and final MPO; benched waste rock buttresses are generally no less than 150 feet wide at the crest and have an overall crest-to-toe slope of about 3.5:1 (horizontal: vertical); slopes are generally 3:1 between benches; slopes are stable with no major failures or erosion. Surface deformation, slides, sloughs and settlement do not affect stability; materials are placed according to ADEQ approved Waste Rock Segregation Plan (APP approved April 3, 2012, p. 28). **Effectiveness:** Monitoring indicates acid rock drainage meets predictions in FEIS and ROD, and does not contaminate ground or surface waters; surfaces are stable and excessive erosion does not occur; view of plant site is reduced from most viewpoints.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring of perimeter buttress construction, location, and condition and reporting to the Forest Service. Rosemont is responsible for conducting water quality monitoring and reporting to the Forest Service and ADEQ. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with NEPA decision and effectiveness of mitigation. ADEQ is responsible for determining compliance with APP. Forest Service is responsible for conducting and reporting monitoring of visual screening.
Timing	**Implementation and Effectiveness:** Commencing when construction of perimeter buttress begins and continuing until buttress construction has been completed.

Other Monitoring Items for Soils and Revegetation

MONITORING ITEM	FS-SR-05 – Sediment transport monitoring
Description	This monitoring item monitors the movement of sediment within the channel of Barrel Canyon, including any aggradation or scour.
Source	Coronado ID Team.
Purpose	To determine whether erosion and downstream geomorphological changes are within the range of impacts described in the NEPA decision.
Location	Barrel Canyon from compliance point dam downstream to Highway 83 bridge. Includes assessment of scour/aggradation at bridge itself.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Baseline conditions would be established prior to mine construction (before pre-mining phase), and periodic comparison monitoring every 5 years. Baseline condition determination and subsequent monitoring would use techniques that are sufficient to describe areas along the sandy wash bottom of Barrel Canyon where the surface elevation has increased from baseline, decreased from baseline, or remained the same.
Performance Criteria	**Implementation and Effectiveness:** Monitoring is performed and reported to Forest every 5 years. Reporting to include comparison of current conditions to baseline measurement and assess trends of any geomorphological changes.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

Surface Water Quantity and Quality

MITIGATION MEASURE	FS-SW-01 – Location, design and operation of facilities and structures intended to route stormwater around the mine and into downstream drainages
Description	This mitigation involves the design, location and operation of stormwater diversion facilities in order to maintain flow downstream and avoid contact with processing facilities and ore stockpiles.
Source	Design feature of the preliminary MPO, that has been revised for the various action alternatives. AZPDES MSGP does not require, but encourages consideration of diversion structures.
Impacts Mitigated	Reduces risk of flooding damage to mine facilities; allows noncontact stormwater to flow into natural drainages. Diversions designed and operated to route stormwater through or around project facilities would reduce loss of surface water and groundwater flows in drainage downstream of mine facility.
Location	Pit and permanent diversion channels; drop structures, compliance point pond and dam (sediment control structures).
Monitoring / Reporting Action	**Implementation:** Complete inspection when these facilities are constructed to ensure consistency with location and specifications contained in the final MPO. **Effectiveness:** Quarterly visual inspections to identify unusual physical conditions and take appropriate actions. Quarterly, and during/after significant rainfall/surface water flow events visually inspect all structures to ensure proper routing of water and identify corrective actions as needed. Permanent facilities may need post-closure monitoring for a period of time to be determined to ensure continued effectiveness.
Performance Criteria	**Implementation:** Facilities are constructed in locations and to specifications contained in final MPO. **Effectiveness:** Structures are stable; show no excessive erosion, settling, slumping or deformation that could affect water routing. Water is routed to desired natural features (washes) in an efficient manner. Permanent facilities are designed to minimize the need for long term maintenance post-closure.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with NEPA decision and effectiveness of mitigation.
Timing	**Implementation:** During construction (pre-mining phase) to ensure compliance with final MPO. **Effectiveness:** Throughout pre-mining, active mining and final reclamation and closure phases.

MITIGATION MEASURE	FS-SW-02 - Stormwater diversion for Barrel Alternative designed to route more stormwater into downstream drainages post-closure
Description	This mitigation reflects the results of an effort to apply the concepts of geomorphic reclamation to the Barrel alternative. The result is a design that would route more stormwater into downstream drainages post-closure than previous designs.
Source	Coronado ID Team.

MITIGATION MEASURE	FS-SW-02 - Stormwater diversion for Barrel Alternative designed to route more stormwater into downstream drainages post-closure
Impacts Mitigated	Reduces impacts to surface flows and groundwater in drainages downstream by allowing more stormwater delivery into natural drainages (washes). Design grades the tops of facilities to shed water to lower benches, where water moves laterally until reaching concrete drop structure and/or discharged into a diversion channel and then into a natural drainage. Channel is built to drain plant site to McCleary Canyon. Post-closure, no water is stored on waste rock or tailings facilities.
Location	Tailings, waste rock and plant facilities; benches designed to move stormwater laterally; diversion channels; and concrete drop structures.
Monitoring / Reporting Action	**Implementation:** Complete inspection when these facilities are constructed to ensure consistency with location and specifications contained in the final MPO. **Effectiveness:** Quarterly visual inspection of facility integrity and to ensure water delivery is occurring efficiently and sufficient channel capacity exists; additional inspections during and following significant rainfall events (1/2" or greater precipitation within 24-hour period).
Performance Criteria	**Implementation:** Monitoring ensures that construction adheres to final MPO. **Effectiveness:** Facilities are stable over time without excessive erosion, and effectively deliver stormwater into natural drainages.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation:** During construction (pre-mining phase) to ensure compliance with final MPO. **Effectiveness:** During active mining phase to ensure water deliver is effective and complies with final MPO. Monitoring post-closure for a period of time to be determined ensures that facilities would operate with no or minimal maintenance.

Seeps, Springs and Riparian

MITIGATION MEASURE	FS-SSR-01 – Purchase water rights to be used for compensating for impacts in the Cienega Creek watershed
Description	This mitigation requires the following actions in the Cienega Creek Watershed: Purchase approximately 1,122 acre-feet of surface water rights to be used to enhance aquatic habitat values in the Cienega Creek watershed for federal threatened and endangered species and for riparian resources. This would include the severance and transfer of portions of surface water rights to appropriate entities to become in-stream flow rights on Lower Cienega Creek and Davidson Canyon within the Cienega Creek Natural Preserve; and in-stream flow rights on Upper Cienega Creek within the Las Cienegas National Conservation Area. This would also include the discharge of a portion of the water right below Pantano Dam in order to establish groundwater recharge credits, which would also create an enhanced riparian corridor below Pantano Dam within the Cienega Creek Natural Preserve. Acquire and retire groundwater well on lands associated with Pantano Dam in order to eliminate impacts to surface water in Cienega Creek from the withdrawal of groundwater.
Source	Rosemont Copper identified this parcel as a component of the Clean Water Act section 404 permitting process; it is also included in the Biological Opinion.
Impacts Mitigated	Partially mitigates for potential impacts to jaguar, ocelot, Chiricahua leopard frog, Gila chub, Gila topminnow, Huachuca water umbel, western yellow-billed cuckoo, and southwestern willow flycatcher, and aquatic and riparian vegetation.
Location	Cienega Creek watershed.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Responsible Party	**Implementation:** Rosemont is responsible for purchasing water rights and assigning them in the manner specified in the Biological Opinion. The Forest Service is responsible for ensuring measures in the Biological Opinion are implemented. **Effectiveness:** As per requirements in the Biological Opinion.
Timing	**Implementation and Effectiveness:** Throughout the life of the project (pre-mining through final reclamation and closure phases) and for 5 years following mine closure.

Other Monitoring Items for Seeps, Springs, and Riparian Areas

MONITORING ITEM	FS-SSR-02 – Spring, seep, and constructed/enhanced waters monitoring
Description	A suite of seeps and springs have been monitored for baseline conditions since 2007 and would be monitored to identify any impacts that may occur due to dewatering of the regional aquifer in the vicinity of the mine pit. Rosemont has committed to enhancing or replacing up to 30 water sources to offset potential impacts to surface waters, and the performance and success of these waters would be monitored as well. The Cienega Creek Watershed Conservation Fund (FS-BR-17) could be used for monitoring of success of replacement or enhanced water features. If springs levels decrease, mitigation could come from this fund.
Source	Monitoring of constructed waters as required under Biological Opinion; monitoring of seeps and springs was proposed by Rosemont.
Purpose	To measure effects of groundwater drawdown and to determine if decreased water levels are due to mine activities. Surface water level is monitored in a variety of locations.
Location	As specified in the Biological Opinion. Suite of springs shown in table below.
Monitoring / Reporting Action	**Implementation**: Baseline condition of springs is assessed, including extent of riparian habitat, presence/absence of water, extent of standing or flowing water, and flow measurements if possible. **Effectiveness:** Quarterly measurement of spring condition (presence/absence of water, flow measurements if possible), with results reported to the Forest Service.
Performance Criteria	**Implementation:** Baseline condition of springs and other water resources is accurately documented. **Effectiveness:** Quarterly monitoring accurately records spring condition.
Responsible Party	**Implementation:** Rosemont is responsible for baseline monitoring of springs. Forest Service is responsible for determining spring locations and obtaining access for any springs not located on public lands. **Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine whether modeled groundwater levels in the EIS analysis are accurate.
Timing	**Implementation:** During pre-mining to establish baseline conditions. **Effectiveness:** From issuance of the ROD to five years post-closure.

Springs to be Monitored in relation to SSR-02

Cadastral Location	Spring Name
(D-19-15)1dbd	Deering Spring
(D-19-15)1bdb	Locust Spring
(D-19-15)1bbb	SW
(D-18-16)9dbb	Lower Mulberry Spring
(D-18-16)9cbd	Crucero Spring
(D-18-16)9abc	Mulberry Spring
(D-18-16)30abc	MC-1 Spring
(D-18-16)29bda	McCleary Dam
(D-18-16)27ddd	Questa Spring
(D-18-16)19ccd	MC-2 Spring
(D-18-16)19abb	Fig Tree Spring
(D-18-16)17acc	SC-2 Spring
(D-18-16)16ccc	Scholefield Spring (SC-1)
(D-18-16)16bba	Papago Spring
(D-18-16)14cab	Barrel Spring
(D-18-15)35bdc	Ruelas Spring
(D-18-15)24dcc	Peligro Adit
(D-18-15)14dba	Helvetia Spring
(D-18-15)13aab	SS-2
(D-18-15)12dba	Sycamore Spring
(D-17-17)6bdd	Reach 2 Spring
(D-16-17)30abd	Escondida Spring
(D-19-17)18aad	Upper Empire Gulch Springs
(D-18-15)14bcd	Shamrod Spring
(D-18-15)14ada	Zackendorf Spring

Waters of the United States

MITIGATION MEASURE	FS-WUS-01 – Record a restrictive easement on private land parcels in Davidson Canyon to compensate for impacts to waters of the U.S., and provide other benefits
Description	This mitigation would require Rosemont Copper to record restrictive covenants on the Davidson Canyon Watershed Parcels**.** These parcels total 74 acres in Davidson Canyon. The restrictive covenant would preclude real estate development and similar land use activities, and restrict grazing activities. The parcels include ephemeral wash and riparian habitat along ~5,000’ of Davidson Canyon and ~3,000’ of Barrel Canyon and portions of Mulberry Canyon and the East Fork of Davidson Canyon. Approximately 15.5 acres of ephemeral drainages are included, including 3 springs; 40 acres of riparian habitat and 190 acres of upland buffer habitat adjacent to riparian. Managed grazing, cultural and some low impact public use (hiking, bird watching, minor forms of hunting, etc.) would be allowed in some locations.
Source	Clean Water Act Section 404 Permit Habitat Mitigation and Monitoring Plan (HMMP); Biological Opinion.
Impacts Mitigated	Compensates for loss of waters of the U.S.; loss of riparian habitat; loss of upland buffer habitat; loss of recreational use. Potentially compensates for cultural impacts to Native Americans by allowing reasonable access to culturally important areas.
Location	Davidson Canyon Watershed Parcels (see Section 404 HMMP in this appendix).
Monitoring / Reporting Action	**Implementation:** Recording of a restrictive covenant as per Biological Opinion and the 404 permit, would be required. A copy of said restrictive covenant would be provided to the Forest Service. **Effectiveness:** As per requirements in the 404 permit and/or Biological Opinion, if any.
Performance Criteria	**Implementation:** Restrictive covenant restricts and allows land uses as per requirements specified in Biological Opinion and/or 404permit. Such restrictive covenant would be recorded in the timeframe specified in the Biological Opinion and 404 permit process. **Effectiveness:** As per requirements in the 404 permit and/or Biological Opinion, if any.
Responsible Party	**Implementation:** Rosemont is responsible for crafting and recording a restrictive covenant that meets the requirements specified in the 404 permit and/or Biological Opinion, which is incorporated into the ROD. **Effectiveness:** As per requirements in the 404 permit and/or Biological Opinion, if any.
Timing	**Implementation:** As per requirements in the 404 permit and/or Biological Opinion **Effectiveness:** As per requirements in the 404 permit and/or Biological Opinion, if any.

Biological Resources

MITIGATION MEASURE	FS-BR-01 – Plant site location and design adjustments to reduce impacts to biological resources
Description	The entire plant site is sited and designed to reduce its size and overall footprint, and to use gravity instead of pumping to move process water where possible. Specific plant site details are contained in the preliminary MPO and chapter 2 alternatives descriptions.
Source	This is a design feature of the preliminary MPO.
Impacts Mitigated	Reduced footprint avoids some impacts to cultural resources, native plants, and wildlife habitat. Design uses gravity for supply of process water where possible, reducing energy needs. Reduced footprint minimizes impact to biological core areas identified in Sonoran Desert Conservation Plan.
Location	Plant site (see alternative maps in Chapter 2).
Monitoring / Reporting Action	**Implementation and Effectiveness:** Initial review of plans and weekly visual inspections during construction of plant facilities and removal of plant facilities to ensure that facilities are located and removed in accordance with the final MPO.
Performance Criteria	**Implementation and Effectiveness:** Facilities are located and designed in compliance with the final MPO.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** During pre-mining (construction) and final reclamation and closure (plant facility removal) phases to ensure adherence to final MPO decision; periodically during operations if modifications are proposed.

MITIGATION MEASURE	FS-BR-02 – Redesign of the coarse ore stockpile dome and pebble crusher/ball loading facility to avoid a sub-population of sensitive plants

Description	This facility redesign involves enclosure of the stockpile by a domes structure, and reorientation of the crusher/ball loading facility conveyers to avoid a population of Coleman's coral-root, which is a Forest Service sensitive species. A complete inventory of the National Forest System land disturbance footprint for Coleman's coral-root and beardless chinch-weed would be completed prior to ground-disturbance.
Source	Rosemont Copper. Also addressed in the Biological Evaluation.
Impacts Mitigated	Avoids impacts to sensitive orchid sub-populations of Coleman's coral-root and possibly other sensitive plant species through reduction of the originally proposed footprint and angled arrangement of building and conveyers; reduces impacts to air quality by reducing dust generation; dome is less visually evident than conventional structure, thereby reducing impacts to visual quality.
Location	Plant site (see alternative maps in Chapter 2).
Monitoring / Reporting Action	**Implementation:** Review of plans and weekly visual inspections during construction and removal of plant facilities to ensure that facilities are located and removed in a manner that avoids plant populations, in accordance with the final MPO. **Effectiveness:** Semi-annual inspection and reporting to ensure protections are effective. Air quality monitoring conducted as per Air Quality Permit requirements. Forest Service would assess completed dome from representative viewpoints to determine effectiveness in reducing visual impacts.
Performance Criteria	**Implementation and Effectiveness:** Facilities are constructed according to specifications in final MPO. Protected plant populations are not impacted by plant site and facility construction or operations. Air quality standards are met.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with NEPA decision and effectiveness of mitigation. See monitoring requirements in Air Quality and Visual Resources sections for further information.
Timing	**Implementation and Effectiveness:** Predominately during pre-mining (construction of facilities) and final reclamation and closure (removal of facilities) phases. Monitoring during active mining phase to ensure plants are not indirectly impacted.

MITIGATION MEASURE	FS-BR-03 – Measures to exclude wildlife, livestock and the public from water ponds and other areas
Description	Specific ponds, basins and other facilities would be enclosed, fenced, or otherwise managed to exclude wildlife, livestock and the public. Includes construction of barriers to exclude Chiricahua leopard from, if needed.
Source	This is a design feature from the preliminary MPO. Barriers to exclude Chiricahua leopard frog are specified in the Biological Opinion.
Impacts Mitigated	Avoids or reduces potential impacts to wildlife such as amphibians; birds and bats; livestock; and public safety.
Location	Process water temporary storage pond (PWTS); primary settling basin; raffinate pond, heap leach pad, pregnant leach solution (PLS) pond; stormwater pond; primary settling basin; any other location where process water may be ponded; and chemical and fuel storage areas.
Monitoring / Reporting Action	**Implementation:** Visual inspection at time facilities are constructed to ensure that covers or devices have been installed and facilities are enclosed or fenced. **Effectiveness:** Daily visual inspection to ensure enclosures, fences, covers or devices are functioning properly to exclude wildlife, livestock and the public.
Performance Criteria	**Implementation:** All accumulations of process water and other noted facilities are enclosed, or have covers or devices installed that operate to effectively exclude wildlife. **Effectiveness:** Enclosures, fences, covers or devices are effective in protecting wildlife, livestock and the public.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with NEPA decision and effectiveness of mitigation.
Timing	**Implementation:** During construction (pre-mining phase) to ensure enclosures, fences, covers and devices adhere to final MPO. **Effectiveness:** During active mining to ensure that measures are effective; and at final closure of the facilities to ensure that process water or other facilities do not present hazards to wildlife, livestock or the public.

MITIGATION MEASURE	FS-BR-04 - Salvage, grow, plant and monitor Palmer's Agave

MITIGATION MEASURE	FS-BR-04 - Salvage, grow, plant and monitor Palmer's Agave
Description	Revegetation includes Biological Opinion requirements to plant and monitor agave, study suitability of Palmer's Agave seeds gathered locally for use in reclamation seed mix, and plant native tree species. Palmer's Agave would be included in the Final Reclamation and Closure Plan. Rosemont would plant (transplanted or nursery grown stock) at least 35,850 Palmer Agaves as specified in the Biological Opinion. Palmer's Agave seed would be included in the seed mix provided such seed are commercially available. During the life of the Project Rosemont would work with the Forest Service to identify potential restoration areas outside of the security fence and within 2 miles of the perimeter fence that are suitable for Palmer's Agave. Using the seed mix being used for concurrent reclamation, Rosemont would assist the Forest Service with the revegetation of these areas. In addition to seeding, revegetation efforts would include planting Palmer's Agave transplants or nursery-grown Palmer's Agave. This effort would include portions of the old Arizona Trail being abandoned under the action alternatives. Prior to submittal of proposed modification of the Allotment Management Plan (see RC-BR-02), Rosemont would refine existing estimates of Palmer Agave that would be impacted within the security fence area and conduct studies sufficient to identify and establish baseline conditions of pastures that would be proposed in the Allotment Management Plan modification for seasonal grazing restrictions to increase flowering success of agave.
Source	Biological Opinion.
Impacts Mitigated	Rectifies impacts to wildlife habitat by rehabilitating and restoring this component of the affected environment. Revegetation of Palmer's Agave would provide wildlife habitat (including habitat for jaguar, ocelot, lesser long-nosed bat and southwestern willow flycatcher), and meets the terms and conditions of the Biological Opinion.
Location	All disturbed areas except the mine pit. Includes linear features such as utilities and pipelines.
Monitoring / Reporting Action	**Implementation:** Weekly visual inspections during soil (growth media) salvage and storage activities to ensure compliance with specifications in final MPO and sufficient to meet the terms and conditions of the BO. A Final Reclamation and Closure Plan would be developed by Rosemont and approved by the USFS, prior to issuance of the final MPO and would meet all of the stipulations of the BO. The terms and conditions and conservation measures of the BO would be addressed in the Final Revegetation Plan. Similar to SR-02, revegetation efforts, including maps, GIS data, and acreage of initial seeding, seed/plant mix, seeding/planting application rate, propagation, and transplanting reported on an annual basis. Specific information would include data on shrub and tree species, and agaves are required by the BO. Information would be reported as required by the BO. Revegetation would be conducted following an adaptive management process and would ensure compliance with the BO. **Effectiveness:** Annual quantitative monitoring of revegetation and site stability would be required, including whether shrub/tree and agave objectives have been met. Vegetation measurements may include: species richness, canopy cover, density/frequency, and plant community structure. Additional surveys would be conducted to track agave planting and survivorship. . A record of the agave transplanted and planted from nursery grown stock during concurrent reclamation efforts and the general location and density of transplants would be maintained and reported as per Biological Opinion stipulations.
Performance Criteria	**Implementation:** As part of the USFWS consultation, the Biological Opinion requires a minimum number of agaves species be planted and survival criteria to remediate lesser long nosed bat habitat (The Biological Opinion proposes am average density of plantings of 10.3 per acre). Revegetation monitoring requirements would be contained in the Final Reclamation and Closure Plan, and all monitoring activities would be designed to meet the terms of the Biological Opinion. **Effectiveness:** Seeding and planting is successful in establishing agave and meeting the survival criteria and minimum numbers established in the Biological Opinion
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for salvaging agave from areas prior to disturbance; gathering seed locally; growing agave from gathered seed, transplanting and seeding agave according to the Biological Opinion, and monitoring both planting/seeding efforts and survival. The Forest Service is responsible to evaluate monitoring results to determine compliance with the BO. Monitoring of the revegetation stipulations of the BO are also incorporated into the monitoring of FS-SR-02.
Timing	**Implementation:** Rosemont is currently experimenting with agave salvage and transplanting associated with their greenhouse and growth plot studies. This effort is expected to continue. Salvage would begin prior to any ground disturbing activities (pre-mining phase). Activities would end at completion of the final reclamation and closure phase, or at an unknown time during post-closure, depending on the success of agave planting and seeding efforts. **Effectiveness:** Effectiveness monitoring would continue until the terms and conditions specified in the Biological Opinion have been met, either at completion of the final reclamation and closure phase, or at an unknown time during post-closure.

MITIGATION MEASURE	FS-BR-05 – Construction, management and maintenance of water features to reduce potential impacts to wildlife and livestock from reduced flow in seeps, springs, surface water and groundwater

MITIGATION MEASURE	FS-BR-05 – Construction, management and maintenance of water features to reduce potential impacts to wildlife and livestock from reduced flow in seeps, springs, surface water and groundwater
Description	Existing water features, including stock ponds, would be enhanced, and additional water features added as needed. Seven water features would be managed for sustainability of surface water. Up to 23 additional water features would be managed or constructed if needed for threatened and endangered species. Includes a requirement that Rosemont establishes a long-term management and maintenance fund to maintain the water features constructed. These include tank/water feature construction or renovation to support Chiricahua leopard frog from metapopulations in the Greaterville area. Restored or replaced springs within jaguar critical habitat would be constructed in accordance with jaguar primary constituent elements for surface water. In addition, Rosemont would establish a long-term management and maintenance fund to maintain the water features constructed in furtherance of this BO requirement.
Source	Biological Opinion. Originally proposed by Rosemont Copper.
Impacts Mitigated	Partially compensates for potential impacts to Chiricahua leopard frog, jaguar, and other wildlife and to livestock grazing from decreased water availability.
Location	Forest Service allotments currently leased by Rosemont: Thurber, Debaud, Greaterville and Rosemont grazing allotments; and seven tanks in the Greaterville area that are specified in the Biological Opinion.
Monitoring / Reporting Action	**Implementation:** Water levels would be monitored annually to determine if and when artificial waters need to be enhanced, modified, or constructed, to meet the needs of threatened and endangered species. Construction and improvement of water sources conducted as per Biological Opinion. **Effectiveness:** As per requirements in the Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for constructing of improving the water sources as specified; and for all monitoring and reporting.
Timing	**Implementation and Effectiveness:** As per the Biological opinion.

MITIGATION MEASURE	FS-BR-06 – Locating the electrical power line that provides power to the pit area so that it avoids talus slopes to the extent practicable
Description	Construction of the electrical power line that provides electricity to the pit would be located on the west-side of pit operations and within the disturbance perimeter of the pit and diversion structures.
Source	Rosemont Copper.
Impacts Mitigated	Reduces disturbance to talus slopes and talussnail habitat. Reduces impacts to visual resources by avoiding construction on the ridgeline.
Location	Powerline from Rosemont substation to the pit and surrounding areas.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Daily inspections during construction and removal of this facility to ensure that disturbances to the talus areas are minimized.
Performance Criteria	**Implementation and Effectiveness:** Location avoids talus areas as practicable and complies with specifications contained in final MPO.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** During construction of the pit power loop and during removal of these facilities to ensure avoidance of talus slopes to the extent practicable.

MITIGATION MEASURE	FS-BR-07 – Record a restrictive easement on the private Helvetia Ranch Annex North Parcel to compensate for impacts to species listed as threatened or endangered
Description	This mitigation requires the following actions for the Helvetia Ranch Annex North Parcel: A restrictive covenant that precludes real estate development and similar land uses would be recorded by Rosemont Copper. This parcel contains about 940 acres of semi-desert grassland on the west side of the northern Santa Rita Mountains near the proposed Rosemont infrastructure corridor. The property contains Pima pineapple cactus. The property directly links Santa Rita Experimental Range to BLM land, which could benefit habitat and connectivity for ocelot and jaguar. It provides limited late-summer foraging habitat for lesser long-nosed bat. Management of the parcel would include modification of grazing practices to reduce grazing pressure on native vegetation.
Source	Biological Opinion.

MITIGATION MEASURE	FS-BR-07 – Record a restrictive easement on the private Helvetia Ranch Annex North Parcel to compensate for impacts to species listed as threatened or endangered
Impacts Mitigated	Partially compensates for impacts to habitat for ocelot, jaguar, lesser long-nosed bat, and Pima pineapple cactus.
Location	Helvetia Ranch Annex North Parcel.
Monitoring / Reporting Action	**Implementation:** Recording of a restrictive covenant as per the Biological Opinion would be reported. A copy of said restrictive covenant would be provided to the Forest Service. **Effectiveness:** As per requirements in the Biological Opinion.
Performance Criteria	**Implementation:** Restrictive covenant restricts and allows land uses as per requirements specified in U.S. Fish and Wildlife Biological Opinion. The restrictive covenant would be recorded in the timeframe specified in the Biological Opinion. **Effectiveness:** As per requirements in the Biological Opinion.
Responsible Party	**Implementation:** Rosemont is responsible for crafting and recording a restrictive covenant that meets the requirements specified in the Biological Opinion, which is incorporated into the ROD. **Effectiveness:** As per requirements in the Biological Opinion.
Timing	**Implementation:** As per requirements in the Biological Opinion. **Effectiveness:** As per requirements in the Biological Opinion.

MITIGATION MEASURE	FS-BR-08 - Record a restrictive easement on the private Sonoita Creek Ranch Parcel to compensate for impacts to species listed as threatened or endangered
Description	This mitigation requires the following actions for the Sonoita Creek Ranch Parcel: Rosemont would record a restrictive covenant; and convey ownership of the ranch and accompanying water rights to Arizona Game and Fish Department (AGFD) or other approved conservation partner; and providing funding for long-term management. The parcel totals of 1,200 acres; contains an estimated 590 acre-ft. of certified water rights; 6 acres of open water in two ponds; forested wetland and riparian components; 15 acres of ephemeral drainages, 52 acres of riparian habitat; 320 acres of upland habitat adjacent to riparian; 5 seasonal ponds; 700 acres of semi-desert grassland and Madrean evergreen woodland including mature Arizona white oaks.
Source	Biological Opinion.
Impacts Mitigated	Partially compensates for impacts to wildlife habitat and habitat connectivity, including jaguar, ocelot, Mexican spotted owl, lesser long-nosed bat, Gila chub, Gila topminnow, Chiricahua leopard frog, yellow-billed cuckoo, and Huachuca water umbel. Currently, most or all of these species are absent and invasive, non-native species are present. The site is currently managed for agricultural uses and water diversions are not well-suited for wildlife needs. The site needs to be restored to accommodate colonization or transplant of threatened and endangered species. Rosemont would establish a management account for AGFD or other approved conservation partner of $170,000 annually ($150,000/year for 10 years for long term management, and $20,000/year for five years to support pond renovation efforts) into the account. Surface water rights would be managed according to stipulations contained in the Biological Opinion. Funded management measures could include renovation efforts to remove invasive species, restore ponds and wetland habitat, passive restoration of upland habitat, fenced with wildlife-friendly fencing.
Location	Sonoita Creek Ranch.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Report upon recording of restrictive covenant that precludes real estate development and similar land use activities, and limits livestock grazing and other agricultural uses to those described in the Biological Opinion; report upon transfer of ownership; and report upon establishment of a management account and annual payments.
Performance Criteria	**Implementation and Effectiveness:** Ownership transfers as per requirement in the Biological Opinion. Management account is established and funded as per Biological Opinion stipulations.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for implementation, monitoring and reporting as per Biological Opinion.
Timing	**Implementation and Effectiveness:** As per Biological Opinion.

MONITORING ITEM	FS-BR-09 - Funding to support camera studies for large predators including jaguar and ocelot
Description	Rosemont would contribute $50,000 to AGFD for camera studies for large predators.
Source	Biological Opinion.
Purpose	Provides information on travel corridors and habitat use of the Santa Rita and Whetstone Mountains, as well as prey base travel corridors. This is information needed to determine locations where road crossing structures may be warranted in the future.

MONITORING ITEM	FS-BR-09 - Funding to support camera studies for large predators including jaguar and ocelot
Location	Santa Rita and the Whetstone mountains and areas between.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Funding would be provided to AGFD or other suitable entity approved by the Coronado and U.S. Fish and Wildlife Service for monitoring.
Performance Criteria	**Implementation and Effectiveness:** N/A
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for making contribution.
Timing	**Implementation and Effectiveness:** N/A

MITIGATION MEASURE	FS-BR -10 – Measures to reduce and rectify impacts to Pima pineapple cactus
Description	This mitigation would mitigate impacts to Pima pineapple cactus mitigation by minimizing surface disturbance in the utility corridor; survey and monitoring; and transplanting those cacti that cannot be avoided. Pre-disturbance surveys for the cactus would occur, and plants would be marked and avoided where possible.
Source	Biological Opinion.
Impacts Mitigated	Avoids or reduces impacts to the listed Pima pineapple cactus. See also the Helvetia North parcel (FS-BR-07) mitigation for this species.
Location	Utility corridor.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Criteria specified in the Biological Opinion are met.
Performance Criteria	**Implementation and Effectiveness:** Criteria specified in the Biological Opinion are met.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for surveying, identifying, avoiding, and transplanting cactus. Rosemont if further responsible for conducting monitoring and reporting results to the Forest Service. The Forest Service is responsible for determining whether actions comply with the final MPO and Biological Opinion.
Timing	**Implementation:** Pre-mining phase (construction of utility facilities) and final reclamation and closure phase (removal of utility facilities). **Effectiveness:** As per Biological Opinion.
MITIGATION MEASURE	**FS-BR-11 - Monitoring and control actions to reduce or prevent impacts to Chiricahua leopard frog from invasive aquatic species**
Description	This mitigation includes specific actions to monitor, identify and remove invasive species that could impact the Chiricahua leopard frog, including American bullfrogs, northern crayfish, tiger salamanders and warm-water fish species. Rosemont has prepared a preliminary invasive species management plan (Rosemont Copper, July 2012). This is a brief report that outlines some invasive species and general management plans. It states that the plan “will be updated to address aquatic invasive species, including bullfrogs and northern crayfish, in wetland and riparian habitats, as well as selected stock tanks once Section 7 consultation is complete.”
Source	Biological Opinion.
Impacts Mitigated	Reduces impacts to Chiricahua leopard frog from invasive species such as American bullfrogs, northern crayfish, tiger salamanders and warm-water fish species.
Location	The seven tanks renovated as part of the Chiricahua leopard frog Biological Opinion stipulations near Greaterville (see FS-BR-05); new tanks constructed as part of these stipulations during the life of the project; and at other suitable Chiricahua leopard frog habitats within the perimeter fence. See the Biological Opinion for further detail.
Monitoring / Reporting Action	**Implementation:** Annually monitor disturbed areas within perimeter fence to determine occurrence of invasive plant species; implement best management practices to prevent introduction and spread. **Effectiveness:** Monitor effectiveness of treatment efforts after invasive species are identified.
Performance Criteria	**Implementation:** Best management practices are followed with all equipment. **Effectiveness:** Invasive species remain at levels similar to or less than those observed prior to construction.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for conducting monitoring, implementing control activities and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO and Biological Opinion.
Timing	**Implementation and Effectiveness:** Commencing the first year copper is produced, and continuing as per the Biological Opinion.

MITIGATION MEASURE	FS-BR-12– Relocation of Chiricahua leopard frogs from areas in the immediate vicinity of the project area
Description	Survey, monitor, capture, and relocation of Chiricahua leopard frogs; disinfection methods; testing for chytridiomycosis.

MITIGATION MEASURE	FS-BR-12– Relocation of Chiricahua leopard frogs from areas in the immediate vicinity of the project area
Source	Biological Opinion.
Impacts Mitigated	Avoids or minimizes impacts to Chiricahua leopard frogs. Methods prevent spread of disease, especially chytridiomycosis.
Location	Within the footprint of proposed construction and a ¼ mile buffer of the security fence.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for surveys, monitoring and reporting as specified in the Biological Opinion. Rosemont is responsible for testing any captured frogs prior to relocation as per Biological Opinion.
Timing	**Implementation and Effectiveness:** Pre-disturbance surveys would be conducted the season prior to initiation of construction activities.

MITIGATION MEASURE	FS-BR-13 – Modifying stormwater ponds to make them useable by Chiricahua leopard frogs
Description	Up to four stormwater ponds would be designed in a fashion that would facilitate their use by Chiricahua leopard frogs.
Source	Biological Opinion.
Impacts Mitigated	Partially compensates for impacts to Chiricahua leopard frogs and provides post-closure water resources for frogs, jaguar, ocelot, wetland plants, and other wildlife.
Location	Along perimeter of reclamation footprint.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for design, construction, monitoring and reporting as specified in the Biological Opinion.
Timing	**Implementation and Effectiveness:** Timing of construction would be dictated by the timing of concurrent reclamation programs, as per Biological Opinion.

MITIGATION MEASURE	FS-BR-14 – Measures to ensure relocation of lesser long-nosed and other bat species in the immediate vicinity of the mine
Description	Rosemont would fence and/or close abandoned mine features that may be impacted by mine activities. This is in part a pre-disturbance survey and implementation measure to ensure that roosting bats are not trapped in abandoned adits, or succumb to mining activities. Fencing or closing mines not within the mine footprint (or immediate vicinity) would help reduce human influences (such as keeping people out of the Helena Mine complex).
Source	Biological Opinion.
Impacts Mitigated	Reduces impacts to lesser long-nosed bats and other bat species. This measure keeps bats that are roosting in the vicinity of the mine (including the footprint) from on-site mortality by forcing bats to relocate.
Location	Chicago mine; R2 mine, Helena Mine complex, and other sites as specified in the Biological Opinion.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for closure, fencing, monitoring and reporting as specified in the Biological Opinion.
Timing	**Implementation and Effectiveness:** To be determined. Refer to the Biological Opinion.

MITIGATION MEASURE	FS-BR-15 – Measure to reduce impacts to western yellow-billed cuckoo
Description	Limitation on vegetation clearing during western yellow-billed cuckoo nesting season**.** Includes monitoring for nesting yellow-billed cuckoo and limitation on clearing while nesting is occurring.
Source	Biological Evaluation.
Impacts Mitigated	Reduces or avoids impacts to yellow-billed cuckoo.
Location	Any area where vegetation clearing is proposed within 100 meters of an active yellow-billed cuckoo nest or the center of an active yellow-billed cuckoo territory, including disturbance in riparian area having suitable habitat (riparian, including xeroriparian).
Monitoring / Reporting Action	**Implementation and Effectiveness:** Rosemont would survey for yellow-billed cuckoo in potential nesting areas within the perimeter fence in the season prior to vegetation clearing. Vegetation clearing would not occur within 50 meters of an active yellow-billed cuckoo nest or the center of an active yellow-billed cuckoo territory.
Performance Criteria	**Implementation and Effectiveness:** As per Biological Evaluation.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper is responsible for pre-disturbance surveys and ensuring clearing activities are appropriately monitored.
Timing	**Implementation and Effectiveness:** During the nesting season prior to ground-disturbing activities.

MITIGATION ITEM	FS-BR-16 – Measures to protect two occurrences of Coleman's coral-root during road decommissioning
Description	Occurrences of Coleman's coralroot (Forest Service sensitive) occur on two locations on roads 4015 and 4015A, which are scheduled for decommissioning. These locations would be identified on the ground before decommissioning activities occur, and disturbance would be avoided.
Source	Coronado ID Team.
Impacts Mitigated	Avoids direct impacts to specific locations of Forest Service sensitive plants.
Location	Forest Service roads 4051 and 4051A.
Monitoring / Reporting Action	**Implementation:** Pre-activity surveys would occur to identify, or confirm and locate vulnerable populations on the ground (flagging or other method to identify area to be avoided with disturbance). **Effectiveness:** Daily inspections would occur while decommissioning activities were occurring in the vicinity of identified plant populations to ensure they are avoided.
Performance Criteria	**Implementation and Effectiveness:** Plant populations to be protected are located on the ground in advance of ground disturbing activities; plants are ultimately protected by avoiding disturbance near their occurrence.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for confirming populations of protected plants that could be impacted by road decommissioning activities; and for monitoring implementation of such activities to ensure plants are not impacted.
Timing	**Implementation and Effectiveness:** During road decommissioning activities (pre-mining phase).

MITIGATION MEASURE	FS-BR-17 - Establish the Cienega Creek Watershed Conservation Fund be used for future mitigation to in the Cienega Creek watershed
Description	Rosemont Copper would establish an endowment, the Cienega Creek Watershed Conservation Fund, and provide $2,000,000 of funding. This fund would essentially be established as (1) a resource to help restore the watershed to a functioning ecosystem and (2) a mechanism to promote adaptive management and allow flexibility in mitigation to achieve desired outcomes in light of future uncertainties. Funds would be used to implement future mitigations and management strategies to offset unanticipated effects resulting from groundwater drawdown from the mine, if necessary. Up to 15% of the funds could be used for administrative costs. Monies would be spent for on-the-ground restoration (except the 15% mentioned above), rather than inventory, monitoring, and research. The Conservation Fund would be managed by Arizona Game and Fish Department or other to-be-designated third party with recommendations by partners with regulatory authority, The Cienega Creek Watershed Conservation Fund is to be managed by a to-be-designated third party with input by partners to recommend projects for enhancing habitat and populations of native species, especially those that are threatened and endangered. This could include funding development and implementation of measures designed to preserve and enhance aquatic and riparian ecosystems and protect and maintain habitat for federally listed threatened and endangered aquatic and riparian species in the Cienega Creek watershed.
Source	Biological Opinion.
Impacts Mitigated	Potentially compensates or off-sets impacts to Chiricahua leopard frog, Gila chub, Gila topminnow and Huachuca water umbel.
Location	Use of funds from the Cienega Creek Watershed Conservation Fund would be limited to the Cienega Creek watershed beyond the Rosemont Copper-permitted grazing allotments on National Forest System lands.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont would be responsible for funding conservation fund at the rate of $200,000/yr. for 10 years following the commencement of mineral production. The Forest Service is responsible for determine whether the fund has been established as required by the Biological Opinion. The Fund's managing agency would be responsible for identifying potential mitigation actions; coordinating those actions with the Forest Service, Bureau of Land Management, Arizona Game and Fish Department (if not the managing agency) and U.S. Fish and Wildlife Service; overseeing expenditures of the fund; as well as all monitoring and reporting.
Timing	**Implementation and Effectiveness:** As per Biological Opinion.

Other Monitoring Items for Biological Resources

MONITORING ITEM	FS-BR-18 – Monitoring to determine impacts from pit dewatering on downstream sites in Barrel and Davidson canyons
Description	This consists of monitoring in Barrel and Davidson canyons to evaluate impacts from pit dewatering to surface water features following the conceptual monitoring plan prepared by Water and Earth Technologies (2012). This also includes a Biological Opinion requirement to monitor geomorphic changes to Davidson Canyon.
Source	Biological Opinion.
Purpose	To determine existence and extent of impacts to groundwater drawdown to surface water features from pit dewatering.
Location	For pit dewatering monitoring - a minimum of two sites in Barrel and Davidson Canyons identified in the report; and potentially others if authorization to install and access proposed monitoring sites are obtained. For geomorphic changes to Davidson Canyon – four sample sites would be established.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont would be responsible for all monitoring and reporting.
Timing	**Implementation and Effectiveness:** As per Biological Opinion.

MONITORING ITEM	FS-BR-19 – Monitor to determine the extent of road-kill near the project area
Description	This monitoring involves regular field surveys to determine motor vehicle-caused mortality jaguar, ocelot or their prey base. In addition, Rosemont would be required to immediately report all sightings of jaguar and ocelot to the Forest Service.
Source	Biological Opinion.
Purpose	To determine impacts from traffic related mortality to jaguar, ocelot, and jaguar prey-base (white-tailed and mule deer, collared peccary, white-nosed coati in particular), and any Forest Service or Bureau of Land Management sensitive species.
Location	Between the northern end of the proposed critical habitat and Gardner Canyon on SR 83 and Box Canyon road.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Annual reporting, as specified in the Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As specified in the Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible to ensure this is carried out.
Timing	**Implementation and Effectiveness:** This would be conducted for four years after the mining activity has started, then would be re-evaluated to determine if additional monitoring needs to be conducted.

MONITORING ITEM	FS-BR-20 – Survey and monitor for lesser long-nosed bats
Description	Rosemont would monitor the Helena Mine complex, Adit R2 and other large lesser long-nosed bat roost sites (>100 bats) within 1 mile of the perimeter fence annually for lesser long-nosed bat following stipulations described in the Biological Opinion.
Source	Biological Opinion.
Purpose	To determine impacts to lesser long-nosed bats to determine site fidelity during mining activities and ascertain if shielding from artificial night light emitted by the mine is possible or prudent.
Location	Helena Mine and Adit R2 other large lesser long-nosed bat roost sites within 1 mile of the perimeter fence.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As specified in the Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As specified in the Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for monitoring and reporting.
Timing	**Implementation and Effectiveness:** Active life of the mine (pre-mining through final reclamation and closure phases). Monitoring would be conducted annually until five years after final mine closure. Monitoring surveys area anticipated to commence beginning in 2013.

MONITORING ITEM	FS-BR-21 – Survey for bats in the vicinity of the project area
Description	Rosemont would also conduct reconnaissance-level surveys of other known cave and mine features capable of supporting bats within in the perimeter fence and within 1 mile of the perimeter fence for lesser long-nosed bat and other bat species following stipulations described in the Biological Opinion.
Source	Biological Opinion.

MONITORING ITEM	FS-BR-21 – Survey for bats in the vicinity of the project area
Purpose	Impacts to lesser long-nosed bats and Forest Service and Bureau of Land Management sensitive bat species.
Location	Known mine and cave features capable of supporting bats within the perimeter fence, and within 1 mile of the perimeter fence.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Monitoring of each site would occur once per year, on an annual basis, during late summer lesser long-nosed bat survey period – July, August and September. Reporting of monitoring results would be made within ten working days of each monitoring effort. Actions to be taken to protect species, if any, would be determined by the Forest Service and U.S Fish and Wildlife Service based upon monitoring results.
Performance Criteria	**Implementation and Effectiveness:** As specified in the Biological Opinion.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for monitoring and reporting.
Timing	**Implementation and Effectiveness:** Active life of the mine (pre-mining through final reclamation and closure phases).

MONITORING ITEM	FS-BR-22 – Annual monitoring for Chiricahua Leopard Frog
Description	This involves surveying and testing procedures for Chiricahua leopard frog that would provide population information and trends.
Source	Biological Opinion.
Purpose	To provide information on the status of Chiricahua leopard frog.
Location	To be determined.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Performance Criteria	**Implementation and Effectiveness:** As per requirements in the Biological Opinion.
Responsible Party	**Implementation:** Rosemont is responsible for conducting monitoring for Chiricahua leopard frogs and reporting results to the Forest Service. The Forest Service is responsible for ensuring measures in the Biological Opinion are implemented. **Effectiveness:** As per requirements in the Biological Opinion.
Timing	**Implementation and Effectiveness:** Commencing from the first spring survey period after construction activities begins through final reclamation closure.

Land Ownership and Boundary Management

MITIGATION MEASURE	FS-LO-01 – Re-survey of existing survey monuments and land lines to allow reestablishment post-mining
Description	A Bureau of Land Management administered land resurvey and control network has been completed.
Source	Coronado ID Team.
Impacts Mitigated	Rectifies impacts to survey monuments and land ownership boundaries from mining and related actions.
Location	Approximately 202 mineral survey corner monuments that control approximately 19.5 miles of property boundary between National Forest System lands and private land owned by Rosemont Copper within or very near the footprint of the proposed action on the Coronado National Forest.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Implementation by the BLM has been completed. No further monitoring is required.
Performance Criteria	**Implementation and Effectiveness:** BLM criteria have been met.
Responsible Party	**Implementation and Effectiveness:** Rosemont funded dependent resurvey efforts.
Timing	**Implementation and Effectiveness:** Completed.

MITIGATION MEASURE	FS-LO-02 – Re-establish survey monuments and surveyed land line upon completion of final reclamation
Description	Upon reclamation survey monuments would be restored and land ownership boundaries be properly marked.
Source	Coronado ID Team.
Impacts Mitigated	Rectifies impacts to survey monuments and land ownership boundaries by restoring survey monuments and land ownership boundaries.
Location	Currently, approximately 19.5 miles of property boundary between National Forest System lands and private land owned by Rosemont Copper within or very near the footprint of the proposed action on the Coronado National Forest. (Exact locations are not known at this time.)

MITIGATION MEASURE	FS-LO-02 – Re-establish survey monuments and surveyed land line upon completion of final reclamation
Monitoring / Reporting Action	**Implementation:** Weekly inspections to ensure that closure actions comply with final MPO, Bureau of Land Management survey control network and USFS land ownership boundaries. **Effectiveness:** Quarterly inspection and reporting to ensure that closure activities are achieving specifications in final reclamation and closure plan, which is contained in the final MPO.
Performance Criteria	**Implementation:** Upon Reclamation and closure, Rosemont would use the Bureau of Land Management's "Field Notes of the Dependent Resurvey" to restore survey monuments referring to GPS Control Network. **Effectiveness:** Closure actions result in conditions that meet specifications in final reclamation and closure plan
Responsible Party	**Implementation:** Rosemont would fund a US Forest Service approved, Arizona Licensed Surveyor to oversee the reclamation and restoration of survey monuments and boundaries. Rosemont would provide personnel, equipment and materials to restore physical monuments where needed. **Monitoring:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation:** Closure. **Effectiveness:** Final closure and post-closure until surveying and boundary management objectives are met.

Dark Skies

MITIGATION MEASURE	FS-DS-01 – Implementation of an outdoor lighting plan that would reduce potential impacts from artificial night lighting
Description	This mitigation involves following Rosemont's outdoor lighting mitigation plan (Monrad et al. 2012) during construction and operation of the mine. Following construction of the mine and during the initial year of operation, Rosemont would work with the Forest Service to review the efficacy of light mitigation measures at key resource areas around the mine, such as the Helena Mine. If additional shielding could be placed to further reduce lighting effects without adverse consequences to safety and unreasonable operational expectations, Rosemont would implement the additional requested shielding in a manner consistent with safe mining practices.
Source	Rosemont Copper; Biological Opinion.
Impacts Mitigated	Compared to the initial MPO, this lighting mitigation plan would reduce potential impacts from artificial night lighting to commercial and recreational astronomy, and to wildlife species, including lesser long-nosed bats and Mexican spotted owls. See Monrad et al, Rosemont Copper Project Light Pollution Mitigation Recommendation Report, Revision 1 dated June 18, 2012 for details, as well as Mitigation Recommendation Report addendum dated August 17, 2012. WestLand (2012X) further analyzed the Monrad et al. (2012) findings to interpret effects to wildlife.
Location	All areas requiring outside night lighting, including facilities, pit, plant site, and equipment mounted light systems and extending out at least 12 miles (WestLand 2012X).
Monitoring / Reporting Action	**Implementation:** Fixtures will be inspected before installation to ensure lighting equipment complies with final MPO, which would incorporate Monrad et al, Rosemont Copper Project Light Pollution Mitigation Recommendation Report. (June 18, 2012) and addendum (August 17, 2012). **Effectiveness:** Baseline data monitoring would occur at a frequency to be determined that represent periods of maximum outside night light use, during construction and operational phases. Monitoring would duplicate the baseline monitoring that is described in Monrad et al, Rosemont Copper Project Light Pollution Mitigation Recommendation Report, dated June 18, 2012, pages 23-24 (which would be incorporated into the final MPO), and the 20 Year Monitoring Plan: Light at Night (LAN) Measurements at Rosemont Copper Project report, dated May 20, 2012. Includes mobile aerial, mobile ground-based, and static ground-based measurements. If additional shielding could be placed to further reduce lighting effects without adverse impacts to safety and unreasonable operational expectations, Rosemont would implement those additional shielding in a manner consistent with safe mining.
Performance Criteria	**Implementation:** Lighting used complies with final MPO, which incorporates Monrad et al, Rosemont Copper Project Light Pollution Mitigation Recommendation Report dated June 18, 2012 and addendum (dated August 17, 2012), except as personal safety or operational requirements necessitate modifications to this plan (30 CFR Part 56.17001). **Effectiveness:** Monitoring provides for review and comparison of lighting emissions of Rosemont Mine and other new developments. Effectiveness monitoring demonstrates that all site lighting lumen emissions is 15% or less of the amount allowed by the Pima County Outdoor Lighting Code lumen per acre table for Zone 1a (Monrad et al, Rosemont Copper Project Light Pollution Mitigation Recommendation Report, dated June 18, 2012, page 5). The intent is to fully comply with the Pima County Outdoor Lighting Code; however deviations may be required to comply with MSHA regulations.

MITIGATION MEASURE	FS-DS-01 – Implementation of an outdoor lighting plan that would reduce potential impacts from artificial night lighting
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation:** During pre-mining phase to ensure compliance with final MPO. **Effectiveness:** Annual or semi-annual monitoring (as per the 20 Year Monitoring Plan: Light at Night (LAN) Measurements at Rosemont Copper Project report, dated May 20, 2012). Monitor localized and regional quantitative trends in sky-brightness changes due to on-site lighting systems to establish current sources and allow for comparison of Rosemont Mine and all other new developments determine whether predictions of lumens is accurate; includes direct measurement of sky brightness using over flights and land-based measurements. Monitoring every 5 years during later years of operations phase (as per the 20 Year Monitoring Plan: Light at Night (LAN) Measurements at Rosemont Copper Project report, dated May 20, 2012). Review of the efficacy of light mitigation measures would occur following construction of the mine.

Visual Resources

MITIGATION MEASURE	FS-VR-01 - Color of mine related buildings be selected to blend into the natural landscape
Description	Rosemont would submit, and the Forest Service would approve colors for mine related buildings to reduce potential color contrasts. A dark, neutral color, such as the Bureau of Land Management Standard Environmental Color called "Carlsbad Canyon," is recommended.
Source	Coronado IDT.
Impacts Mitigated	Reduces contrast and related visual impact associated with plant buildings.
Location	Plant site.
Monitoring / Reporting Action	**Implementation:** Rosemont would receive Forest Service approval of color selection prior to selecting or applying final color in order to ensure that buildings are painted or stained in compliance with the final MPO. **Effectiveness:** Forest Service would reevaluate finished results from representative viewpoints to determine effectiveness.
Performance Criteria	**Implementation:** Rosemont uses approved colors for buildings. **Effectiveness:** Colors are effective in reducing contrast of plant site buildings with natural environment.
Responsible Party	**Implementation:** Rosemont is responsible for obtaining Forest Service approval before selecting color or applying paint or stain to buildings, during construction and maintenance, and during mine life if facilities are added or repainted. **Effectiveness:** The Forest Service is responsible for effectiveness monitoring.
Timing	**Implementation and Effectiveness:** Pre-mining phase when buildings are constructed, and during mine life if facilities are added or repainted.

MITIGATION MEASURE	FS-VR-02 - Removal of unneeded facilities during closure
Description	This mitigation involves the removal of mining facilities that would not be needed for future management of the land. These facilities include buildings, the plant site, some roads, the perimeter and security fence, (if not incorporated into allotment management plans), power supply line, and piping systems, (consistent with Forest Service requirements, as well as requirements specified in Certificate of Environmental Compatibility and Arizona State Lands Department right of way permit); and water supply pipeline. The plant site would be recontoured and revegetated with native vegetation. Building foundations would either be removed or broken up and buried.
Source	This is a design feature from the preliminary MPO. Requirements regarding this mitigation are also contained in the Arizona Corporation Commission Certificate of Environmental Compatibility, Arizona State Lands Department right of way permit, and by the Coronado.
Impacts Mitigated	Reduces visual impacts; reduces potential impacts to surface water from erosion; restores ability to allow public access.
Location	Plant site, roads, fences, utility corridor.
Monitoring / Reporting Action	**Implementation**: Daily inspections to ensure that closure actions comply with final MPO, ACC Certificate of Environmental Compatibility and Arizona State Lands Department Right-of-Way Permit. **Effectiveness:** Quarterly inspection and reporting to ensure that closure activities are achieving specifications in final reclamation and closure plan, which is contained in the final MPO. Monitor for revegetation progress and success quarterly, including mapping general areas of vegetation species, density and location. Monitor disturbed and revegetated areas for noxious and invasive weeds quarterly; map such locations and take action to prevent, eliminate, or control weeds should they occur, in accordance with the final MPO.

Performance Criteria	**Implementation:** Sites that contain structural improvements are reclaimed by removing all unneeded ore processing facilities, ancillary facilities (including foundations unless Forest indicates breaking and burial is appropriate), roads, fences, and utility lines on NFS lands, and consistent requirements specified in Certificate of Environmental Compatibility and Arizona State Lands Department right of way permit. Growth media would be placed on reclaimed areas and revegetated with native grasses, trees, and/or shrubs to meet desired conditions, to be determined by the Forest Service. **Effectiveness:** Closure actions result in conditions that meet specifications in final reclamation and closure plan, including revegetation objectives of the Final Reclamation and Closure Plan. If foundations are broken and buried, specifications for size of remnant pieces and depth of burial comply with those identified in the final MPO.
Responsible Party	**Implementation and Monitoring:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation:** During final reclamation and closure. **Effectiveness:** During final reclamation and closure and post-closure until revegetation objectives of the Final Reclamation and Closure Plan are met.
MITIGATION MEASURE	**FS-VR-03 – Measures to reduce color contrasts from cuts, fills and concrete structures associated with the mine**
Description	Light colored areas resulting from cut and fill of the highly-visible southern diversion channel would be treated if needed to reduce visual contrast. Additionally, Rosemont would work with the Forest Service to explore the feasibility of coloring drop structures for applicable alternatives to reduce impacts to visual resources.
Source	Coronado ID Team.
Impacts Mitigated	Would reduce visual impacts by reducing color contrast.
Location	Southern diversion channel and concrete drop structures.
Monitoring / Reporting Action	**Implementation:** Visual inspection and report to ensure that implementation has occurred. **Effectiveness:** Visual inspection from selected viewpoints to determine effectiveness.
Performance Criteria	**Implementation:** Color is applied as early in the pre-mining or active mining phase as feasible, in accordance with manufacturer's instructions. **Effectiveness:** Results are effective in reducing color contrast.
Responsible Party	**Implementation:** Rosemont is responsible for implementing this action in accordance with the final MPO. **Effectiveness:** The Forest Service is responsible for conducting effectiveness monitoring.
Timing	**Implementation:** Pre-mining through early active mining. **Effectiveness:** From implementation of coloring through final closure.

Recreation and Wilderness

MITIGATION MEASURE	**FS-RW-01 – Relocation of a segment of the Arizona National Scenic Trail and construction of trailheads**
Description	Rosemont would fund relocation of a section of the Las Colinas portion of the Arizona National Scenic Trail away from Rosemont mine facilities and trailheads. The trail relocation would result in moving the trail farther away from the Helena Mine complex that its current location.
Source	Relocation of the trail is a design feature from the preliminary MPO. The Forest Service has mapped the alternative locations. Locating the trail farther away from the Helena Mine complex is a component of the Biological Opinion.
Impacts Mitigated	Reduces impacts to recreational users of the Arizona National Scenic Trail. Potential impacts to lesser long-nosed bats at the Helena Mine complex would be reduced by funneling hikers farther away from the adit entrances.
Location	Section of Arizona National Scenic Trail that would be relocated. See alternative maps in Chapter 2 for locations.
Monitoring / Reporting Action	**Implementation:** Field evaluations during trail construction indicate that trail is built to Forest Service furnished specifications. **Effectiveness:** User surveys are conducted periodically to identify user experience.
Performance Criteria	**Implementation**: Trail is constructed in location and to specifications specified by the Forest Service. Relocated trail segment is pioneered and available for public use, or an alternate trail route is provided at the time the existing trail segment is closed to public use. Construction of relocated trail and associated facilities are completed within one year of the NEPA decision. **Effectiveness:** Trail user experience meets those specified in the FEIS.

MITIGATION MEASURE	FS-RW-01 – Relocation of a segment of the Arizona National Scenic Trail and construction of trailheads
Responsible Party	Implementation: Rosemont is responsible for providing funds to the Arizona Trail Association to ensure that trail relocation occurs according to Forest Service specifications, and is completed before mine related activities close existing trail to public use. Details of the agreement for fund disbursement and trail construction are contained in an agreement between Rosemont and the Arizona Trail Association. **Effectiveness:** The Forest Service is responsible for maintenance and effectiveness monitoring.
Timing	**Implementation and Effectiveness:** Commences with approval of final MPO; concludes when relocated trail segment and associated facilities are constructed and open for public use.

MITIGATION MEASURE	FS-RW-02 – Arizona National Scenic Trail - easement to allow the trail to be constructed across Rosemont Copper's private land
Description	The relocation of the Arizona National Scenic Trail would require locating the trail across two private parcels of land owned by Rosemont Copper. A trail easement would be required before trail relocation construction could commence. These are the same land parcels described in FS-WUS-01 that would compensate for impacts to waters of the U.S. Coordination between future land uses allowed under the restrictive covenant developed for FS-WUS-01 and those appropriate for the National Scenic Trail corridor would occur.
Source	Coronado ID Team.
Impacts Mitigated	Reduces impacts to recreational users of the Arizona National Scenic Trail.
Location	Davidson Canyon private land parcels (see FS-WUS-01).
Monitoring / Reporting Action	**Implementation and Effectiveness:** Recording of an easement, a copy of which would be provided to the Forest Service.
Performance Criteria	**Implementation and Effectiveness**: An easement is recorded that allows a segment of the Arizona National Scenic Trail to be constructed to Forest Service standards. The easement complies with stipulations contained in the National Trail Systems Act (United States Code, Volume 16, Sections 1241-1251).
Responsible Party	**Implementation:** Rosemont is responsible for providing an easement allowing trail construction, use and management across their private land. **Effectiveness:** The Forest Service is responsible for any effectiveness monitoring deemed appropriate.
Timing	**Implementation and Effectiveness:** Prior to relocation construction of the Arizona National Scenic Trail (see FS-RW-01).

Hazardous Materials

MITIGATION MEASURE	FS-HM-01 - Hazardous materials containment and management
Description	This mitigation involves handling, storage, use and communication information about hazardous materials, in accordance with laws and regulations. A variety of agencies have regulations defining what materials are classified as hazardous, and how they should be transported, handles and stored. These include the U.S. Environmental Protection Agency, U.S. Department of Transportation, Arizona Department of Environmental Quality, Pima County department of Environmental Quality, and Mining Safety and Health Administration. Table 3 in Chapter 2 provides a summary of some of these regulations.
Source	This is a design feature of the preliminary MPO.
Impacts Mitigated	Reduces potential impacts to human health and environmental risks (such as impacts to surface and groundwater quality) from transportation, use and storage of hazardous materials.
Location	Area within the perimeter fence and any other area where hazardous materials are under the direct control of Rosemont, its employees or contractors.
Monitoring / Reporting Action	**Implementation:** As required by applicable regulations. **Effectiveness:** As required by applicable regulations.
Performance Criteria	**Implementation**: Inspections during construction to ensure that facility construction adheres to final MPO and complies with applicable laws and regulations. Frequency would comply with applicable regulations. **Effectiveness:** Inspections during operations, reclamation and closure phases to determine whether operation and maintenance during operations is effective and complies with laws and regulations related to transporting, use and storage of hazardous materials. Frequency would comply with applicable regulations.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service.
Timing	**Implementation:** During construction (pre-mining phase). **Effectiveness:** Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	FS-HM-02 - Maintain material safety data sheets in accordance with 30 CFR 47
Description	This mitigation involves maintaining material safety data sheets on-site; and providing this information to emergency service providers. Regulations require material safety data sheets be available to workers and that notification of potential hazards be provided to site visitors. Access to Material data safety sheets would also be provided to as appropriate emergency response departments and hospitals.
Source	This is a design feature of the preliminary MPO.
Impacts Mitigated	Reduced impacts to worker and public health and safety in the case of exposure, by allowing appropriate treatment to be implemented more rapidly.
Location	Project area; emergency response departments and local hospitals.
Monitoring / Reporting Action	**Implementation and Effectiveness:** The Mine Safety and Health Administration (MSHA) would monitor MSDS availability during their scheduled inspections. Rosemont would report when material data safety sheets provided to emergency response departments and hospitals to the Forest Service.
Performance Criteria	**Implementation:** Rosemont Copper Project is in compliance with regulations specified in 30 CFR 47. **Effectiveness:** Information on hazardous materials is readily available to employees and visitors to the site. Rosemont provides copies of all pertinent material data safety sheets provided to emergency response departments and hospitals.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for making material data safety sheets available to employees and site visitors; providing access to emergency response departments and local hospitals; and reporting to the Forest Service. MSHA is responsible for ensuring compliance with 30 CFR 47.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

Transportation and Access

MITIGATION MEASURE	FS-TA-01 - Develop a comprehensive Transportation Plan
Description	The transportation plan would address maintenance standards; levels of appropriate use; methods to maintain the roadways sufficiently to prevent washboard, rutting, and drainage problems; commitment to replace surfacing lost to drainage; commitment to repair roads damaged by use; commitment to restore temporary roads to natural pre-operation conditions during reclamation/closure; and installation and maintenance of wildlife crossing structures (e.g., corrugated metal pipes) under the primary access road at locations of known wildlife concentration. Details would be contained in the Transportation Plan.
Source	This is a design feature from the preliminary MPO.
Impacts Mitigated	Reduced impacts to surface water from erosion; reduced impacts to wildlife from vehicle-caused injury and mortality.
Location	All project related roads on National Forest System lands.
Monitoring / Reporting Action	**Implementation and Effectiveness:** To be determined in Transportation Plan, which would be completed and approved by the Forest Service prior to approval of the final MPO.
Performance Criteria	**Implementation and Effectiveness:** Completion of a plan approved by the Forest Service; and compliance with the stipulations of the approved plan.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for developing the Transportation Plan; for following its direction once it is approved and incorporated into the Final MPO; and monitoring implementation and effectiveness as agreed to with the Forest Service. The Forest Service is responsible for reviewing and approving the plan, and for determining compliance with the Final MPO.
Timing	**Implementation and Effectiveness:** The transportation plan would be developed after issuance of the ROD and prior to approval of the final MPO. Implementation monitoring would occur during the pre-mining phase; effectiveness monitoring would occur from the pre-mining through the final reclamation and closure phase.

Noise

MITIGATION MEASURE	FS-N-01 – Management techniques to reduce potential noise impacts from blasting
Description	This mitigation is focused on noise management techniques, including generally limiting blasting to once per day, during daylight hours; sequenced blasting using time-delay technology; explosive usage is limited to 52 tons per day as consistent with the limits contained in the Air Quality Permit (dated January 31, 2013, p. 17).
Source	Design feature of preliminary MPO; Aspects required by the Air Quality Permit.
Impacts Mitigated	Reduces impacts from noise to humans and wildlife.
Location	Mine pit.
Monitoring / Reporting Action	Implementation and Effectiveness: Daily recording of when blasting occurs.

MITIGATION MEASURE	FS-N-01 – Management techniques to reduce potential noise impacts from blasting
Performance Criteria	**Implementation and Effectiveness:** Blasting is generally limited to once per day, during daylight hours, sequenced using time-delay technology.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** Pre-mining through active mining phases.

MITIGATION MEASURE	FS-N-02 – Actions to deduce potential noise impacts from vehicles
Description	This mitigation would reduce potential noise from certain vehicles by requiring backup alarms on vehicles to be attuned to reduce noise. MSHA standards for back-up alarms would be met (56/57.1432 (a) and (b). 56/57.14132(a) and (b) Horns and Backup Alarms For Surface Equipment Standard 56/57.14132(a)).
Source	Coronado IDT.
Impacts Mitigated	Reduces human impacts associated with noise pollution.
Location	All mining-related vehicles equipped with back-up alarms.
Monitoring / Reporting Action	**Implementation:** Inspection of each vehicle equipped with back-up alarm at the time of initial use to determine that back-up alarms comply with final MPO. **Effectiveness:** Quarterly inspections to ensure that back-up alarms are attuned to levels that reduce noise as permissible by MSHA regulations.
Performance Criteria	**Implementation:** Equipment inspections demonstrate that back-up alarms have been attenuated to reduce noise. **Effectiveness:** All back-up alarms are attuned to reduce noise; monitoring demonstrates that noise levels are reduced from those that would occur without attuned back-up alarms.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

Public Health and Safety

MITIGATION MEASURE	FS-PHS-01 – Construction of a perimeter fence that would exclude the public
Description	This mitigation involves construction of a perimeter fence to keep the public from coming into contact with mining operations or potentially hazardous conditions. Construction would use horses and ATVs. Existing roads and motorized routes would be used to deliver posts and wire to the extent practicable. No road construction or off-road use of vehicles larger than ATVs would be allowed.
Source	This is a design feature of the preliminary MPO.
Impacts Mitigated	Avoids or reduces public air impacts - ensures that public would not come into contact with operations and therefore reduces risk of public accident or injury; installation methods that would reduce surface disturbance and impacts to cultural sites.
Location	Perimeter fence location; differs by alternative. See alternative maps in chapter 2.
Monitoring / Reporting Action	**Implementation:** Daily inspections during installation to ensure location and construction techniques comply with final MPO. **Effectiveness:** Annual inspections the entire length of the fence ensure it is effective in restricting public access.
Performance Criteria	**Implementation:** Construction is conducted using techniques that reduce surface disturbance; cultural sites are avoided; location and fencing materials meet specifications in final MPO. **Effectiveness:** Monitoring indicates that fence is regularly maintained and is effective in restricting public access.
Responsible Party	**Implementation and Effectiveness:** Effectiveness: Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	FS-PHS-02 – Preparation of emergency response and contingency plans, including a fire plan
Description	This mitigation requires Rosemont to coordinate with Emergency Medical Services providers and local fire districts in development of emergency response and contingency planning.
Source	This is a design feature of the preliminary MPO. The Coronado ID Team brought the fire plan forward.

MITIGATION MEASURE	FS-PHS-02 – Preparation of emergency response and contingency plans, including a fire plan
Impacts Mitigated	Pre-emergency planning and coordination with Emergency Medical Services providers and local fire districts would reduce response time and improve services of Emergency Medical Services, reducing impacts of wildfires and potential human injuries from accidents.
Location	To be determined in agreement between the Coronado, Rosemont, EMP providers and local fire districts.
Monitoring / Reporting Action	**Implementation:** Determination that the plan is prepared and incorporated into the final MPO. **Effectiveness:** annual review to ensure that implementation is occurring according to the plan; and annual determination with applicable parties to determine effectiveness.
Performance Criteria	**Implementation:** Agreement and plan is developed and incorporated into the final MPO. **Effectiveness:** Annual multi-party review to determine whether plan is being implemented according to final MPO, and whether results are effective in reducing response time to wildfires and accidents.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and applicable fire districts and EMP providers. Forest Service is responsible for spot checking monitoring activities; Forest Service, applicable fire districts and EMP providers responsible for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** From time of final MPO approval through final closure.

Cultural Resources

MITIGATION MEASURE	FS-CR-01 – Archaeological Data Recovery On Sites That Would Be Adversely Affected
Description	This involves excavation and recovery at cultural sites that would be directly impacted.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Compensates for loss of information important to cultural history and archaeology
Location	All archaeological sites within the areas of direct impact
Monitoring / Reporting Action	**Implementation and Effectiveness:** All testing and data recovery work would conform to the stipulations in the Memorandum of Agreement and in the Treatment Plan.
Performance Criteria	**Implementation and Effectiveness:** Testing and data recovery, including reporting and curation, is completed as specified in the Treatment Plan
Responsible Party	**Implementation and Effectiveness:** Forest Service: oversight; Rosemont: funding.
Timing	**Implementation and Effectiveness:** As specified in the Treatment Plan: No testing or data recovery field work would occur until after the MPO has been approved by the Forest and all permits have been obtained; however, testing and data recovery field work for any specific archaeological site would be completed ***before*** ground disturbance related to mine construction and operation begins in that specific area.

MITIGATION MEASURE	FS-CR-02 Respectful and appropriate treatment of human remains that would be disturbed by the project
Description	This involves removal of human remains from sites that would be directly impacted.
Source	Burial Action Plan in the Historic Properties Treatment Plan.
Impacts Mitigated	Partially compensates for disturbance of human remains.
Location	Measure applies to (1) all known prehistoric and historic sites (some of which are known to have, or likely to have, human remains) and (2) any inadvertent discovery of human remains during project work.
Monitoring / Reporting Action	Human remains would be treated according to the protocols in the Burial Action Plan for federal lands and the Burial Agreement for state and private lands. O'odham or Hohokam burials, funerary objects, sacred objects, objects of cultural patrimony, or sacred animal burials would be repatriated directly from the field to the Tohono O'odham Nation via the Tohono O'odham Nation Cultural Resources Office. Any burials, funerary objects, sacred objects, objects of cultural patrimony, or sacred animal burials identified as other than O'odham or Hohokam would be handled according to the affiliated tribes' wishes.
Performance Criteria	All human remains and associated funerary objects that would be disturbed by the project are repatriated and reburied in accordance with the Burial Action Plan.
Responsible Party	Forest Service: oversight and coordination; Representatives of consulting tribes for monitoring and reburial of recovered ancestral remains; Rosemont: funding.
Timing	Most intensive work related to this mitigation measure is expected to occur during the archaeological testing and data recovery, but all parties would be prepared to implement the measure at any time during surface-disturbing activities related to the project.

MITIGATION MEASURE	FS-CR-03: Curation of archaeological collections in accordance with 36 CFR 79 and the HPTP
Description	This involves storage and interpretation of artifacts that are removed from sites that would be directly impacted
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Partially compensates for damage to integrity and transmission of O’odham culture that would occur with the damage to the Ce:wi Duag TCP and destruction of ancestral sites in the project area.
Location	A curation facility meeting requirements specified in 36CFR79, (either Tohono O’odham Nation Cultural Center and Museum (TONCCM) or Arizona State Museum).
Monitoring / Reporting Action	As detailed in the Historic Preservation Treatment Plan.
Performance Criteria	All archeological materials and associated field notes, photographs, etc. generated during surface collection, mapping, testing, and/or data recovery on the Project, would be curated at the designated repository. The collections would be available to researchers and for educational programming. An exhibit based on the results of the archaeological investigations would be developed made available to the public.
Responsible Party	Federal collections remain the responsibility of the Forest, in perpetuity; Rosemont funding of curation and exhibit; Repository responsible for development of exhibit and care of collections, with annual report to the Forest.
Timing	Any required improvements necessary to prepare the museum facility to house the collections would begin concurrently with the approval of the MPO. The Rosemont exhibit would be developed within 18 months of the completion of the data recovery report.

MITIGATION MEASURE	FS-CR-04 - Monitoring and treatment of inadvertent discoveries.
Description	This involves procedures in the event of discovery during project activities of previously unknown archaeological sites.
Source	Historic Properties Treatment Plan. This involves procedures in the event of discovery during project activities of previously unknown archaeological sites.
Impacts Mitigated	Partial compensation for inadvertent and unplanned impacts to archaeological sites, should they occur.
Location	Within the Area of Potential Effect (APE).
Monitoring / Reporting Action	The Forest, in consultation with the SHPO, may identify areas of Project construction within the APE that would require monitoring by a Forest-approved archaeologist and tribal monitor designated by the consulting tribes. Work in areas so identified cannot proceed without a monitor in place. All work at the site of a discovery would be suspended and the archaeologist and tribal monitor would examine and evaluate the discovery, and follow the procedures in the Discovery Plan included in the Historic Properties Treatment Plan.
Performance Criteria	Appropriate documentation of cultural resources and repatriation of human remains.
Responsible Party	Professional archaeologist and tribal monitor with oversight by the Forest; Rosemont funding and oversight of contractors.
Timing	Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	FS-CR-05 - Limit ground-disturbing activity between the boundary fence and security fence.
Description	Ground disturbing activities between the perimeter and security fences would be approved in advance by the Forest Service (anticipated to be limited to construction of compliance wells, stormwater drainage facilities, and the perimeter fence). Monitors would be present for all ground-disturbing work. Cultural material discovered during monitoring would be dealt with in accordance with the Discovery Plan in the Historic Properties Treatment Plan.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Avoids or minimizes ground disturbance and other physical impacts to archaeological sites and cultural deposits.
Location	Area between security fence and perimeter fence.
Monitoring / Reporting Action	Rosemont would coordinate any proposed ground-disturbance in this area with Forest to identify recorded historic properties, which would be avoided. If historic properties cannot be avoided, treatment will comply with Section 106 testing/data recovery given in the Treatment Plan. Monitoring and reporting ground-disturbing activities would conform to the stipulations in the Treatment Plan.
Performance Criteria	Acceptance of report by Forest.
Responsible Party	Forest oversight; professional archaeologist and designated tribal monitors; Rosemont funding.
Timing	Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	FS-CR-06 - Cultural resources protection training
Description	This requires Rosemont Copper to provide appropriate training to their employees regarding identification, avoidance and protection of cultural sites, and other topics.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Could potentially avoid inadvertent impacts to cultural resources.
Location	Rosemont headquarters.
Monitoring / Reporting Action	As part of RCC's Environmental Training Program, all personnel (including archaeological contractors) would be instructed, to the degree appropriate to their involvement with the Project, by the RCC's qualified cultural resources contractor on identification of cultural resources, site avoidance and protection measures, and the procedures to be followed in the Discovery Plan. Information on the statutes and regulations protecting cultural resources and respectful treatment of human remains would be provided. Representatives of the consulting tribes would be offered the opportunity to assist in the training according to agreements to be developed between them and the RCC.
Performance Criteria	Regular report, as specified in the Historic Properties Treatment Plan.
Responsible Party	Rosemont.
Timing	Before project operations begin, and throughout pre-mining through final reclamation and closure phases as personnel changes occur.

MITIGATION MEASURE	FS-CR-07 - Project proponent would allow tribal members access, upon five (5) days advance request, to the project area for cultural practices.
Description	Requirement to allow reasonable access to the project area for tribal members.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Partially reduces impacts of loss of access to sacred sites and collection areas.
Location	1. All springs, vision sites, and other sacred sites within project area; 2. Resource-collecting areas within project area.
Monitoring / Reporting Action	Access would be documented in annual report by Rosemont to Forest.
Performance Criteria	Access would be subject to compliance with all safety requirements.
Responsible Party	Forest would coordinate requests with Rosemont.
Timing	Throughout pre-mining through final reclamation and closure phases of the project.

MITIGATION MEASURE	FS-CR-08 - Cultural resource survey of springs, and project avoidance to the maximum extent possible
Description	This measure requires knowledge of culturally important spring locations, and consideration of all reasonable means of avoiding impacts.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Potential avoidance or reduction of damage to, or disturbance of, sacred springs.

MITIGATION MEASURE	FS-CR-08 - Cultural resource survey of springs, and project avoidance to the maximum extent possible
Location	Springs within the project area, and other springs that may be impacted by changes in the water table due to project activities.
Monitoring / Reporting Action	Cultural resource surveys by tribal representatives would be completed for all springs that would be potentially impacted by the Project. A report would be prepared identifying the survey results, submitted to the Forest for determination of NRHP eligibility with concurrence of the SHPO, and distributed to the consulting tribes. Impacts to springs would be avoided to the maximum extent possible.
Performance Criteria	Completion of survey and report and implementation of protection measures where feasible.
Responsible Party	Forest Service oversight; funded by Rosemont.
Timing	Surveys to be completed for each spring before ground disturbance occurs in that area; avoidance and protection measures would occur throughout the pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	FS-CR-09 - Transplant critical plant resources and include species within re-vegetation mixture
Description	This involves incorporating culturally important plants into the revegetation efforts described in the Final Reclamation and Closure Plan.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Partially rectifies for the loss of culturally important plants in the portion of the Ce:wi Duag TCP that is the project area.
Location	RCC private land with deed restrictions to protect vegetation.
Monitoring / Reporting Action	Prior to ground-disturbance, RCC would coordinate plant removal with consulting tribes. Tribes would be offered an opportunity to collect plants for removal to their reservations; other plants would be transplanted to an RCC-designated area and access provided to members of consulting tribes to collect plants used for medicinal, ceremonial, and craft purposes. RCC would incorporate plant species designated by the consulting tribes in its revegetation mix.
Performance Criteria	Successful plant transplantation and propagation as reported in RCC report.
Responsible Party	Rosemont.
Timing	Prior to removal of pit overburden and vegetation and soil in the waste rock and tailings area.

MITIGATION MEASURE	FS-CR-10 - Interpretation of the results of the cultural resources investigations for Tribal members, the Hispanic community, and the public
Description	This involves compiling and interpreting the results of cultural investigations in a manner that is accessible and understandable to the public.
Source	Historic Properties Treatment Plan.
Impacts Mitigated	Partial compensation of destruction of archaeological sites; damage to traditional cultural properties; loss of place-based transmittal of cultural values.
Location	Areas with views of the mine, e.g., Pullout along Highway 83, BLM's interpretive kiosk at Las Cienegas; Arizona State Museum; Tribal cultural centers; online exhibit.
Monitoring / Reporting Action	Information collected as part of the cultural resource studies undertaken for the Rosemont project is made available for Tribal youth, local school districts, and the public, to dispel stereotypes by providing accurate and culturally aware information about the history of the project area.
Performance Criteria	Interpretative signs, print and electronic media, online and museum exhibits, traveling exhibits, presentations or lectures at local venues such as libraries, meetings of avocational organizations, conferences, etc.; Presentations given during Arizona Archaeology and Heritage Awareness Month; Booth at the Arizona Archaeology Expo; laboratory and/or collections tours; public tours during fieldwork, as appropriate; development of curriculum for local school districts.
Responsible Party	Rosemont with oversight by Forest.
Timing	Tours of excavations during mitigation; development of interpretive signs within 18 months of the initiation of mitigation fieldwork; public presentations within 12 months of the initiation of fieldwork; online and museum exhibits within 18 months of the submission of mitigation reports.

MITIGATION MEASURE	FS-CR-11 – Stabilization of previously excavated historic properties between the security and perimeter fences.

MITIGATION MEASURE	FS-CR-11 – Stabilization of previously excavated historic properties between the security and perimeter fences.
Description	This would include bringing in clean fill to fill the trenches and other excavations left open at sites excavated during the ANAMAX project. All restoration work would be monitored as per the Reclamation Plan in the Historic Properties Treatment Plan.
Source	Reclamation Plan in the Historic Properties Treatment Plan.
Impacts Mitigated	Eliminates physical impacts to historic properties currently monitored by the Forest.
Location	In the area between the security and perimeter fences designated as an area of no ground-disturbance and no patrol.
Monitoring / Reporting Action	**Implementation:** Restoration work would be supervised by archaeologists and designated tribal monitors. Decommissioned forest roads would be blocked by the placement of large boulders and allowed to revegetate naturally. **Effectiveness:** Monitors would be designated by the Forest to inspect the sites quarterly for the first four years of the project, and semi-annually for the remainder of the project duration, to ensure refilled holes have stabilized, and that no ancillary activities are affecting the sites.
Performance Criteria	**Implementation:** Clean fill sediments are stable and support native vegetation in densities consistent with natural occurrence. **Effectiveness:** No signs of excessive erosion or human-caused ground disturbance.
Responsible Party	Forest Service oversight; Rosemont funding.
Timing	Concurrent with data recovery, prior to ground disturbance by project construction.

Mitigation and Monitoring - Other Regulatory and Permitting Agencies

The mitigation and monitoring in this section would be required by a permit issued under the jurisdiction of a permitting agency, such as the Arizona Department of Environmental Quality. As such, these mitigation and monitoring items would be included in the Record of Decision, and implementation would be required. The impact analyses that are disclosed in Chapter 3 of the FEIS note this, and final conclusions regarding impacts consider the effectiveness of these mitigation measures.

Soils and Revegetation

MITIGATION MEASURE	OA-SR-01 - Powerline and water line locations
Description	Final location is shortest route of alternatives considered by the Arizona Corporation Commission, and eliminates one waterline pump station.
Source	Arizona Corporation Commission Certificate of Environmental Compatibility.
Impacts Mitigated	Location selected reduces acres of surface disturbance, acres of plant and animal habitat impacted and acres of potential cultural resources impacted compared to other alternative locations considered.
Location	Utility corridor. See map in Chapter 2.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Weekly inspections during construction of power supply line and water supply pipeline to ensure location complies with ACC Certificate of Environmental Compatibility and final MPO.
Performance Criteria	**Implementation and Effectiveness:** Location and acres disturbed complies with Certificate of Environmental Compatibility and final MPO.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for working with TEP to ensure construction on lands other than National Forest System land complies with Certificate of Environmental Compatibility. Rosemont is responsible for monitoring work on National Forest System lands to ensure compliance with final MPO. The Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** During construction of electrical supply line and water supply pipeline (pre-mining phase).

Air Quality

MITIGATION MEASURE	OA-AQ-01 – Paving mine related roads to reduce dust emissions
Description	All routes used by the shipment and delivery vehicles would be paved including the entrance road (3.1 miles) plus the shipment/delivery light duty roads within the facility.

Source	Air Quality Permit (Air Quality Permit dated January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality from fugitive emissions (dust) that would otherwise be produced by vehicle use of these roads if they were unpaved.
Location	Primary access road and other roads that are not used by haul trucks or heavy mine equipment.
Monitoring / Reporting Action	**Implementation:** Weekly inspection during road construction and paving activities, including road maintenance or repair, to ensure that applicable MSHA construction requirements and/or Forest Service specifications are met. **Effectiveness:** Effectiveness monitoring related to fugitive dust emissions are specified in the Air Quality Permit. Road conditions, including the condition of paved surfaces, would be visually observed monthly and inspected in further detail quarterly to ensure that pavement remains intact and maintenance is scheduled and implemented in a timely manner.
Performance Criteria	**Implementation:** Designated roads within the Plant site are constructed and paved to specification following the substantial completion of the plant site facilities for the duration of prior to construction operations of the plant site. **Effectiveness:** Specifications stated in Air Quality Permit are met.
Responsible Party	**Implementation:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO regarding road specifications and paved surface. **Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation:** Begins with construction of the road system (pre-mining phase), and ends at completion of final reclamation and closure phase (due to periodic road maintenance). **Effectiveness:** Refer to the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-02 - Dust control for unpaved roads
Description	This mitigation contains a number of actions that are designed to control at least 90% control of PM_{10} emissions from the unpaved road network. These actions include application and reapplication of chemical dust suppressant, and watering as needed.
Source	This is a design feature for the preliminary MPO. The Dust Control Plan contained as Appendix D of the Air Quality Permit (Permit # 55223, January 31, 2003).
Impacts Mitigated	Reduces impacts to air quality from fugitive dust emissions.
Location	The network of unpaved haul roads used for transporting ore and waste rock from the open pit mine to the primary crushing area, leaching area, and waste rock areas, respectively; and any unpaved general roads within and around the perimeter fence surrounding the facility used by support vehicles. Primary roads include: (a) haul roads located in the pit, (b) haul roads for transporting concentrating ore from the pit to the primary crusher/run of mine stockpile, (c) haul roads for transporting leaching ore from the pit to the leach pad, (d) haul roads for transporting waste rock from the pit to the waste rock storage area, waste rock buttresses, or other general areas and (e) general facility roads around the project area for support vehicles.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Inspections and dust control measures according to specifications contained in Dust Control Plan, which is included in the Air Quality Permit (Air Quality Permit dated January 31, 2013, Appendix D).
Performance Criteria	**Implementation and Effectiveness:** As per Dust Control Plan, during actual operation, Rosemont would evaluate the haul truck traffic rates at different time periods throughout the life of the mine to correctly identify the application intensity needed for road watering to achieve a 90% control efficiency on haul roads. Also, Rosemont would evaluate the traffic rate of support vehicles to determine the water application intensity needed to control the general unpaved facility roads to a 90% control efficiency. Other requirements contained in the Air Quality Permit, such as opacity limits also apply.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	OA-AQ-03 - Dust control for open areas and storage piles
Description	This mitigation contains a number of actions that are designed to control fugitive dust emissions from open areas and storage piles. These activities include application and reapplication of chemical dust suppressant, and water. Open areas and storage piles which are not actively used would be controlled by applying sufficient chemical dust suppressant and/or water to develop and maintain a visible crust. Other means such as use of an adhesive soil stabilizer, paving covering, landscaping, detouring or other acceptable means of dust control may be used.
Source	The Dust Control Plan contained as Appendix D of the Air Quality Permit (Permit # 55223, January 31, 2003).
Impacts Mitigated	Reduces impacts to air quality from fugitive dust emissions.
Location	Open areas and storage piles include mined areas, overburden storage areas, as well as waste rock storage areas.
Monitoring / Reporting Action	**Implementation and Evaluation:** Inspections and dust control measures according to specifications contained in Dust Control Plan, which is included in the Air Quality Permit (see Air Quality Permit dated January 31, 2013, Appendix E).
Performance Criteria	**Implementation and Effectiveness:** As per Dust Control Plan, monitoring would demonstrate a 90% control efficiency (See Air Quality Permit dated January 31, 2013, Appendix D).
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	OA-AQ-04 – Control of particulate emissions from lime slaking process
Description	Refinement of the design of the lime slaking system, including the addition of a lime slaker scrubber.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality by controlling particulate matter emissions from the lime slaking process.
Location	Lime silo at the plant site area.
Monitoring / Reporting Action	**Implementation:** Inspection and reporting at the time of construction of said facilities to ensure design meets specifications in the Air Quality Permit application and amendment. **Effectiveness:** As per Air Quality Permit requirements.
Performance Criteria	**Implementation:** Equipment used complies with that specified in the Air Quality Permit application and amendment. **Effectiveness:** Air Quality Permit processes and specifications are met.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Beginning with installation of specified equipment and continuing as per requirements in the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-05 – Control of particulate emissions from major metallic mineral processing operations
Description	Installation, operation and maintenance of cartridge dust filters and other measures to control particulate matter emissions from major metallic mineral processing operations.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality from particulate matter emissions associated with processing operations.
Location	At all locations specified in the Air Quality Permit dated January 31, 2013; APP, Section III (D) (2) a through l.
Monitoring / Reporting Action	**Implementation:** Inspection and reporting at the time of construction of said facilities to ensure design meets specifications in the Air Quality Permit application and amendments. **Effectiveness:** As per Air Quality Permit requirements. See Air Quality Permit dated January 31, 2013, sections III (D)(3) a through f; III (D)(4) a through b; and III (D)(5).
Performance Criteria	**Implementation:** Equipment used complies with that specified in the Air Quality Permit, application and amendments. **Effectiveness:** Air Quality Permit processes and specifications are met.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.

Timing	**Implementation and Effectiveness:** Beginning with installation of specified equipment and continuing as per requirements in the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-06- Use of covers on mix tanks and settlers to reduce emissions of volatile organic chemicals
Description	This mitigation involves the installation of covers on specific facilities that could otherwise result in volatile organic chemicals emissions.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality by reducing emissions of volatile organic chemicals and hazardous air pollutants from mix tanks and settlers used in the solvent extraction system.
Location	Mix tanks and settlers within the plant site.
Monitoring / Reporting Action	**Implementation:** Inspection and reporting at the time of construction of said facilities to ensure design meets specifications in the Air Quality Permit application and amendments. **Effectiveness:** As per Air Quality Permit requirements.
Performance Criteria	**Implementation:** Equipment used complies with that specified in the Air Quality Permit application and amendments. **Effectiveness:** Air Quality Permit processes and specifications are met.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Beginning with installation of specified equipment and continuing as per requirements in the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-07 - Use of drip emitters on heap leach pad to reduce emissions
Description	This mitigation involves the installation and use of drip emitters to apply solution to the heap leach.
Source	This is a design feature from the preliminary MPO. It is also required by the Air Quality Permit (January 31, 2013).
Impacts Mitigated	Prevents or reduces impacts to air quality from aerosol production and losses to wind, thereby reducing release of contaminants into the air, and reduces evaporative losses of water.
Location	Heap leach pad.
Monitoring / Reporting Action	**Implementation:** Visual inspection at time of construction to ensure that drip emitters have been installed. **Effectiveness:** Daily visual inspection to ensure emitters are functioning properly to prevent or reduce aerosol production and release due to wind.
Performance Criteria	**Implementation:** Inspection and reporting at the time of construction of heap leach facility. Drip emitters are installed as per final MPO. **Effectiveness:** Monitoring of emitter operations indicates they are effecting in preventing aerosol production and reducing potential release due to wind. Air Quality monitoring results meet requirements specified in the Air Quality permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the final MPO and Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Beginning with installation of specified equipment and continuing as per requirements in the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-08 – Reduction in air emissions from diesel engines associated with stationary equipment
Description	This mitigation required the use of low-sulfur diesel for all stationary equipment.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality from potential air emissions.
Location	All stationary equipment equipped with diesel engines.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Record keeping and quarterly reporting of diesel fuel deliveries to stationary diesel equipment to ensure low-sulfur diesel is being used.
Performance Criteria	**Implementation and Effectiveness:** Review of delivery data shows that all diesel fuel delivered to stationary equipment within the mine is low sulfur diesel.

Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service according to the final MPO and Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

MITIGATION MEASURE	OA-AQ-9 - Reduction in air emissions from diesel engines associated with mobile sources (haulage equipment, etc.)
Description	Use of newer engine designs on haulage equipment and on select mobile sources – includes use of Tier 4 EPA compliant equipment for emission standards on selected non-road engines (all except haul trucks and the 2,000 horsepower front-end loaders); use of Tier 2 diesel engines for haul trucks; and use of Tier 4 engines for large haulage trucks and support equipment purchased after 2014. Note: EPA standards have been changing based on what is technologically available and on equipment production schedules – Rosemont would purchase equipment that meets EPA standards, the dates may change based on EPA requirements.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces impacts to air quality from internal combustion engine emissions.
Location	Specific equipment listed, and addressed in Air Quality Permit, application and amendments.
Monitoring / Reporting Action	**Implementation:** Certification and reporting that specified equipment meets requirements before it is put into use. **Effectiveness:** According to Air Quality Permit requirements.
Performance Criteria	**Implementation:** Specified equipment meets specifications stated in Air Quality Permit application and amendments. **Effectiveness:** Meets criteria specified in the Air Quality Permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to ADEQ and the Forest Service. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** Commences with purchase of stated equipment, prior to putting that equipment into service, through closure or as stated in the Air Quality Permit.

MITIGATION MEASURE	OA-AQ-10 – Air Pollution Control Requirements for Electrowinning Process
Description	This mitigation requires several actions and methods to control potential emissions in the electrowinning process, including installation and use of scrubbers to control sulfuric acid emissions; dilution of sulfuric acid and use of drip system to minimize mist emissions; installation, use and maintenance of covers to control acid emissions; and using foam, dispersion/poly balls, surfactants or other effective means of controlling sulfuric acid emissions. Locations where these requirements apply are specified in the Air Quality Permit.
Source	Air Quality Permit (January 31, 2013).
Impacts Mitigated	Reduces emissions from electrowinning process.
Location	All equipment and locations specified in Section IV (C) of the Air Quality Permit.
Monitoring / Reporting Action	**Implementation:** According to Air Quality Permit requirements. **Effectiveness:** According to Air Quality Permit requirements.
Performance Criteria	**Implementation:** According to Air Quality Permit requirements. **Effectiveness:** According to Air Quality Permit requirements.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conduction monitoring and reporting in accordance with the Air Quality Permit requirements. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.
Timing	**Implementation and Effectiveness:** During electrowinning processing.

Other Monitoring Items for Air Quality

MONITORING ITEM	OA-AQ-11 - Opacity Monitoring
Description	This monitoring describes emission limitations and established monitoring, reporting and recordkeeping requirements regarding opacity.
Source	Air Quality Permit (January 31, 2013).
Purpose	To determine whether opacity meets the requirements of the Air Quality Permit.
Location	Locations specified in the Air Quality Permit.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per Section the Air Quality Permit.
Performance Criteria	**Implementation and Effectiveness:** As per Section the Air Quality Permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for monitoring and reporting in accordance with the Air Quality Permit. ADEQ is responsible for determining compliance with the Air Quality Permit and the Clean Air Act, and keeping the Forest Service informed of the results of such determinations.

Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

Groundwater Quantity and Quality

MITIGATION MEASURE	OA-GW-02 – Reduction of the potential for acid generation from tailings and waste rock
Description	This mitigation involves requirements for the segregation and encapsulation of potentially acid-generating waste rock with rock that has buffering capabilities in order to reduce the risk of potential acid generation.
Source	This is a design feature that was contained in the preliminary MPO. It is also a requirement of the Aquifer Protection Permit (APP dated April 3, 2012).
Impacts Mitigated	Avoidance or reduction of impacts to groundwater and surface water quality by reducing the potential of acid production and drainage from waste rock areas.
Location	Waste rock facilities and waste rock perimeter buttress locations.
Monitoring / Reporting Action	**Implementation:** Monthly monitoring to ensure that placement of waste rock potentially acid generating (PAG) and non-acid generating (NAG) rock types complies with stacking plan specified in the final MPO, and approved Waste Rock Segregation Plan (APP, p. 28). **Effectiveness:** Monthly and quarterly visual inspections of surface features and overall integrity as per APP; after significant rainfall events (1/2" or greater precipitation within 24-hour period); waste rock managed by monitoring PAG and NAG as per APP (APP dated April 3, 2012, Table 4.2.1, Required Inspections and Operational Monitoring). See also groundwater quality monitoring.
Performance Criteria	**Implementation:** Placement of PAG and NAG materials complies with stacking plan and Waste Rock Segregation Plan, and therefore complies with final MPO and APP. **Effectiveness:** No consistent, long-term indications of elevated metals concentrations or other characteristics of acid rock drainage are detected, based on Aquifer Quality Limits to be specified by ADEQ through the APP (Table 4.2.3, Quarterly Compliance Groundwater Monitoring). See also groundwater quality monitoring in this section.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and quarterly reporting to the Forest Service and ADEQ. ADEQ is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with APP.
Timing	**Implementation:** Beginning when waste rock is segregated and placed and ending when those activities are completed. **Effectiveness:** Until closure of the APP tailings and waste rock facilities.

MITIGATION MEASURE	OA-GW-03 – Equipment and methods to keep potentially contaminated water from being released into the environment
Description	This mitigation measure requires the use of lined ponds; retention of all contact stormwater for reuse as process water; and the installation of overflow alarms to alert operators of a potential overflow situation.
Source	Pond liners, and retention and reuse of contact stormwater as process water were contained in the preliminary MPO and are also required by the APP (APP dated April 3, 2012). The installation and use of overflow alarms originated with the Coronado ID Team.
Impacts Mitigated	Avoidance or reduction of surface water and groundwater contamination.
Location	Process water temporary storage pond, raffinate pond, stormwater pond, primary settling basin, and pregnant leach solution pond.
Monitoring / Reporting Action	**Implementation:** Complete inspection at time of construction to ensure consistency with location and specifications contained in the final MPO and APP (APP dated April 3, 2012, p. 27-28 and Table 4.1.1, Permitted Facilities and BADCT). **Effectiveness:** Quarterly visual inspection of pond integrity; additional inspections for process upset events or significant rainfall events (0.50 inches or greater precipitation within 24-hour period), as per APP.
Performance Criteria	**Implementation:** Liners meet specifications contained in the APP. Containment structures and liner installation comply with final MPO and APP. **Effectiveness:** Fluids accumulated in the Stormwater Pond are removed within 45 days, as per APP specifications.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. ADEQ is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with APP.
Timing	**Implementation:** Monitoring during pre-construction phase to ensure compliance with APP and final MPO, as well as APP BADCT requirements. **Effectiveness:** During active mining to ensure effectiveness and permit compliance; and during final reclamation and closure phase to ensure that facilities are adequately reclaimed as per the APP requirements.

MITIGATION MEASURE	OA-GW-04 - Control and recycling of process water
Description	Overall reduction of fresh water use and avoidance of potentially contaminated discharges by containing all process water in lined facilities, to be recycled back into the process stream to offset fresh water use; and the installation of overflow alarms to alert operators of a potential overflow situation.
Source	Pond liners, and retention and reuse of process water were a design feature contained in the preliminary MPO and are also required by the APP (APP dated April 3, 2012). The installation and use of overflow alarms originated with the Coronado ID Team.
Impacts Mitigated	Avoids impacts to groundwater and surface water from potential contamination; and reduces impacts to groundwater quantity used for processing.
Location	Process water temporary storage pond (PWTS); primary settling basin; raffinate pond, heap leach pad, pregnant leach solution (PLS) pond; stormwater pond; primary settling basin.
Monitoring / Reporting Action	**Implementation:** Daily visual inspections and quarterly reporting during construction to ensure that facilities and processes are constructed in a manner that complies with final MPO and APP (APP dated April 3, 2012, Table 4.1.1, Permitted Facilities and BADCT). **Effectiveness:** Inspections and operational monitoring occur daily and quarterly, as specified in the APP (APP dated April 3, 2012, Table 4.2.1, Required Inspections and Operational Monitoring).
Performance Criteria	**Implementation:** Tailings facilities are located within the footprint depicted in the FEIS, ROD and APP, and liners and collection systems are installed as described in the APP (APP dated April 3, 2012, Table 4.1.1, Permitted Facilities and BADCT). **Effectiveness:** Pump systems, valves and structures are functioning properly; overflow pipes and spillway structures are not blocked; flow rates are less that maximum specified in APP; liner(s) integrity is intact and not impaired; design a capacity is not exceeded. See APP dated April 3, 2012, Table 4.2.1, Required Inspections and Operational Monitoring, p. 30 for further details.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. ADEQ is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with APP.
Timing	**Implementation:** During pre-mining and active mining phases. **Effectiveness:** For the life of the mine, commencing when production begins; and ending at closure of the APP.

MITIGATION MEASURE	OA-GW-05 –Tailings are processed and placed to reduce water content and overall footprint
Description	This mitigation requires the use of dry stack tailings technology, which eliminated the need for traditional tailings impoundments; and allows tailings to be placed and compacted in a manner that reduces the overall footprint of tailings facilities.
Source	This is a design feature that was contained in the preliminary MPO. It is also a requirement of the Aquifer Protection Permit (APP dated April 3, 2012).
Impacts Mitigated	Smaller footprint avoids impacts to cultural sites; wildlife habitat; soils; waters of the United States; and surface water. Reduces impacts related to water use; reduced seepage avoids or reduces impacts related to potential groundwater contamination; reduced evaporation reduces water use. Reclamation can begin earlier, improving vegetative recovery.
Location	Entire tailings facility.
Monitoring / Reporting Action	**Implementation:** Daily inspections and quarterly reporting to ensure that the footprint of the tailings facility is within the area specified in the FEIS/ROD, and those facilities are constructed according to final MPO. **Effectiveness:** Monitoring to determine (1) the moisture content and compaction of the tailings being placed; (2) assuring tailings placement adheres to the stacking plan to ensure adequate buffering of potential acid generating materials; and (3) complies with subgrade preparation, grading, and applicable BADCT requirements described in the APP (APP dated April 3, 2012, p. 22 and 24, Table 4.1.1, Permitted Facilities and BADCT). In accordance with the APP monitoring requirements (APP dated April 3, 2012, p 31 Table 4.2.1, Required Inspections and Operational Monitoring), daily monitoring relating to ponding of water, dry stack deformation, excessive erosion, and moisture content. Monitoring results would be compiled into an annual monitoring report and provided to the Forest Service and Arizona Department of Environmental Quality (ADEQ) (APP dated April 3, 2012).
Performance Criteria	**Implementation:** Tailings facilities are located within the footprint depicted in the FEIS/ ROD and final MPO. **Effectiveness:** Moisture content of tailings is a maximum of 18% coming out of the filter plant and is in compliance with final stacking plan, which is included in the MPO. Excessive ponding of water does not occur or is pumped into process water facility before it can infiltrate; excessive erosion does not occur; dry stack facility does not experience substantial deformation, movement, subsidence, or slope sloughing.

MITIGATION MEASURE	OA-GW-05 –Tailings are processed and placed to reduce water content and overall footprint
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with NEPA decision. ADEQ is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with APP.
Timing	**Implementation:** During the period that tailings are being placed (primarily active mining phase). **Effectiveness:** For the life of the mine, commencing when tailing stacking begins; and ending when tailings are no longer being placed in the facility.

Other Monitoring Items for Groundwater Quantity and Quality

MONITORING ITEM	OA-GW-06 – Groundwater quality and aquifer level monitoring required by the APP
Description	This monitoring requires the construction and operation of point of compliance monitoring wells, groundwater quality monitoring and sampling protocols, and reporting as specified in the APP.
Source	Aquifer Protection Permit (APP dated April 3, 2012, Parts 2.4 and 2.5, Pgs. 7-10).
Purpose	To determine whether measures designed to avoid or reduce risk of groundwater are effective, and whether applicable laws and regulations are being met
Location	Eight point of compliance well locations, as specified in the APP permit (APP dated April 3, 2012, Table 2.3, POC Well Locations) and in the ROD. Specific well locations are expected to be amended in APP to reflect selected alternative.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As specified in the APP permit.
Performance Criteria	**Implementation and Effectiveness:** As specified in the APP permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. ADEQ is responsible for determining compliance with the APP.
Timing	**Implementation and Effectiveness:** As specified in the APP permit.

MONITORING ITEM	OA-GW-07 – Monitor quantity of supply water removed from the Santa Cruz Basin
Description	This monitoring item measures the amount of groundwater pumped by the mine water supply wells located near Sahuarita.
Source	Requirement under ADWR mineral extraction permit.
Purpose	To determine whether reduction of groundwater resources within the Upper Santa Cruz Basin are within those projected in the NEPA decision. This information is also needed for ADWR for permit compliance.
Location	At wellhead for all water supply wells.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As specified by ADWR permit.
Performance Criteria	**Implementation and Effectiveness:** As specified by ADWR permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADWR. ADWR is responsible for determining compliance with the mineral extraction permit.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation and closure phases.

Surface Water Quantity and Quality

MONITORING ITEM	OA-SW-01 Detention and testing of stormwater
Description	This mitigation measure requires detention and testing of stormwater quality from perimeter waste rock buttress areas for water quality testing prior to flowing downstream of the mine site.
Source	AZPDES Multi Sector General Permit (AZMSG2010-003), Specific Rosemont Copper Permit Authorization AZMSG-74939).
Purpose	Avoids or reduces impacts to surface water quality by reducing the risk of discharging contaminated water; controls sediment load of water released into downstream drainages. Potentially reduces impacts to Gila Chub, Gila Topminnow and Huachuca water umbel.
Location	Sediment ponds, sediment control structures, compliance point pond and dam. Specific locations of sampling would be defined in Stormwater Pollution Prevention Plan (SWPPP) which is required by the AZPDES Multi-Sector General Permit, and would be prepared after selection of alternative, but typically is tied to "outfalls" and in this case is likely to be the proposed sediment control structures and compliance point dam.

MONITORING ITEM	OA-SW-01 Detention and testing of stormwater
Monitoring / Reporting Action	**Implementation:** Complete inspection at time of construction of these facilities to ensure consistency with location and specifications contained in the final MPO and SWPPP. **Effectiveness:** As specified in the final MPO and AZPDES Multi-Sector General Permit.
Performance Criteria	**Implementation:** Facilities are constructed in locations and to specifications contained in final MPO and AZPDES SWPPP. **Effectiveness:** As specified in the final MPO and AZPDES Multi-Sector General Permit.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. ADEQ is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with stormwater permit.
Timing	**Implementation:** During construction (pre-mining phase) to ensure compliance with final MPO and SWPPP. **Effectiveness:** During active mining phase to ensure effectiveness and permit compliance; and during final reclamation and closure to ensure that facilities are adequately reclaimed.

MITIGATION MEASURE	OA-SW-02 - Implementation of Stormwater Pollution Prevention Plan
Description	This mitigation involves requirements of the Arizona Pollutant Discharge Elimination System Multi-Sector General Permit or Construction General Permit to prepare a Stormwater Pollution Prevention Plan; The SWPPP identifies methods to reduce potential pollution of stormwater; this plan is site specific, flexible, and constantly updated. It typically includes a variety of ways to reduce potential pollution including structural controls (i.e., sediment basins, silt fences, straw bales); best management practices (i.e., good housekeeping, spill prevention); stabilization practices (i.e., water bars, reseeding, tackification). The plan is implemented by following best practices, installing appropriate structural control measures, continually monitoring those measures and repairing/replacing if needed, and revising or updating the plan to reflect project changes and adapt to changing conditions.
Source	AZPDES Multi-sector general permit.
Impacts Mitigated	Reduces impacts to surface quality through potential degradation and loss of soil through erosion, and prevention of contact of stormwater with hazardous materials.
Location	All construction areas, including utility lines and access roads; all operational mine areas within security fence
Monitoring / Reporting Action	**Implementation and Effectiveness:** Final monitoring details and locations would be decided when the SWPPP is prepared.
Performance Criteria	**Implementation and Effectiveness:** Results of this monitoring would be used to evaluate the success of the measures taken to protect the water resources. Any changes in water exceedances of MSGP criteria would be evaluated to determine whether the changes are related to the reclaimed mining features, and appropriate steps would be taken to address the problem by modifying the SWPPP.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service and ADEQ. ADEQ is responsible for determining compliance with AZPDES permit.
Timing	**Implementation and Effectiveness:** Surface water would be monitored as required in the Arizona Pollution Discharge Elimination System program during construction (pre-mining phase), active mining, and following cessation of mining operations (post-mining phase).

Transportation and Access

MITIGATION MEASURE	OA-TA-01 - Arizona Department of Transportation activities to mitigate impacts of increased traffic on State Route 83
Description	This mitigation consists of Rosemont providing funding to ADOT to implement activities to reduce impacts resulting from increased traffic on State Route 83. ADOT has indicated the activities they plan to implement include; 3 inch pavement overlay from Interstate10 to the intersection of the primary access road; striping; raising guardrails and signs to match new pavement height; and paving 3 existing bus pullouts for school bus use. Rosemont and ADOT are currently negotiating the amount of funding that would be provided.
Source	ADOT.
Impacts Mitigated	Reduction of potential traffic safety hazards.
Location	State Route 83 from Interstate 10 to intersection with the primary access road.
Monitoring / Reporting Action	**Implementation and Effectiveness:** As per agreement between Rosemont and ADOT.
Performance Criteria	**Implementation and Effectiveness:** As per agreement between Rosemont and ADOT.
Responsible Party	**Implementation and Effectiveness:** Arizona Department of Transportation has jurisdiction over these actions, and therefore would determine responsibility for monitoring actions.
Timing	**Implementation and Effectiveness:** To be determined.

Mitigation and Monitoring Measures - Rosemont Copper

Rosemont has publically agreed to consider or implement the following mitigation and monitoring items. These mitigation and monitoring items are beyond the authority of the Forest Service or other regulatory and permitting agency. Since the Forest Service and regulatory permitting agencies have no mechanism to require implementation of the remaining mitigation and monitoring items in this category, their implementation is not assured. While the effectiveness of these mitigation measures is included in Chapter 3 of the FEIS, environmental impacts are addressed as measures that may occur, as opposed to measures that would occur, with the following exception. For the purposes of impact analysis, the Coronado assumed that those mitigation and monitoring items with legally-binding agreements in place (such as RC-GW-01 below) at the time the decision is made (ROD approved) would be implemented, and therefore they are addressed as such in the mitigation effectiveness sections in Chapter 3 of the FEIS.

Groundwater Quantity and Quality

MITIGATION MEASURE	RC-GW-01– Provide protection for individual private residential well owners against the risk that mine-associated groundwater drawdown could impact their well
Description	This mitigation involves implementing a legally-binding well owner protection agreement that provides certain protections for potential impacts to individual well owners.
Source	Rosemont.
Impacts Mitigated	May compensate for potential impacts to domestic wells for homeowners who are eligible for and sign up for the plan. Includes water level monitoring program, water well pump warranty program, residential well deepening and an in-lieu cash option. Conditions and restrictions apply.
Location	Two distinct agreements. One covers Sahuarita Heights neighborhood near Rosemont's supply wells; the second covers portions of Hilton Ranch, Helvetia, and Singing Valley.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Agreements have been executed and are currently in place. No Forest Service or agency monitoring would occur. Involvement of homeowners is voluntary, and the agreement is between the homeowner and Rosemont Copper.
Performance Criteria	**Implementation and Effectiveness:** As per Rosemont Copper Residential Water Well Warranty Service Agreements. Not applicable to the Forest Service or permitting agencies.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper.
Timing	**Implementation and Effectiveness:** Agreements become effective for the Sahuarita Heights neighborhood are already in place and effective, agreements for the Hilton Ranch, Helvetia, and Singing Valley areas when Rosemont receives final Forest Service approval for the project.

MITIGATION MEASURE	RC-GW-06 – Extension of Central Arizona Project pipeline to Green Valley
Description	Rosemont would fund a 7-mile extension of Central Arizona Project (CAP) to deliver Community Water Company of Green Valley's CAP allotment; and use the extra capacity of that pipeline to recharge in the general vicinity of the mine supply wells.
Source	Rosemont Copper.
Impacts Mitigated	Reduces impacts of groundwater use for mine supply. Provides access to CAP water to Community Water Company, allows recharge by Rosemont Copper in vicinity of pumping, and recharge would compensate for some or all of the mine supply water pumped out of the aquifer.
Location	CAP pipeline extension location.
Monitoring / Reporting Action	**Implementation:** N/A **Effectiveness:** N/A
Performance Criteria	**Implementation:** N/A **Effectiveness:** N/A
Responsible Party	**Implementation:** N/A **Effectiveness:** N/A

Timing	**Implementation:** U.S Bureau of Reclamation completed environmental documentation needed for construction in July 2012; construction was initiated in July 2012. **Effectiveness:** N/A

Surface Water Quantity and Quality

MONITORING ITEM	RC-SW-01 - Continued operation and data gathering of U.S. Geological Survey flow gauge that would provide data for surface water flows downstream of the mine site
Description	Rosemont Copper would annually fund U.S. Geological Survey to operate and maintain existing flow storm at Barrel Canyon.
Source	Rosemont Copper.
Purpose	Allows for continued baseline data collection and monitoring collection of flows in Barrel Canyon.
Location	Barrel Canyon flow gauge at Highway 83.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Rosemont would annually report to the forest service on the status on this funding obligation.
Performance Criteria	**Implementation and Effectiveness:** Fully executed agreement and documentation of funds transferred to USGS fiscal year cut off dates.
Responsible Party	**Implementation and Effectiveness:** Rosemont would maintain a contract agreement with a government agency to fund the U.S. Geological Survey to operate and maintain Barrel Canyon flow gage. Potential agencies include, but not limited to, Pima County Flood Control District, Arizona Department of Water Resources, or Forest Service.
Timing	**Implementation and Effectiveness:** Funding would continue for at least 5 years after mining and processing operations cease (post-mining phase).

Biological Resources

MITIGATION MEASURE	RC-BR-01 – Record a restrictive easement on private land referred to as the Fullerton parcel to protect wildlife habitat
Description	This mitigation would result from Rosemont Copper recording a restrictive covenant on the Fullerton parcel. The Fullerton Parcel contains about 1,780 acres of semi-desert grasslands in the Sierrita Mountains. Recording of a restrictive covenant could benefit general wildlife habitat. Management would exclude grazing to enhance habitat values.
Source	Rosemont Copper.
Impacts Mitigated	May partially compensates for losses of habitat for general wildlife species.
Location	Fullerton Parcel.
Monitoring / Reporting Action	**Implementation:** Recording of a restrictive covenant would be reported. A copy of said restrictive covenant would be provided to the Forest Service. **Effectiveness:** N/A
Performance Criteria	**Implementation:** Recording of a restrictive covenant. **Effectiveness:** N/A
Responsible Party	**Implementation:** Rosemont is responsible for crafting and recording a restrictive covenant. **Effectiveness:** N/A
Timing	**Implementation and Effectiveness:** To be determined.

MITIGATION MEASURE	RC-BR-02 – Future modification of allotment management plans
Description	Rosemont would prepare and submit to the Coronado a request to modify the Allotment Management Plans (AMPs) for the Thurber, Debaud, Greaterville, and Rosemont Forest Service grazing allotments within 1 year of issuance of the Record of Decision. The modifications would be developed in consultation, cooperation, and coordination with the Coronado range staff, with input from the Arizona Game and Fish, and would include the following: To compensate for the loss of flowering agaves for the lesser long-nosed bat due to the proposed mine grazing by cattle would be restricted during the April 1 to June 15 period through rotation to alternative pastures on approximately 8,000 acres of portions of the Debaud, Greaterville, and Rosemont allotments that currently are permitted to be grazed during the agave bolting period. This could increase foraging resources for the lesser long-nosed bat. Portions of pastures within these grazing allotments would be put on a winter rotation to limit grazing during the growing season within riparian areas. This could enhance riparian vegetation. Key pastures would be rested for extended periods of time and made available for grazing when forage production on active pastures is reduced because of drought or other factors. This "grass bank" element could enhance overall production within the allotments without the reduction of current cattle stocking rates. In addition, Rosemont would conduct a scientifically designed study to document the efficacy of seasonal grazing restrictions to enhance agave flowering success. The study would be implemented annually for five years following approval of the Allotment Management Plan and implementation of grazing management practices. Also see FS-BR-04.
Source	Rosemont Copper.
Impacts Mitigated	To be determined, depending on final decision of allotment management plans.
Location	Thurber, Debaud, Greaterville, and Rosemont Forest Service grazing allotments.
Monitoring / Reporting Action	**Implementation and Effectiveness:** To be determined.
Performance Criteria	**Implementation and Effectiveness:** To be determined.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible preparing and submitting a request to modify allotment management plans. The Forest Service is responsible for determining when allotment management plans are revised; and for making the final decision on plan modifications.
Timing	**Implementation and Effectiveness:** To be determined.

Land Ownership and Boundary Management

MITIGATION MEASURE	RC-LO-01 – Transferring ownership of small slivers of land within the mining footprint from National Forest to Rosemont Copper
Description	A number of small mineral survey fractions are located within the footprint of the mine pit and tailings/waste rock facilities. These small slivers of land are currently National Forest System lands that would be difficult to manage as public lands post-project. Rosemont has expressed interest in purchasing these mineral survey fractions from the Coronado. The sale would comply with the Small Tracts Act (36 CFR 254.24). The proponent would pay for surveys of the mineral fractions, appraisals, Commitment of title for each parcel and other administrative costs as agreed upon with the Forest Service.
Source	Coronado ID Team.
Impacts Mitigated	Avoids difficulties related to managing slivers National Forest System lands that are covered by waste rock and tailings as public lands.
Location	Seven known mineral survey fractions with a total of approximately 5.5 acres are completely surrounded by the patented mining claims owned by Rosemont Copper.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Forest Service would process sale following final Forest Service approval of the project; sale must be finalized prior to mine closure.

Performance Criteria	**Implementation and Effectiveness:** Sale is processed and finalized prior to mine closure.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for following through on their commitment to purchase mineral fractions; Forest Service is responsible for processing sale.
Timing	**Implementation and Effectiveness:** Prior to closure of mine.

MITIGATION MEASURE	RC-LO-02 - Eliminate future development of private lands located on top of waste rock and tailings facilities
Description	This mitigation would include recording a restrictive easement or other mechanism intended to avoid future development on private lands located on waste rock and tailings facilities that could compromise stability or reclamation results.
Source	Coronado ID Team.
Impacts Mitigated	Avoid future activities that could compromise reclamation of waste rock and tailings areas over the long term.
Location	Waste rock and tailings facilities.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Forest Service would work with Rosemont Copper to implement mechanisms such as restrictive covenants to accomplish goals.
Performance Criteria	**Implementation and Effectiveness:** Restrictive covenants or other legally binding instruments are developed and implemented to restrict future development of private lands on or within tailings and waste rock facilities.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for developing and implementing appropriate instruments to accomplish stated goals.
Timing	Implementation and Effectiveness: Restrictive easement or other mechanism would be in place at time of final closure.

Visual Resources

MITIGATION MEASURE	RC-VR-01 – Architectural designs for buildings associated with the water supply line pump stations
Description	Rosemont Copper has stated that they would follow University of Arizona College of Architecture and Landscape Architecture design guidance for buildings associated with four pump stations to ensure that they maintain the tenor of the Santa Rita Experimental Range.
Source	Rosemont Copper.
Impacts Mitigated	Reduces visual contrast and associated visual impacts of buildings associated with water line pump stations located on the Santa Rita Experimental Range.
Location	Four pump stations along utility corridor.
Monitoring / Reporting Action	**Implementation and Effectiveness:** N/A
Performance Criteria	**Implementation and Effectiveness:** N/A
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for obtaining and implementing design guidance.
Timing	**Implementation and Effectiveness:** Construction of these facilities (pre-mining phase).

MITIGATION MEASURE	RC-VR-02 – Measures to reduce the visual impact of the mining pit
Description	This mitigation involves using commercially available products to color exposed rock in the upper portions of the pit, if needed, where color contrasts may be visible from a variety of viewpoints. Rosemont would also explore the feasibility of breaking up upper horizontal benches within the pit to reduce impacts to visual resources.
Source	Coronado ID Team.
Impacts Mitigated	Would reduce visual impacts by reducing color contrast and linear features.
Location	Exposed rock in the upper pit area, which is primarily on Rosemont Copper private land.
Monitoring / Reporting Action	**Implementation:** Visual inspection and report to ensure that implementation has occurred. **Effectiveness:** Visual inspection from selected viewpoints to determine effectiveness.
Performance Criteria	**Implementation:** Color is applied and benches broken up as early in the pre-mining or active mining phase as feasible, in accordance with manufacturer's instructions. **Effectiveness:** Results may be effective in reducing color contrast.
Responsible Party	**Implementation:** Rosemont is responsible for implementing this action in accordance with the final MPO. **Effectiveness:** The Forest Service is responsible for conducting effectiveness monitoring.
Timing	Implementation: Pre-mining through early active mining. Effectiveness: From time of application through closure.

Transportation and Access

MITIGATION MEASURE	RC-TA-01 – Scheduling deliveries to the mine to take place outside of peak traffic hours to avoid adding to traffic congestion
Description	Deliveries would be scheduled to minimize material delivery on State Route 83 during peak traffic hours (6:30 - 7:30 am for northbound traffic; and 5:00 - 6:00 pm for southbound traffic).
Source	This is a design feature of the preliminary MPO.
Impacts Mitigated	Reduces impacts to the public from mine-related traffic on State Route 83 during peak traffic hours.
Location	State Route 83.
Monitoring / Reporting Action	**Implementation:** Plan for delivery schedule would be developed and incorporated into the final MPO. **Effectiveness:** Record keeping of deliveries would include time of delivery; quarterly reporting of delivery information to ensure deliveries occurs outside of peak traffic hours.
Performance Criteria	**Implementation:** Delivery schedule plan is developed and incorporated into final MPO **Effectiveness:** Review of delivery records indicates that delivery traffic on SR 83 occurs outside peak traffic hours.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for conducting monitoring and reporting to the Forest Service. Forest Service is responsible for spot checking monitoring activities; and for evaluating monitoring results to determine compliance with final MPO.
Timing	**Implementation and Effectiveness:** Pre-mining through final reclamation.

MITIGATION MEASURE	RC-TA-02 - Provide public access to Rosemont Copper private lands not affected by mine operations through the Arizona Game and Fish Cooperative Landowner incentive program
Description	Rosemont would enter into the Cooperative Landowner incentive program to allow some public access to portions of their private lands.
Source	Rosemont Copper.
Impacts Mitigated	Reduction of loss of public access.
Location	To be determined.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Arizona Game and Fish would work with Rosemont Copper to identify location and specifics of allowable use.
Performance Criteria	**Implementation and Effectiveness:** To be determined by Arizona Game and Fish and Rosemont.
Responsible Party	**Implementation and Effectiveness:** Rosemont Copper in cooperation with Arizona Game and Fish.
Timing	**Implementation and Effectiveness:** To be determined by Arizona Game and Fish and Rosemont.

MITIGATION MEASURE	RC-TA-03 – Restore public access over the Santa Rita Mountains through Lopez Pass
Description	Rosemont Copper has expressed an interest in reestablishing an east-west road over the Santa Rita Mountains through Lopez Pass and private land after mining, which may include a permanent public access easement. It is noted that such an easement would take place post-closure and stipulations would be agreeable to both Rosemont Copper and the Forest Service.
Source	Rosemont Copper.
Impacts Mitigated	Potentially reduces loss of public access post-mining by connecting the primary access road to the utility maintenance road, and providing a permanent public access easement across Rosemont Copper private lands.
Location	Road over Lopez Pass.
Monitoring / Reporting Action	**Implementation:** Notification when road is reestablished. **Effectiveness:** N/A
Performance Criteria	**Implementation:** Through route from the project area over Lopez Pass is reestablished after mining activities are completed. A permanent public access easement is established and recorded. **Effectiveness:** Public access is allowed.
Responsible Party	**Implementation and Effectiveness:** Rosemont.
Timing	**Implementation and Effectiveness:** Post-closure, when public travel through the project area is safely allowed.

Fire and Fuels

MITIGATION MEASURE	RC-FF-01 – Allow access to a new water source for firefighting efforts
Description	Rosemont Copper has stated they would allow Arizona State Land Department personnel to access the water fill station at #2 booster pump station for firefighting purposes. The #2 booster pump station is located along the water supply pipeline.
Source	Rosemont Copper.
Impacts Mitigated	Potentially reduces impacts from wildfire, particularly on and near the Santa Rita Experimental Range, by providing a new water source to firefighting agencies.
Location	Water line booster pump station #2.
Monitoring / Reporting Action	**Implementation and Effectiveness:** Arizona State Land Department and Rosemont would enter into agreement to construct pump station that accommodates access by firefighter agencies. This is an agreement between Arizona State Land Department and Rosemont Copper. No Forest Service or other agency monitoring would occur.
Performance Criteria	**Implementation and Effectiveness:** Arizona State Land Department and Rosemont.
Responsible Party	**Implementation and Effectiveness:** Arizona State Land Department and Rosemont.
Timing	**Implementation and Effectiveness:** From the time this facility is constructed through final reclamation.

Cultural Resources

MITIGATION MEASURE	RC-CR-01 - Rosemont acquisition of other lands with similar vegetation, with conservation easements, for use by the public and tribes
Description	This involves acquiring other lands or restrictive easement that could off-set losses to the public and tribal members.
Source	Ongoing negotiations between Rosemont Copper and Tribes.
Impacts Mitigated	Partial compensation of loss of public land for tribal and public use.
Location	Within 100 miles of project area; exact location to be determined.
Monitoring / Reporting Action	Acquisition of land and recording of conservation easements.
Performance Criteria	Acreage and vegetation comparable to the public land removed by the project from public and tribal use.
Responsible Party	Rosemont.
Timing	Within a number of years from commencement of project operations, as agreed in ongoing negotiations.

Power Use

MITIGATION MEASURE	RC-PU-01 - Use alternative methods of power generation such as solar and wind to augment power at the mine administration building
Description	Rosemont has stated their intent to use alternative energy sources to augment electrical power for their mine administration building.
Source	This is a design feature from the preliminary MPO.
Impacts Mitigated	Reduction in electric power use from TEP.
Location	Administration building.
Monitoring / Reporting Action	**Implementation:** Inspection during construction of administration building to ensure that it includes solar or wind power. **Effectiveness:** Semi-annual report to ensure that alternative energy sources are continuing to function.
Performance Criteria	**Implementation and Effectiveness:** Monitoring would focus on ensuring that facilities include alternative energy sources in compliance with the NEPA decision.
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for following through on their commitment to purchase and install alternative power generating equipment for administration building.
Timing	**Implementation and Effectiveness:** Pre-mining, active mining, and final reclamation and closure phases when the alternative power sources are operational.

Community Programs

MITIGATION MEASURE	RC-CP-01 – Establishment of the Santa Rita Mountains Community Endowment Trust, for the purposes of funding priority community projects
Description	Rosemont Copper intends to establish the Santa Rita Mountains Community Endowment Trust, for the purposes of funding priority community projects that include community recreation, cultural, and environmental conservation. The endowment would comprise assets, commitments, and funding from Rosemont Copper, including conservation easements and restrictive covenants donated in the first year of production ($6 million), $500,000 contributed from Rosemont Copper each year for 25 years ($12.5 million), and up to $25 million in variable contributions from Rosemont Copper, based on the price of copper (Rosemont Copper Company 2010). Because the Trust would be established as an independent charitable trust, with a Board of Trustees and Advisory Council, the projects that the Trust would fund would be decided at a later date, upon the board's specific decisions.
Source	This is a design feature from the preliminary MPO.
Impacts Mitigated	Compensation for cultural, environmental and recreation impacts.
Location	N/A
Monitoring / Reporting Action	**Implementation and Effectiveness:** N/A
Performance Criteria	**Implementation and Effectiveness:** N/A
Responsible Party	**Implementation and Effectiveness:** Rosemont is responsible for establishing Endowment Trust, and funding such trust.
Timing	**Implementation and Effectiveness:** Unknown