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In Reply Refer to:
AESO/SE
22410-2009-F-0389R1

April 28, 2016

Kerwin Dewberry, Forest Supervisor
Coronado National Forest
300 West Congress Street
Tucson, Arizona 85701

RE: Amended Final Reinitiated Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona

Dear Mr. Dewberry:

Thank you for your May 25, 2015, letter, which transmitted your May 2015 *Third Supplement to the Biological Assessment for the Rosemont Copper Project* (SBA). Your letter and the SBA were received by us via electronic mail on the same date, and together they constitute a request to reinitiate formal interagency consultation and conference pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act) on our October 30, 2013, *Final Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona* (October 2013 BO).

Your May 25, 2015, letter and SBA include determinations that the proposed action may affect, and will likely adversely affect, the threatened Chiricahua leopard frog (*Lithobates chiricahuensis*) (with critical habitat), the threatened northern Mexican gartersnake (*Thamnophis eques megalops*) (with proposed critical habitat), the endangered desert pupfish (*Cyprinodon macularius*), the endangered Gila chub (*Gila intermedia*) (with critical habitat), the endangered Gila topminnow (*Poeciliopsis occidentalis occidentalis*), the endangered jaguar (*Panthera onca*) (with critical habitat), the endangered ocelot (*Felis pardalis*), the endangered lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) (with critical habitat), the threatened western yellow-billed cuckoo (*Coccyzus americanus*) (with proposed critical habitat), the endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) (with critical habitat), and the endangered Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). Your May 2015 SBA also includes the

determinations that the proposed action: (1) may affect, but is not likely to adversely affect the threatened Mexican spotted owl (*Strix occidentalis lucida*) or its critical habitat; and (2) have no effect on the nonessential experimental population of the Mexican gray wolf (*Canis lupus baileyi*).

This final biological and conference opinion (BO) is based on information provided in: (1) your May 2015 SBA; (2) your May 2015 *Supplemental Information Report, Rosemont Copper Project* (SIR); (3) Rosemont Copper's September 26, 2014 *Habitat Mitigation and Monitoring Plan, Permit No. SPL-2008-00816-MB* (HMMP); (3) your December 2013, *Final Environmental Impact Statement* (FEIS) for the Rosemont Copper Project; (4) our October 30, 2013, Final BO; (5) your February 2013 *Supplement to the Biological Assessment – Proposed Rosemont Copper Mine - Santa Rita Mountains, Pima County, Arizona - Nogales Ranger District* (Second Supplemental BA); (6) your October 2012 *Supplement to the Biological Assessment, Proposed Rosemont Copper Mine, Santa Rita Mountains, Arizona, Coronado National Forest* (First Supplemental BA); (7) the results of discussions and exchanges of scientific information between our respective agencies, other Federal, State, and local agencies, the Rosemont Copper Company (Rosemont), and consultants; and (8) other published and unpublished sources of information. Literature cited in this biological opinion is not a complete bibliography of all literature available on the threatened and endangered species at issue, the effects of the action on those species and their critical habitats, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at this office.

The U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) published a Final Rule on February 11, 2016 (81 FR 7214), revising the definition for destruction or adverse modification of critical habitat in the Act's implementing regulations at 50 CFR 402.02. Specifically, we finalized the following regulatory definition: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." This revised definition will be applied to the applicable critical habitat analyses in this consultation and supersedes the November 30, 2015, Draft BO's reliance 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), which we used, at that time, to complete our analyses with respect to critical habitat.

Furthermore, FWS and NMFS published a Final Rule on May 11, 2015 (80 FR 26832- 26845), amending the incidental take statement provisions of the implementing regulations for section 7 of the Act (50 CFR 402.02 and 402.14) to: (1) to refine the basis for development of incidental take statements for programmatic actions; and (2) address the use of surrogates to express the amount or extent of anticipated incidental take. The subject action is site-specific, not programmatic; therefore, the former amendment is not applicable. The latter amendment, however, is directly relevant to this consultation. We note that our October 2013 BO on the subject action already incorporated surrogate measures of take for affected species, and this practice has been implemented in this biological opinion as well.

Lastly, in reaching our findings that there is a reasonable certainty that lesser long-nosed bat,

Chiricahua leopard frog, northern Mexican gartersnake, Gila chub, Gila topminnow, desert pupfish, jaguar, ocelot, western yellow-billed cuckoo, and southwestern willow flycatcher, 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

October 30, 2013: We transmitted the Final Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona (File Number 22410-2009-F-0389) to you. The October 30, 2013, Final BO concluded that the then-proposed action would not jeopardize the Gila chub (*Gila intermedia*), Gila topminnow (*Poeciliopsis occidentalis occidentalis*), Huachuca water umbel (*Lilaeopsis schaffneriana* subsp. *recurva*), southwestern willow flycatcher (*Empidonax traillii extimus*), Chiricahua leopard frog (*Lithobates chiricahuensis*), lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), jaguar (*Panthera onca*), ocelot (*Leopardus pardalis*), and Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). We also concluded that the proposed action would not destroy or adversely modify the critical habitat for Gila chub, Huachuca water umbel, southwestern willow flycatcher, Chiricahua leopard frog or, in conference, the jaguar's proposed critical habitat. We further concurred with your determination that the proposed action was not likely to adversely affect the Mexican spotted owl (Strix occidentalis lucida) or its critical habitat. The then-proposed northern Mexican gartersnake (*Thamnophis eques megalops*) and yellow-billed cuckoo (*Coccyzus americanus*) were not included in conference.

December 13, 2013: You published your Final Environmental Impact Statement (FEIS) for the proposed action. The FEIS was accompanied by the *Draft Record of Decision and Finding of Nonsignificant Forest Plan Amendment for the Rosemont Copper Project* (ROD); the proposed action is not final unless and until the ROD is signed.

March 5, 2014: We published a Final Rule designating critical habitat for the jaguar (79 FR 12572).

March 5, 2014: We participated in a conference call with your staff and staff of the Environmental Protection Agency (EPA) regarding substantive differences in the hydrologic analyses found in the FEIS and the hydrology that formed the basis of many of the effects analyses in our October 30, 2013, BO.

March 21, 2014: We participated in a meeting with your staff as well as the EPA to discuss the differences in the hydrology disclosed in the FEIS and that used for the analysis in the October 13, 2103, BO. This meeting precipitated the eventual formation of a hydrology working group composed of members of your staff, Federal and County agencies, and consulting scientists.

May 16, 2014: We transmitted a letter to you with respect to the need to reinitiate formal consultation on the proposed action (File Number 22410-2009-F-0389). We stated that reinitiation was warranted due to: (1) substantive differences in the effects analysis in the October 30, 2013, Final BO and the impact analysis in the FEIS; (2) the listing of additional species not considered in the initial consultation; (3) adoption of conference; and (4) the detection of an ocelot within the action area.

May 28, 2014: We attended a meeting with your staff wherein we were informed that you would be preparing a Supplemental Information Report (SIR) in order to evaluate new information and changed conditions that had come to your attention. Meetings associated with the SIR and revised BA process occurred semi-regularly from this date until shortly before the Draft SIR was transmitted (see below).

July 8, 2014: We published a Final Rule listing the northern Mexican gartersnake as a threatened species (79 FR 38678).

October 3, 2014: We published a Final Rule listing the western yellow-billed cuckoo as a threatened species (79 FR 59992).

November 24, 2014: We received the September 26, 2014, HMMP from WestLand Resources, Inc. (WestLand), consultants for the Rosemont Copper Company.

March 1, 2015: We received your draft February 2015 *Supplemental Information Report - Rosemont Copper Project* (Draft SIR).

March 10, 2015: We transmitted an electronic mail to your staff indicating that consultation on the effects of the proposed action was not necessary for the non-essential, experimental population of Mexican grey wolf.

March 25, 2015: We transmitted our *Review of the Draft February 2015 Supplemental Information Report - Rosemont Copper Project* (Draft SIR Review) (File Number 22410-2009-F-0389).

May 22, 2015: We received the final version of your May 2015 SIR.

May 25, 2015: We received your request for reinitiation of formal consultation, accompanied by the May 2015 SBA.

May 28, 2015: We received correspondence from the U.S. Army Corps of Engineers (Corps) requesting that we consider the September 26, 2014, HMMP in this consultation.

June 22, 2105: We transmitted a letter (File Number 22410-2009-F-0389-R001) to you stating that we had reviewed the May 2015 SBA and determined that all information required of you to initiate formal consultation required by the regulations governing section 7(a)(2) interagency consultation at 50 CFR §402.14 had been provided. Our letter also provided notice that, pursuant to section 7(d) of the Act, you were not to make any irreversible or irretrievable commitment of resources which would have the effects of foreclosing the formulation or implementation of any reasonable and prudent alternative measures which would not violate section 7(a)(2) and would avoid jeopardizing the continued existence of endangered or threatened species or destroying or adversely modifying their critical habitats. We concluded by stating that we anticipated providing you with a draft BO by August 23, 2015, a final BO by October 7, 2015, and indicating that a request for an extension was likely.

August 18, 2015: We transmitted a written request for a 60-day extension, revising the Draft BO due date to October 22, 2015, and the Final BO due date to December 6, 2015.

September 11, 2015: We received your letter granting the 60-day extension we requested on August 18, 2015.

October 16, 2015: Based on agreements made during an October 14, 2015, meeting with you, Corps staff, and representatives of the Rosemont Copper Company and HudBay Minerals, we transmitted a written request for an additional 30-day extension, this time revising the Draft BO due date to November 30, 2015, and the Final BO due date to January 22, 2016.

November 30, 2015: We transmitted our Draft Reinitiated Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona (File Number 22410-2009-F-0389R1) to you and the Corps.

December 4, 2015: We receive a telephone call from the FS noting jurisdictional issues related to the November 30, 2015, Draft BO.

December 14, 2015: We received a copy of correspondence between Rosemont and your agency detailing concerns and comments on the November 30, 2015, Revised Draft BO, including; (1) question with respect to the methodologies used to calculate effects to threatened and endangered species; and (2) issues regarding the FS jurisdiction with respect to the Reasonable and Prudent Measures.

December 21, 2015: We received a copy of correspondence between Rosemont and your agency containing specific comments on the November 30, 2015, Revised Draft BO.

December 21, 2015: We transmitted a letter that documented the progress and agreements made during the December 2015 meetings and establishing revised timelines for the transmittal of a Revised Draft BO (January 22, 2016) and a Final BO (February 26, 2016).

December 16, 2015 to January 29, 2016: Your biological resource staff coordinated review comments and revisions with FWS species lead biologists. In addition, potential conservation measures to offset take were discussed with Rosemont Copper Company and your staff. The proceedings of these efforts are contained in our administrative record.

January 8, 2016: We transmitted a preliminary version of the Revised Draft BO to you and the Corps.

January 22, 2016: We received an electronic mail from your staff transmitting the Rosemont's January 20, 2015, proposed Conservation Measures offered in lieu of certain aquatic and riparian species' Terms and Conditions appearing in the November 30, 2015, Draft BO.

February 1, 2016: We received your comments on the Reasonable and Prudent Measures, Terms and Conditions, and Conservation Recommendations for the threatened and endangered species analyzed in the January 22, 2016, Draft BO.

February 3, 2016: We met with your staff, SWCA, Rosemont, and WestLand to discuss the contents of the January 22, 2016, Draft BO.

February 5, 2016: We received your preliminary technical comments on the November 30, 2015, Draft BO for consideration in the Revised Draft BO.

February 6, 2016: We received an electronic mail message from Fennemore Craig, outside legal counsel to Rosemont, transmitting a December 21, 2015, review of the November 30, 2015, Draft BO.

February 9 and 11, 2016: Our respective staffs, SWCA, Rosemont, and WestLand participated in workshops to clarify the effects analyses in the January 22, 2016, Draft BO and to discuss the development of Conservation Measures.

February 10, 2016: We received an electronic mail message from SWCA, Inc. staff, transmitting suggested edits to the Sources of Uncertainty subsection of the Effects to Aquatic Ecosystems section.

February 11, 2016: We received a courtesy copy of a letter from Rosemont to the Coronado NF in which Rosemont's draft proposed Conservation Measures in lieu of aquatic and riparian species Terms and Conditions were described.

February 16, 2016: We received WestLand's letter containing detailed comments on the use of groundwater model predictions used in the November 30, 2015, Draft BO; comprehensive

comments on the overall content of the BO; and information regarding yellow-billed cuckoo habitat along Davidson Canyon and Cienega Creek.

February 18, 2016: We received a detailed description of the Sonoita Creek Ranch conservation measure and detailed information regarding our jaguar effects analysis from WestLand. Due to internal FWS electronic mail difficulties, an additional copy was provided on February 18, 2016.

February 23, 2016: We transmitted an electronic mail message to you containing our input on the February 11, 2016, draft Conservation Measures.

February 24, 2016: We received a copy of a letter you transmitted to Rosemont. Your letter included suggested revisions to Rosemont's February 11, 2016, Conservation Measure letter.

February 24, 2016: We received a courtesy copy of a letter from Rosemont to the Coronado NF in which the final proposed Conservation Measures were described (Rosemont 2016a).

March 3, 2016: We transmitted a Revised Draft BO to you.

March 8, 2016: Our staffs discussed, via telephone and electronic mail, specific comments related to conservation measures and the treatment of climate change as a component of baseline conditions in the Revised Draft BO.

March 10, 2016: We received Rosemont's comprehensive comments on the March 3, 2016, Revised Draft BO via electronic mail.

March 15, 2016: We received your initial, technical comments on the March 3, 2016, Revised Draft BO.

March 17, 2016: We received written comments from the Corps via electronic mail.

March 18, 2016: We received, via electronic mail, a written commitment by Rosemont to pursue conservation measures at Sonoita Creek Ranch and other sites regardless of Corps' ultimate determination regarding its wetland mitigation value. The full implementation of such conservation measures was stated to be contingent on receipt of a Department of the Army (Clean Water Act section 404) Permit form the Corps and approval of a Final Mine Plan of Operations from your agency. The latter action is the ultimate result of your approval of the proposed action (Rosemont 2016b).

March 25, 2016: We received, via electronic mail, your substantive comments on the March 3, 2016, Revised Draft BO as well as your review of Rosemont's March 10, 2016, comprehensive comments.

April 22, 2016: We transmitted our Final BO to you via electronic mail.

April 27, 2016: We received your additional comments on our April 22, 2016 Final BO via electronic mail.

April 28, 2016: We transmitted this amended Final BO to you via electronic mail. The amended Final BO addressed your April 27, 2016, comments to the extent we determined was appropriate; incorporated additional text with respect to the status of the respective draft recovery plans for the Huachuca water umbel and Pima pineapple cactus; and included refinements to the reach-scale acreages of affected riparian habitat in the yellow-billed cuckoo and southwestern willow flycatcher analyses.

BIOLOGICAL OPINION

Description of the Proposed Action

The proposed action, known as the Barrel Alternative (including the proposed conservation measures), was described in detail in the October 30, 2013, BO, and is incorporated herein via reference, with the exception of the changes (to both the proposed action and conservation measures) described below.

The May 2015 SBA employs both the terms *project area* and *action area.* The term project area is defined as all areas in which any ground disturbance would take place as a result of the proposed project, the Barrel Alternative (i.e., the preferred alternative, chosen by the Coronado National Forest Supervisor), including the mine pit, waste rock piles, tailings, access roads, utility corridors, and onsite facilities (i.e., the mine "footprint"). The project area acreage, expected to result in direct impacts owing to project activities, is 5,431 acres.

The May 2015 SBA defined the action area as the project area *plus* a larger, surrounding area that may experience direct or indirect temporal and spatial impacts from the project. This corresponds well with the action area definition appearing in the *Endangered Species Consultation Handbook* (FWS and National Marine Fisheries Service 1998), which is: [all] areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

Temporally, the potential onsite and offsite impacts resulting from the proposed project encompass all the activities associated with mine construction, operation, reclamation, and postclosure, as well as conservation measures. 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). Thus defined, the action area totals approximately 146,163 acres, including the project area. The action area is located primarily in Pima County but also encompasses a small portion of Santa Cruz County; 65,289 acres are on Forest Service and Bureau of Land Management (BLM) lands, and the remaining 80,874 acres within the action area are on Arizona State Land Department State Trust land and private land. The methodology for determining the action area was discussed in the January 2012 deliberative *Draft Biological Assessment, Rosemont Copper Project, Santa Rita Mountains, Nogales Ranger District*, and subsequently refined in the October 2012 SBA and February 2013 SBA.

The acreages of the project and action areas are based on those found in the FEIS where the action area for purposes of Section 7 consultation is equivalent to the biological analysis area delineated for purposes of the National Environmental Policy Act (NEPA) process, and these acreages have changed since they were last mentioned in the October 2012 SBA based on refinements to the number of acres disturbed in the project area for utility line corridors and Forest Service road creation and decommissioning. The project area is 64 acres larger in the FEIS than in the October 2012 SBA (an approximately 1 percent change); the action area is 37 acres larger in the FEIS than in the October 2012 SBA (an approximately 0.03 percent change). Table 1 shows the updated breakdown of impacts as described in the FEIS.

Table 1 (adapted from Table 1 in the May 2015 SBA): Directly affected acreage in the project area by disturbance element.

Disturbance Element	Direct Effect (acres disturbed)
Security fence disturbance area – all area within security fence	4,228
Primary access road corridor - 600 feet wide to allow for designed cut areas (outside security fence)	226
Utility line corridor –500 feet wide for transmission with others co-located – water line and utility maintenance road – 150-foot corridor where not within transmission line, except for the designated 30- to 40-foot easement or ROW (outside security fence)	899
Road disturbance– outside security fence New Roads – 100 feet wide; Decommissioned Roads – 14 feet wide	39 20
Arizona National Scenic Trail – 8 feet wide trail plus trailheads	19
Total Disturbance Area (acres)	5,431

For the purpose of section 7 consultation, the action area also includes lands proposed for acquisition (or already acquired) and areas in which conservation measures will be implemented (see Table 2, below).

The action area includes 4,827 acres in which land acquisition-based conservation measures (see below) will be implemented, including: Sonoita Creek Ranch (1,580 acres); and the Davidson Canyon (545 acres), Helvetia Ranch Annex North (939 acres) and Fullerton Ranch (1,763) parcels.

We have also anticipated that no less than 31 acres of hydroriparian habitat will be restored at a to-be-determined location (see Table YBCU-6 and its supporting narrative in the effects analyses for the yellow-billed cuckoo, below) in association with implementation of Revised Conservation Measure 3 – Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management. Once site selection for this riparian restoration is complete, the parcel(s) will be included in the action area.

The action area also includes National Forest System lands on the Sierra Vista Ranger District of the Coronado National Forest in which a portion of Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal will be implemented to benefit the Huachuca water umbel (see effects analysis, below). Based on the taxon's occurrences (which are larger than the actual area occupied by plants; again, see the effects analysis for details), we anticipate that 538 acres of land encompassing the Sunnyside (125 acres); Turkey Creek (45 acres); Bear/Lone Mountain (107 acres); Scotia (189 acres); O'Donnell (10 acres); Sycamore (8 acres); and Cave Creek (46 acres) Huachuca water umbel occurrences will be affected.

The action area also conceptually includes portions of the San Rafael Valley and the Huachuca and Patagonia mountains, necessitated by the eventual implementation of Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal to benefit the northern Mexican gartersnake, Chiricahua leopard frog, Gila chub, Gila topminnow, and desert pupfish (see the respective effects analyses, below). There are no definitive acreage values for the portion of Revised Conservation Measure 2 for these vertebrate species, but future unanticipated effects will be analyzed and evaluated within the framework of this Final Biological Opinion prior to implementation.

Table 2: Acreage affected directly and indirectly by the implementation of off-site Conservation Measures (i.e. not within the action area defined by adverse effects in Table 1, above).

Conservation Measure	Effect (acres)
Sonoita Creek Ranch	1,580
Davidson Canyon	545
Helvetia Ranch Annex North	939
Fullerton Ranch	1,763
Revised Conservation Measure 3 (Hydroriparian Habitat Enhancement)	≥ 31
Revised Conservation Measure 2 (Harmful Nonnative Species Management and Removal to benefit Huachuca water umbel)	538
Revised Conservation Measure 2 (Harmful Nonnative Species Management and Removal to benefit vertebrate species)	TBD
Total Disturbance Area	≥ 5,396

Summary of Other Sources of New Information

The May 2015 SBA is only the most recent document considered in this BO. The May 2015 SBA is additive to the SIR, June 2012 BA, October 2012 SBA, and February 2013 SBA (see the Consultation History in our October 30, 2013 BO).

Much of the information that has changed subsequent to our October 30, 2013, BO is related to changes in the on-the-ground and/or listing status for threatened and endangered species, including the yellow-billed cuckoo, northern Mexican gartersnake, Chiricahua leopard frog, Mexican gray wolf, jaguar, and ocelot. The new information appears in these species' respective Status of the Species and/or Environmental Baseline sections.

New documents—primarily from the Bureau of Land Management (BLM), Pima County, and FWS, but also including the final report for the Frog and Fish Restoration Outreach Group Conservation Project (FROG Project), occurrence records from University of Arizona wildlife cameras, and new species-specific surveys conducted in the action area—have changed the baseline for some of the species within the action area, adding new documented occurrences and in some cases providing new trend analyses. The new information also appears, as appropriate, in the respective Status of the Species and/or Environmental Baseline sections.

Lastly, we reiterate that the proposed conservation measures described in the October 30, 2013, Final BO remain part of the proposed action. They are incorporated here by reference, except as noted below or as modified by Reasonable and Prudent Measures and Terms and Conditions for species incidentally taken by implementation of the proposed action.

U.S. Army Corps of Engineers Habitat Mitigation and Monitoring Plan

The U.S. Army Corps of Engineers' (Corps) September 2014 Habitat Mitigation and Monitoring Plan (HMMP) contains the Rosemont Copper Company's proposed mitigation to offset impacts to Waters of the United States. The HMMP post-dates the October 30, 2013, BO, and was therefore not specifically analyzed. Our initial BO did, however, include analyses of various mitigation sites proposed in varying levels of detail by the Rosemont Copper Company.

Our analysis of HMMP implementation appears here as a separate section, but we recognize that its implementation is relevant to both the preceding Effects to Aquatic Ecosystems and Effects to Riparian Ecosystems sections, as well as to effects analyses individual threatened and endangered species.

The HMMP must be approved by the Corps as part of the proponent's pursuit of a Department of the Army Permit (also referred to as a Clean Water Act Section 404 Permit). We note, as stated in Rosemont's March 18, 2016, letter (see Consultation History, above) (Rosemont 2016b), that implementation of the conservation measures within the HMMP is contingent on both the issuance of a permit by the Corps as well as your approval of a Mine Plan of Operations. The March 18, 2016, letter concludes, in part, by stating "…we will record appropriate conservation easements to ensure the protection of resources and future conservation value of these properties, regardless of whether a particular parcel is accepted as mitigation by the Corps." We thus consider that implementation of all aspects of the HMMP relevant to threatened and endangered species is reasonably certain to occur.

We are also aware that the ecosystem restoration proposed for the Sonoita Creek Ranch may involve its own impacts to Waters of the United States thus likely to require additional Corps permitting prior to implementation. Given the likely presence of threatened and endangered species on the Sonoita Creek Ranch property, it may also require section 7 consultation.

Several components of the proposed Section 404 mitigation have changed since they were discussed in the previous BA and SBAs. These include additional acreage and a more-detailed restoration design at Sonoita Creek Ranch, and the incorporation of additional acreage on the Davidson Canyon parcels. The Fullerton Ranch parcel represents a new conservation measure in

terms of section 7 consultation; it appeared in the May 2015 SBA and thus was not analyzed in the October 30, 2013 BO.

All descriptions of proposed mitigation stated in the June 2012 BA, February 2013 SBA, and October 30, 2013 BO are incorporated by reference, as are the contents of the February 24, 2016 and March 18, 2016 Rosemont letters (Rosemont 2016a and 2016b, respectively). The following subsections describe changes to those prior descriptions.

Lastly, it must be noted that HMMP-related actions are considered conservation measures for effects to threatened and endangered species as an adjunct their primary intended purpose as Clean Water Act mitigation measures. Further, their status as both proposed conservation measures and as a part of the Federal action undertaken by the Corps means that the parcels are part of the action area for this consultation.

Sonoita Creek Ranch

There are two substantive changes to this mitigation component as analyzed in the FEIS and October 30, 2013 BO; (1) the acreage to be enhanced has increased from 1,200 acres to 1,580 acres; and (2) a detailed restoration plan has been prepared (see below). We note in advance that the beneficial effects described in this section represent the intentions of the Proponent (Rosemont Copper), and are not to be considered effects analyses. The respective Effects of the Proposed Action sections for the species mentioned herein represent our definitive findings on proposed conservation measures' effects.

The Sonoita Creek Ranch Conservation Measures appearing below were received by us on February 24, 2016 (see Consultation History, above) (Rosemont 2016a) , after having been revised based on the input of the U.S. Army Corps of Engineers (Corps), with additional clarifying text provided by USFS and FWS.

1. Rosemont has acquired the right to purchase Sonoita Creek Ranch, which contains approximately 1,580 acres of land along Sonoita Creek with an estimated 590 acre-feet per annum (AFA) of certificated surface water rights from Monkey Spring along Sonoita Creek. The Sonoita Creek Ranch parcel is part of the intended Conservation Measures for the northern Mexican gartersnake, Chiricahua leopard frog, Gila chub, Gila topminnow, Huachuca water umbel, lesser long-nosed bat, jaguar, ocelot, and yellow-billed cuckoo. The Sonoita Creek Ranch lands will be restored by Rosemont to a more natural condition from the current agricultural state. These restoration activities have been designed to meet, in part, the requirement to mitigate for impacts to potential waters of the U.S., in conformance with the Corps' 2008 mitigation rule (73 FR 19594). Regardless of whether the Sonoita Creek Ranch restoration activities ultimately provide mitigation for impacts to potential waters of the U.S., Sonoita Creek Ranch will be managed for conservation purposes, as stated below.
2. In the event that the property is approved for potential waters of the U.S. mitigation, it is not anticipated that the wildlife conservation benefits described below will be affected. If modification of any conservation measure is ultimately determined to be required, Rosemont will propose a modification for review and comment by the Corps and USFS to modify the conservation measures in a manner that would not change the evaluation for each species and

which would result in the same benefits for each species but would not conflict with Section 404 mitigation requirements.

3. Rosemont will record a restrictive covenant (as stated in the HMMP) or conservation easement (started in Rosemont's March 16, 2016 letter) 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 described below. This restrictive covenant shall not restrict access to these lands for recreational or traditional cultural purposes provided that these uses are not incompatible with the conservation uses of the property as determined by the Corps, FWS, and Land Manager (if the latter is designated). Also note that a Restrictive Covenant won't involve a Land Manager as a Conservation Easement does, but the Restrictive Covenant approach will allow Rosemont Copper to convey the property to a conservation agency with Corps approval. Prior to such conveyance, Rosemont would be the responsible party. In addition, it is in the Corps' purview to determine and negotiate allowable uses; current Corps requirements preclude off road vehicles, horseback riding, biking, hunting or fishing.
4. Rosemont anticipates transferring ownership of Sonoita Creek Ranch, including the appurtenant water rights, to a suitable owner for conservation purposes consistent with the conservation and public benefits contemplated by these conservation measures. The transfer of ownership will follow Rosemont's demonstration to the Corps that the success criteria for mitigation of impacts to potential waters of the U.S. have been met.
5. Funding for long-term management will be accomplished through the establishment of both a wasting and non- wasting endowment(referred to as the Dedicated Accounts) subject to approval by the Corps . Rosemont will pay into that account adequate funds to cover the normal long-term management and maintenance activities. Establishment of the long-term wasting and non-wasting accounts shall be in accordance with 33 CFR 332.7 (d). Until the Dedicated Account is fully funded, Rosemont shall provide all funds necessary to conduct required annual management, maintenance, and monitoring activities. Prior to the time that the Dedicated Account is fully funded, the monies from the Dedicated Account will not be used for any management, maintenance, or monitoring activities. Fence replacement actions completed during the Dedicated Account establishment period will be funded by Rosemont with funds other than the funds used to establish the Dedicated Account. An alternative financial assurance mechanism to that described above may be utilized if approved in advance by Rosemont and the Corps. Please note that this funding is distinct from, and cannot be co-mingled with, the amounts described in Revised Conservation Measures 1, 2, and 3.
6. Restoration activities to be implemented at Sonoita Creek Ranch are as described below. Rosemont will fund the construction of the restoration project. Additional detailed information is located in the Rosemont Copper Project: Revised Habitat Mitigation and Monitoring Plan (September 26, 2014).

    a. Re-establish Sonoita Creek floodplain. Sonoita Creek has been altered over much of its length along State Route 82 between Sonoita and Patagonia to accommodate the highway, smaller access and private roads, and agricultural and ranching developments in the valley. Alterations include realigning, straightening and deepening the channel (or berming its banks) to prevent flows from impinging upon roads and fields. The altered reaches confine flows to a high-capacity channel that maximizes flow velocity and

exacerbates both incision and bank instability through scour and degradation. In some places Sonoita Creek's realignment has left tributary inflows without a clear path to a confluence with Sonoita Creek.

As part of the site restoration efforts, Rosemont will construct a minimum of 3.8 miles of new ephemeral channel through historic agricultural fields in order to direct a portion of Sonoita Creek flows back into the Sonoita Creek historic floodplain. The construction of these channels will also allow for the rehabilitation of approximately 5.7 miles of the existing Sonoita Creek channel by directing high flows into the parallel, meandering constructed channels, reducing the volume and velocity of degrading high flows through the primary channel. Channel improvements are intended to result in a more stable channel, which would enhance multiple ephemeral channel functions, including energy dissipation, sediment transport, and habitat connectivity.

The agricultural fields will be retired, recontoured, and reseeded with a mix of native forbs, grasses, shrubs, and trees. In addition, approximately 8,400 xeroriparian trees (anticipated to be mostly *Prosopis velutina*) will be planted along the slopes and adjacent floodplain of the constructed channels to facilitate the development of a xeroriparian corridor within the entirety of the Sonoita Creek floodplain. The intended success of this restoration effort can be seen in previously abandoned agricultural fields in portions of the ranch property, where mature stands of native mesquite have developed over the last 40 years. Downstream of the agricultural fields, Sonoita Creek flows will be restored to a portion of the relatively rare mesquite-sacaton grasslands already established at, and south of, the mouth of Corral Canyon. In addition, the Sonoita Creek Ranch restoration project intends to preserve a cottonwood gallery near the south end of the property.

The total area of restored floodplain within Sonoita Creek Ranch is approximately 730 acres, and is intended to provide substantial, landscape-scale habitat benefits to a number of wildlife species. In particular, planting, reseeding, and reestablishment of flood flows throughout the floodplain are intended to provide habitat for the western yellow-billed cuckoo.

b. Enhancement of two ponds. Two ponds at the north end of the Sonoita Creek Ranch property function as part of an agricultural irrigation system, supplied with water from Monkey Springs. The northernmost pond, which is higher in elevation, fills first and overflows into the lower pond. Overflow water from the lower pond is controlled by an existing structure that diverts water into the irrigation canal serving the agriculture fields. Both ponds are also plumbed at their downstream ends to facilitate draining for pond maintenance. Flow data collected over the last eight months show an average monthly flow volume of 16.2 million gallons of spring water reporting to the pond system; this is as-stated by Rosemont, FWS does not possess these data.

Rosemont will renovate the ponds with the intent to support recovery efforts for sensitive species, including, as appropriate, northern Mexican gartersnake, Chiricahua leopard frog, Gila chub, Gila topminnow, northern Mexican gartersnake, and Huachuca water umbel. The current configuration of the ponds, with relatively deep pools and open water,

supports sport fish and invasive bullfrogs. The final configuration of the ponds is still being developed, but it is anticipated that the ponds will be modified to allow for a passive flow-through system to keep the surface water from stagnating, and that infiltration of the pond water will be reduced through application of a wildlife-friendly chemical sealant. In addition, harmful non-native fish and wildlife species will be eradicated from the pond system and portions of the ponds will be made shallower and planted with native aquatic species, including willow trees (*Salix* spp.).

c. Establishment of pond overflow system. Surface water discharges from the downstream pond will report to a constructed channel that will ultimately discharge to the constructed channels in the Sonoita Creek floodplain, as previously described. Vegetation development along this channel is likely to be more mesic or hydroriparian in nature, given the anticipated flow- through system described above. Where feasible, this vegetation development will be supplemented with plantings.

d. Boundary fencing. Wildlife-friendly fencing will be installed to discourage use by cattle and encourage use by threatened and endangered species, including jaguars and ocelots. 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. The balance of fence repaired or replaced at Sonoita Creek Ranch will be wildlife-friendly four-strand wire fence built in accordance with Arizona Game and Fish Department standards.

7. Sonoita Creek Ranch is intended to be managed for conservation purposes to provide habitat and connectivity for the Jaguar and Ocelot between USFS administered lands in the Canelo Hills/Patagonia Mountains and the Santa Rita Mountains, 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 are intended not to 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.

Fullerton Ranch

Fullerton Ranch was included in the BA and October 2012 SBA as a voluntary mitigation measure, and is noted as having been withdrawn as a mitigation measure in the February 2013 SBA. It was thus not included in the October 30, 2013 BO. Fullerton Ranch was, however, proposed as a mitigation measure in the 2014 HMMP, was included as a proponent voluntary measure in the FEIS (see measure RC-BR-01 in appendix B of the FEIS), and was further refined by Rosemont's February 24, 2016 letter (see Consultation History, above), and will therefore be included in this BO.

Although no Chiricahua leopard frogs were observed at Fullerton Ranch in 2012, aquatic features do occur (WestLand Resources Inc. 2013). Therefore, the enhancements to the Fullerton

Ranch property could benefit Chiricahua leopard frogs and northern Mexican gartersnakes by increasing habitat and metapopulation connectivity near the action area. Preserving the existing agaves and saguaros, as well as any additional planting, on Fullerton Ranch could benefit lesser long-nosed bats by preserving and creating foraging habitat. Further, any species using the ephemeral wash or riparian buffer habitat (including the western yellow-billed cuckoo) may benefit by having higher quality habitat available in the region. We again note that these are the *intended* outcomes; the effects analyses section for these species represent our definitive findings regarding the mitigative value of Fullerton ranch.

1. The 1,763-acre Fullerton Ranch is located approximately 28 miles west of the Project site, within the Altar Valley, which is ultimately tributary to the Brawley Wash and the Santa Cruz River. The parcel is adjacent to the Marley Ranch Conservation Area, an 114,400-acre ranch that is under contract for purchase by Pima County in phases as a conservation area. The site sits at the western terminus of an identified wildlife corridor between the Santa Rita Mountains (the location of the Rosemont Project) and the Sierrita Mountains.
2. The Altar/Brawley Wash has experienced significant degradation due to historic overgrazing in the valley and adjoining uplands coupled with significant flood events, which have resulted in intensive erosion within the Altar/Brawley Wash and its tributaries. Fullerton Ranch, in the headwaters of Altar Valley, has been intensively overgrazed, and restoration activities at the site offer an opportunity to improve the overall watershed function within the Altar Valley.
3. Rosemont will record a restrictive covenant and possibly, a subsequent conservation easement, on the Fullerton Ranch Parcels that precludes grazing, real estate development and similar land use activities.
4. These parcels will be utilized for mitigation of impacts to potential waters of the U.S. as considered under the CWA Section 404 permit for the Rosemont Project. Restoration activities at these parcels are intended to result in the rehabilitation of an estimated 50 acres of potential waters of the U.S. and an additional 263 acres of associated xeroriparian buffer habitat.
5. Restoration activities to be implemented at Fullerton Ranch are as described below. Rosemont will fund the completion of the 404-mitigatory activities (which may have adjunct conservation benefits), which includes funding[1] for long-term management, as described for the Sonoita Creek Ranch mitigation parcel (see above). Additional detailed information is located in the HMMP.

    a. Boundary fencing. Wildlife-friendly fencing will be installed to discourage use by cattle and encourage use by threatened and endangered species. The fence repaired or replaced will be wildlife-friendly four-strand wire fence built in accordance with AGFD standards. Substantial restoration benefits may be realized by excluding domestic livestock grazing from intensively overgrazed landscapes like the one at Fullerton Ranch, with identifiable improvements to stormwater infiltration, peak flow discharges, and sediment yield.
    b. Physical improvements. Proposed physical manipulations of the landscape include: maintenance of a concrete dam; removal and revegetation of unnecessary roads; maintenance and modification of existing roads; gully repair; and removal of corrals and other infrastructure.

Davidson Canyon Parcels

The primary change to this mitigation component as analyzed in the FEIS and October 30, 2013, BO is that the acreage to be protected decreased from 574 acres in the October 30, 2013, BO to 545 acres in the 2014 HMMP, although the management will remain the same (see Rosemont letter of February 24, 2016 in Consultation History). These parcels will still be included as available land for the establishment of water features that may benefit species such as Chiricahua leopard frog, jaguar, ocelot, and northern Mexican gartersnake. The portions of jaguar designated critical habitat that occur within the Davidson Canyon parcels will be preserved because Davidson Canyon will be managed for long-term habitat protection as described in the FEIS and October 30, 2013, BO. We caution that the aforementioned benefits are the intended results of the conservation measure. The respective species effects analyses represent our official determinations regarding the Davidson Canyon Parcels.

1. Rosemont owns six parcels of land on the eastern side of the Santa Rita Mountains, containing approximately 545 acres of land with semidesert grassland and riparian habitat. Four of these parcels are within 2.5 miles of the Rosemont Project, and the other two sites are approximately five miles away. All share habitat similar to those within the Rosemont Project area. Prior to acquisition by Rosemont, four of these parcels were owned by a real estate developer and have value for development. They also have been identified by Pima County as having significant conservation potential.
2. Of these parcels, only Davidson Canyon 3 will be utilized for mitigation of impacts to potential waters of the U.S. as considered under the CWA Section 404 permit for the Rosemont Project. Conservation of these parcels is intended to result in the preservation of an estimated 16 acres of potential waters of the U.S. and an additional 83 acres of associated xeroriparian buffer habitat. In addition, these parcels include three springs (Barrel Spring, Questa Spring, and an unnamed spring) and more developed riparian habitat downstream of Mulberry Spring, all of which will be preserved.
3. Wildlife-friendly fencing will be installed to discourage use by cattle and encourage use by threatened and endangered species. Fence that is repaired or replaced will be wildlife-friendly, four-strand wire fence built in accordance with AGFD standards.
4. Rosemont will record a restrictive covenant per the HMMP (and potentially, a subsequent conservation easement) on the Davidson Canyon Watershed Parcels that precludes grazing, real estate development and similar land use activities, as well as many recreational activities.
5. The Davidson Canyon Watershed Parcels (other than parcel 3, which lacks water features) will be included as available land for the establishment of water features beneficial to listed species and to provide general wildlife benefits.
6. 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.

Helvetia Ranch Annex North Parcels

There is no change to the Helvetia Ranch Annex North parcels as analyzed in the FEIS and

October 30, 2013 BO. Pima pineapple cactus will still benefit by having a Restrictive Covenant recorded to ensure long-term habitat protection, which may reduce the potential harm to Pima pineapple cactus or its habitat from grazing or real estate development. These parcels will still be included as available land for the establishment of water features that may benefit species such as Chiricahua leopard frog, jaguar, and ocelot (per Rosemont letter of February 24, 2016; see below). Note that water features are not a component of the HMMP. Again, our definitive effects analyses appear in the respective species' sections; the benefits stated below represent only the intended effects of the conservation measure

1. The Helvetia Ranch Annex North Parcels are comprised of approximately 939 acres located in the western foothills of the Santa Rita Mountains, immediately north of the proposed utility line and approximately 2.5 miles northwest of the proposed mine area. These parcels were secured from a real estate developer who was marketing them as an opportunity for a housing development, similar to other residential developments in the area (e.g. the Sycamore Canyon development). The Helvetia Parcels provide landscape-scale connectivity between the Santa Rita Experimental Range to the west and federal lands (BLM and the Coronado National Forest) to the east, and will provide conservation benefits for several federally listed species, including but not limited to the lesser long-nose bat and Pima pineapple cactus.
2. Rosemont will record a restrictive covenant or conservation easement on the Helvetia Ranch Annex North Parcels that precludes grazing, real estate development and similar land use activities as well as certain recreational activities.
3. These parcels will be utilized for mitigation of impacts to potential waters of the U.S. as considered under the CWA Section 404 permit for the Rosemont Project. Conservation of these parcels is intended to result in the rehabilitation of an estimated 39 acres of potential waters of the U.S. and enhancement of an additional 270 acres of associated xeroriparian buffer habitat.
4. Activities to be implemented at the Helvetia Ranch Annex North Parcels are as described below. Rosemont will fund[1] the completion of these conservation activities; funding for long-term management will be as described for the Sonoita Creek Ranch mitigation parcel (see Conservation Measure B.5). Additional detailed information is located in the Rosemont Copper Project: Revised Habitat Mitigation and Monitoring Plan (September 26, 2014).

    a. Boundary fencing. Wildlife-friendly fencing will be installed to discourage use by cattle and encourage use by threatened and endangered species. The fence repaired or replaced will be wildlife-friendly four-strand wire fence built in accordance with AGFD standards.
    b. Access road improvements. The wash crossings along the primary access road through the Helvetia Ranch Annex North Parcels are all at-grade crossings. Crushed limestone has been used to stabilize the roadways and this material has in some cases migrated downstream into the ephemeral channels. This material has the potential to create a natural crust, affecting the infiltration of stormwater and sediment transport. Rosemont will import aggregate base material that will be combined with the existing limestone material to create a more stable road bed as the limestone reacts with the fines in the AB

1 The activities described in the HMMP are proposed as mitigation actions and may or may not constitute conservation activities. Funding will need to be provided via an advance financial assurance and long term management wasting and non-wasting endowments.

to form larger cementitious particles. Lime-treated AB is common in construction for its stabilizing and strengthening properties. For maintenance, the road surface will be bladed and watered once or twice a year in order to mix the AB and lime material and continually stabilize the road.

c. Unnecessary road removal and revegetation. Rosemont will rip and reseed approximately 2.4 miles of infrequently used unpaved roadways within the Helvetia Ranch Annex North parcels. This effort is intended to improve stormwater runoff by reducing the degree of runoff concentration, thereby reducing onsite erosion and downstream sedimentation.

5. The Helvetia Ranch Annex North Parcels will be included as available land for the establishment of water features beneficial to listed species such as the Chiricahua Leopard Frog, jaguar, and ocelot and to provide general wildlife benefits; no specific proposals exist at this writing.
6. Preservation of the Helvetia Ranch Annex North Parcels is intended to serve as mitigation for impacts to Pima pineapple cactus.

Other Aquatic Resource Conservation Measures

In the May 2015 SBA, none of the aquatic resource conservation measures had changed substantially from what was analyzed in the FEIS and October 30, 2013 BO; the prior descriptions are incorporated herein by reference. The benefits of the Aquatic Resource Conservation Measures (i.e., Cienega Creek water rights transfer, Cienega Creek Watershed Conservation Fund, surface water features, and grazing management) will vary by species, and are described in the respective analyses.

Revised Conservation Measures

During the latter stages of our interagency consultation, we worked with your staff and Rosemont to develop Conservation Measures that would be implemented in lieu of certain Terms and Conditions associated with the effects analyses for the Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, northern Mexican gartersnake, western yellow-billed cuckoo, and southwestern willow flycatcher. The revised Conservation Measures would also implement one of the Conservation Recommendations for the Huachuca water umbel. It is anticipated that the USFS will act as the Conservation Partner to manage all of the conservation funds[2] described in the three Revised Conservation Measures.

The revised Conservation Measures were proposed by Rosemont in correspondence dated February 18 and 24, 2016, (see Consultation History), and are as follows:

Revised Conservation Measure 1 – Staff Funding

Rosemont will provide funding to the USFS for one full-time Biologist position at a pay grade

2 Under Corps regulations, several types of funding are required for a mitigation site including the financial assurances for all of the costs associated with implementing the mitigation (including land costs if a Restrictive Covenant is recorded); in addition, long term management in the form of wasting and non-wasting endowments are required. While the USFS will serve as a Conservation Partner for implementing the three Revised Conservation Measures, it must be reiterated that the USFS cannot hold funds intended for HMMP-related measures.

level General Schedule (GS)-9 or higher. The full-time Biologist position would support the Rosemont Copper project on all biology related issues and would be responsible for oversight of implementation and monitoring of all Conservation Measures, as well as Terms and Conditions appearing in this BO. Furthermore, this position will incorporate and fulfill the roles previously identified for the Biological Monitor in the October 30, 2013 BO and FEIS. Funding for this position will continue until either such time as the Project is completed or until all conservation funds covered by the BO have been fully expended, whichever happens later. Please note that this conservation measure supplants the Biological Monitor position described in the Description of the Proposed Conservation Measures in the October 30, 2013, Final BO.

The conservation entities to be engaged in the distribution and use of the funds tied to the Conservation Measures consist of those land and resource management agencies with special expertise or knowledge regarding the action area and adjoining areas in southeastern Arizona, as well as the wildlife and other resources associated with these Conservation Measures.

Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal

To benefit threatened and endangered aquatic species, as well as other native Arizona aquatic species potentially impacted by the Rosemont Copper Project, a harmful nonnative aquatic species management and removal program will be developed and implemented. This program is intended to specifically address the threat of harmful nonnative aquatic vertebrate, invertebrate, and plant species invading the aquatic habitat within the action area on USFS lands preferentially in and around Cienega Creek and in the San Rafael-Santa Cruz River Watersheds in the Nogales and Sierra Vista Ranger Districts (but excluding the recreational sport fishery at Parker Canyon Lake). Acreage within these watersheds but outside USFS lands will be considered for inclusion within this program, subject to obtaining consent of the appropriate land owner/management agency and the agreement of FWS and USFS.

The Conservation Measures specified here will augment a program that the Coronado National Forest is currently undertaking that will assemble existing data on efforts to control targeted harmful nonnative species, collect additional data, purchase equipment for the removal of harmful nonnative species, mitigate effects to threatened and endangered species as well as other native aquatic species, and develop a plan for continued control efforts within the Sierra Vista Ranger District.

The purpose of this Conservation Measure is to provide funding for a program with the following goal:

> That subbasins within the Cienega Creek and neighboring San Rafael-Santa Cruz River Watersheds in the Nogales and Sierra Vista Ranger Districts, that are of value to the survival and continued recovery of the Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, northern Mexican gartersnake, Huachuca water umbel, and other native aquatic species, are secured and maintained as a whole or nearly whole native community.

Specific components of the harmful nonnative species management and removal program

include:

1. Baseline surveys and the preparation of plans and priorities of the program.
2. Harmful nonnatives to be addressed in the program will include, but not be limited to, nonnative fish in the families Centrarchidae (sunfishes and black basses) and Ictaluridae (catfishes), American bullfrogs (*Lithobates catesbeianus*), any species of crayfish, other nonnative aquatic invertebrates, and nonnative plants invading aquatic habitat and adjoining riparian areas.
3. Baseline surveys will include all known suitable habitat that has legal access or for which legal access is given for Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frogs, and northern Mexican gartersnakes (and their native prey species [i.e., fish and amphibians]).
4. The plans shall include removal activities of harmful nonnative species using mechanical methods or any other methods, with associated revegetation or restoration where appropriate, which accomplish the repeated removal and control of harmful nonnative species as authorized by the USFS.
5. Data, plans and priorities that arise from this funding will be managed through the Conservation Partners program with USFS ultimately being responsible for program direction and administration.
6. Funding for this measure will be apportioned as follows:
   a. Ten (10) percent of the total funding will be provided to the USFS within 90 days of approval of the Final Mine Plan of Operations for use in planning and survey implementation.
   b. The remainder of the fund will be provided within 30 days of project commissioning, which is defined by the declaration of commercial production for the facility.
   c. The total amount of funding for these activities will be $3,000,000.

The USFS and Conservation Partners will be responsible for appropriate reporting and financial management of the $3,000,000 to ensure that the funds are spent in a way that meet the goals specified above.

Revised Conservation Measure 3 – Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management

Western yellow-billed cuckoos (cuckoo) have been detected along Cienega Creek and Empire Gulch, in areas proposed as critical habitat, and in small numbers in xeroriparian habitat in drainages at the Rosemont Project site. Additionally, small numbers of southwestern willow flycatchers (SWFL) have been detected along upper Cienega Creek and Empire Gulch, in areas that have been designated as critical habitat for the species.

Analysis of the Cienega Creek basin has shown a possibility that, under the range of potential groundwater impacts, habitat for the cuckoo and SWFL may be affected by the Project. Because of this, Rosemont is interested in providing funding for a habitat improvement, preservation, and replacement program to benefit these species. This program also will provide substantial benefits to other native Arizona species that utilize riparian habitat.

Habitat replacement, improvement and survey program

In addition to the elements of the program specified above, habitat replacement, improvement and surveys funded by this Conservation Measure will include these specific components:

1. Baseline surveys, preparation of plans, priorities, and implementation of the plans for a SWFL and cuckoo habitat replacement, improvement and survey program.
2. Specific projects will be identified in areas proximal to the Rosemont Project, preferably on USFS lands (FWS also intends that the sites are in areas not subject to drawdown effects). Rosemont will also work with conservation entities as necessary in other appropriate areas.
3. Baseline surveys[3] for southwestern willow flycatcher and western yellow-billed cuckoo in the action area will include all known suitable habitat that has legal access or for which legal access is given. Proposed habitat monitoring methods will be measurable, repeatable, and capable of detecting changes in extent, density, species composition, canopy height, canopy closure, vertical foliar density, soil moisture, temperature, and humidity of habitat.
4. The program shall include enhancement activities that may include, but not be limited to, the following: planting and maintaining trees native to the local environment, elevating groundwater levels, reducing stressors that affect vegetation establishment and growth, installing rock erosion control structures that slow stream flow, excluding or removing livestock from certain riparian areas, and providing riparian area fencing to prevent damage from humans and livestock.
5. Data, plans and priorities that arise from this funding will be managed through the Conservation Partners program with the USFS ultimately being responsible for direction and administration.
6. Funding for this measure will be apportioned as follows:
   a. Ten (10) percent of the total funding will be provided to the USFS within 90 days of approval of the Final Mine Plan of Operations for use in planning and survey implementation.
   b. The remainder of the fund will be provided within 30 days of project commissioning, which is defined by the declaration of commercial production for the facility.
   c. The total amount of funding for these activities will be $1,250,000.

The USFS and Conservation Partners will be responsible for appropriate reporting and financial management of the $1,250,000 to ensure that funds are spent in a way that meet the goals specified above.

EFFECTS OF THE PROPOSED ACTION

The following sections describe the effects of the proposed action, first to aquatic and riparian ecosystems in general, then to the respective threatened and endangered species and, as appropriate, their proposed or final critical habitats.

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3 Surveys must be conducted by individuals with the appropriate species-specific section 10(a)(1)(a) Recovery Permits employing protocols acceptable to FWS, i.e. Halterman *et al.* (2015) for yellow-billed cuckoos and Sogge *et al.* (2010) for southwestern willow flycatchers.

Effects to Aquatic Ecosystems

This section revises and supplants the analysis of the effects of the proposed action on fluvial aquatic ecosystems that appeared in our October 30, 2013 Final BO on the proposed action.

The Gila chub, Gila topminnow, Desert Pupfish, Chiricahua leopard frog, and northern Mexican gartersnake occur in streams and/or adjacent cienega complexes 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 within this section 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.

As discussed in our October 30, 2013 BO, the excavation of the open pit to an elevation of approximately 3,050 feet will result in the intersection of regional groundwater and/or water-conducting subsurface fracture networks (USFS 2012a). 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 impacts 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 FEIS. The 2012 through 2013 BA and supplemental documents included analyses of impacts 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 the Montgomery and Associates (2010) and Tetra Tech (2010) models was later evaluated by SRK Consulting at the request of the Forest Service (SRK 2012). The Myers (2010) model was not subjected to review by SRK.

Our October 30, 2013 Final BO contained analyses of the three models' relative strengths and weaknesses as well as precautionary statements regarding hydrogeological uncertainties in the action area and porous-media groundwater models in general. These prior analyses and cautions are incorporated herein via reference. The SIR also confirmed the validity of the respective models' utility in evaluating impacts to the groundwater system in the action area.

Our October 30, 2013 Final BO also included a narrative explaining our utilization of largely-qualitative surface water impact analyses based primarily on the Tetra Tech (2010) groundwater drawdown model; this model's results were the largest in magnitude among the three separate models and therefore represented the most precautionary approach for the purposes of an effects analysis (i.e. resulted in the greatest groundwater drawdowns which, in turn affected aquatic and riparian habitat occupied by threatened and endangered species). Table A-4 in the October 30, 2013 Final BO displayed a summary of groundwater drawdowns and was based on the SWCA (2012) interpretation of the Tetra Tech (2010) results.

Despite our prior reliance on Tetra Tech (2010) drawdown results, the October 30, 2013 Final BO also included limited quantitative descriptions of groundwater-driven stream flow losses in upper Cienega Creek based on the findings of Montgomery (2010); Table A-2 described flow losses in upper Cienega Creek and Table A-3 described flow losses in Davidson Canyon Wash. These Montgomery-based analyses' limited geographic site-specificity (upper Cienega Creek and Davidson Canyon Wash) was in contrast to our primary reliance on a different groundwater model (Tetra Tech 2010). The geographic-area shortcomings of the Montgomery (2010) model made it desirable for us to employ an improved approach in this consultation (see Background on Revised Effects Analyses, below).

This prior, primary utilization of Tetra Tech (2010) and secondary utilization of Montgomery (2010) model results have thus been superseded by the rigorous and yet more-precautionary, revised analyses appearing in the SIR and May 2015 SBA. The more-current analyses, and their analytical advantages compared to prior results, are incorporated herein via reference from the SIR and May 2015 SBA. The revised analyses are also summarized in the subsequent section.

Background on Revised Effects Analyses

The FEIS, published after issuance of the October 30, 3013 Final BO, disclosed impacts to groundwater in a comprehensive manner. The FEIS selected the largest predicted drawdown value (the worst-case scenario), at each location and time-step, regardless of the model from which the scenario was derived. The FEIS also disclosed direct (1:1 ratio) linkages between these groundwater drawdowns caused by mining and losses of surface flow in streams (i.e. 0.2-foot drawdown at a stream would result in a 0.2-foot drop in water elevation). While these were reasonable approaches to employ in a disclosure document, they were nevertheless different from the approaches employed in the various BAs and in the Final BO. Moreover, the revised analyses in the FEIS indicated a strong potential to trigger Item 2 in the October 30, 2013 Final BO's Reinitiation Notice, which directs that consultation be reinitiated if "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".

The new groundwater and discharge data presented in the FEIS, in part, resulted in the Coronado National Forest conducting a large-scale, May through November of 2014 reanalysis of groundwater and surface water impacts. These revised analyses were first applied to the analyses found in the FEIS. Forest Service regulatory guidance requires that all potentially new information received after publication of a FEIS must be assessed for "whether or not the new information or changed circumstances are within the scope and range of impacts considered in the original analysis" (Forest Service Handbook 1909.15) (U.S. Forest Service 2012b). This process was described by the Coronado National Forest in the Supplemental Information Report (SIR), a document intended to inform the retention or supplementation of a standing EIS.

The SIR included a refined analysis of impacts to the aquatic environment, informed by the new information obtained between May and November 2014. Full details of the methodology and results of the aquatic analysis, including potential impacts to stream flow, standing pools, and riparian vegetation, are contained in the SIR and are incorporated herein via reference.

By its status as a document disclosing impacts for NEPA purposes, the FEIS contained an analysis of hydrologic impacts that extended 1,000 years after closure of the mine. While the uncertainty involved in estimating impacts this far into the future is substantial and was disclosed in the FEIS, choosing this long time frame was necessary in order to fully examine the potential for the bedrock aquifer impacted by the mine to reach equilibrium with the mine pit. Like the FEIS, the SIR also disclosed potential impacts out to 1,000 years, as the primary purpose of the SIR is to assess whether new information or changed circumstances are within the scope and range of impacts considered in the FEIS.

The May 2015 SBA includes the same hydrological and aquatic and riparian species effects analyses as the SIR, but the May 2015 SBA does not employ the 1,000-year time frames. Federal regulations at 50 CFR 402.02 state that "Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur". We and the Coronado NF have acknowledged the high level of uncertainty associated with effects to threatened and endangered species at up to 1,000 years after closure of the mine, but both agencies have also recognized that effects to aquatic and riparian ecosystems may not manifest themselves until decades after mine closure. Therefore, a reasonable post-closure time frame of 150 years for groundwater drawdown analysis was employed in the May 2015 SBA, with the Coronado National Forest stating the 150-year duration for effects analyses will encompass effects that are reasonably certain to occur. We concur with the Forest Service, primarily because the hydrologic effects of the mine extend far into the future and in large part worsen over time; evaluating 150 years of effects allows us to assess both the proposed action's near-term effects but also their long-term trend as it relates to recovery.

The results of the revised analyses contained in the SIR were reiterated in the May 2015 SBA, although they are adjusted to reflect the 150-year time frame instead of the 1,000 year time frame. The details of the methodologies used to derive the revised results were described in detail in the SIR and as stated above, are incorporated by reference into this BO. The May 2015 SBA contains a brief summary of the methodologies, and this is both incorporated via reference and further summarized below.

Methodology

The SIR and May 2015 SBA contain refined analyses of effects of mine drawdown on the aquatic and riparian environment along Cienega Creek and Empire Gulch, which consist of three parts: (1) analysis of impacts to stream flows (discharge of baseflows), (2) analysis of impacts to standing pools, and (3) analysis of impacts to riparian vegetation (discharge to evapotranspiration). The stream flow and pool analysis was further organized into five key features[4]:

- Documentation of current baseline trends5 associated with the ongoing drought, including

4 The SIR contains an additional aspect of the analysis: analysis of impacts from generic, incremental drawdown, regardless of modeling results. This aspect was not included in the May 2015 SBA, as it is largely duplicated by actual modeling results.
5 We employ a different interpretation of the hydrologic baseline condition than what appears in the SIR. Our approach is described throughout the Background on Revised Effects Analyses and is reiterated in the Background

climatic, aquatic, and vegetation trends.
- Analysis of effects resulting from aquifer drawdown from the mine only.
- Analysis of estimated effects from climate change.
- Analysis of effects resulting from both mine drawdown and climate change.
- Analysis of a range of effects that can be considered to encompass 95 percent of possible analysis outcomes (given the modeling assumptions explained below).

Sources of Uncertainty

As disclosed in the 2013 Final BO, FEIS, SIR, and May 2015 SBA, there are several sources of uncertainty associated with the hydrologic analysis. In both the FEIS and SIR analyses, the following strategies were implemented to address these sources of uncertainty (adapted from the May 2015 SBA: Table 2).

To address inherent uncertainty in groundwater models, due to long distances, long time frames, and prediction of stresses greater than currently observed:
- Use of three individual models, instead of a single model
- Disclosure of predictions using high and low ends of model sensitivity analyses (quantitative)
- Disclosure of predictions using 95th percentile results (quantitative)

To determine seasonal and drought-related changes in flow patterns:
- Use of real-world hydrographs for entire period of record, rather than relying on average or median flow

To determine spatial differences along riparian corridor:
- Use of multiple key reaches, with hydrologic framework assessed independently for each reach, and each analyzed separately

To incorporate climate change:
- Disclosure of predicted impact with mine drawdown alone, as well as impact predicted combining mine drawdown with climate change
- Ongoing riparian trends incorporated into baseline analysis

To translate groundwater drawdown to reductions in stream flow:
- Disclosure of predictions using 95 percent confidence intervals for regression slope, in addition to best-fit regression slope (quantitative)

Subsequent discussions occurring between May and November 2014 resulted in the incorporation of quantitative strategies, when possible, to help inform the analysis of uncertainty with respect to effects analyses. Concerns regarding the disclosure of uncertainty were revisited on February 3, 2016 (see Consultation History section, above); this section was subsequently revised in consultation with USFS (USFS 2016).

Impacts resulting from aquifer drawdown associated with the mine, whether alone or in

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for Analyses and Definition of Baseline sections which appear within aquatic and riparian species effects sections.

conjunction with climate change, fit within a wide range of potential model outcomes, including the low and high ends of the respective models' sensitivity analyses, as well as the best-fit model results for three independent groundwater models (Myers 2010, Montgomery and Associates 2010, and Tetra Tech 2010). Modeling with sensitivity analysis allows for the consideration of a reasonable variation in conditions affecting the behavior of groundwater in the aquifer.

When conducting modeling sensitivity analyses, ranges of values for different input parameters (i.e. the amount of water stored in the aquifer and factors that affect the movement of that water through the aquifer) are modeled in various combinations. Only reasonable values are selected for inclusion in the range of possible values. Thus, any of the sensitivity analyses can be considered to be reasonable outcomes of the modeling. A summary of all sensitivity analyses provided for the three groundwater models is shown in Table A-0, below.

Table A-0: Groundwater model runs developed to test sensitivity of various model components (Myers 2010, Montgomery and Associates 2010, and Tetra Tech 2010)

Model Component	Parameter	Montgomery Sensitivity Analyses	Tetra Tech Sensitivity Analyses
Backbone fault	K	- Increase Kx by factor of 10 - Decrease Ky and Kz by factor of 10	
Basin fill	Sy	- Increase by 50 percent - Decrease by 50 percent	- Increase by 50 percent - Decrease by 50 percent
Bedrock	SS	- Increase by factor of 10 - Decrease by factor of 10	
Bedrock	Sy	- Increase by factor of 2 - Decrease by factor of 2	- Increase by factor of 2 - Decrease by factor of 2
Davidson Canyon fault	K	- Decrease (unknown amount)	
Flat fault	K	- Increase by factor of 10 - Decrease by factor of 10	
Lower Cretaceous sedimentary formation (Ksd)	K	- Increase by factor of 10 - Decrease by factor of 10	
Upper Cretaceous and Early Tertiary intrusive formations (KTi)	K	- Increase by factor of 10 - Decrease by factor of 10	
Upper Cretaceous sedimentary and volcanic formations (Kv)	K	- Increase by factor of 10 - Decrease by factor of 10	
Precambrian igneous and metamorphic crystalline formations (pCb)	K	- Decrease by factor of 10	
Paleozoic sedimentary and metamorphic formations (Pz)	K	- Increase by factor of 10 - Decrease by factor of 10	
Quaternary alluvium (Qal)	K	- Increase by 30 percent - Decrease by 30 percent	
Lowest permeability Late Tertiary to Early Quaternary basin-fill deposits (QTg2)	K	- Increase by factor of 10 - Decrease by factor of 10	
Higher permeability Late Tertiary to Early Quaternary basin-fill deposits (QTg)	K	- Increase by 30 percent - Decrease by 30 percent	
All Units	SS		- Increase by factor of 10 - Decrease by factor of 10
Davidson Canyon Dike			- Remove Davidson Canyon dike from model

Table A-0: Groundwater model runs developed to test sensitivity of various model components (Myers 2010, Montgomery and Associates 2010, and Tetra Tech 2010)

Model Component	Parameter	Montgomery Sensitivity Analyses	Tetra Tech Sensitivity Analyses
Pit evaporation			- Decrease by 20 percent
Boundary cells		- Replace boundary cells with constant flux cells that prevent any changes in inflow/outflow as the model runs	

K – hydraulic conductivity. This parameter can also be specific to a single flow direction (Kx, Ky, Kz)
SS – Specific storage
Sy – Specific Yield

While all the sensitivity analyses shown in Table A-0 are considered reasonable, the sensitivity analyses are not all equally probable to occur because they all result from aquifer conditions that could exist, but not simultaneously. Model calibration typically results in only one modeling run that is considered to best fit the available real-world hydrologic data (i.e., groundwater levels). While the high and low bounds within and between the models may not be as probable to occur as the three models' respective best-fit model scenarios, using the high and low ends of the sensitivity analyses to predict impacts is appropriate, because this allows for disclosure (i.e. under NEPA) of the overall possible range of impacts. This wide range of analyses is also important to us for analyzing the effects of the mine over the long term (up to 150 years), over which time deviations from any one model from observed conditions would become most apparent. By analyzing the results of all models, we are able to analyze the full range of effects to threatened and endangered species that could occur.

For each key stream reach (see May 2015 SBA Figure 1 and below), for each time step, there are predictions of mine-driven groundwater drawdown from 37 to 38 individual modeling scenarios, including the Myers (2010) best-fit model (one scenario, only available for key reaches EG1, CC2, and CC5, and only for certain time steps), the Tetra Tech (2010) best-fit model (one scenario), the Montgomery (2010) best-fit model (one scenario), the Tetra Tech (2010) sensitivity analyses (8 scenarios), and the Montgomery (2010) sensitivity analyses (27 scenarios).

Given this wide array of model runs, it is also useful to condense the very large number of modeling scenarios and parameters into a single useful prediction that incorporates all sources of uncertainty. Often, the 95 percent confidence interval is used to consolidate all sources of uncertainty into a single statistic. In addition to the three modeling scenarios, a "95th percentile" analysis has been included for both mine-only and mine-plus-climate change scenarios in order to allow us to evaluate the effects of climate change relative to present-day, baseline conditions. The 95th percentile analysis incorporates uncertainty from two different parameters: model drawdown and drawdown/stream flow conversion. For model drawdown, the 95th percentile analysis represents a range of drawdown within which 95 percent of the 37 to 38 specific modeling scenarios reviewed in the SIR/SBA fall. This allows a more focused analysis of the results of all models; we are able to more defensibly analyze the full range of effects to threatened and endangered species that could occur.

The drawdown predicted by the models must be converted into reductions in stream flow in order for them to be useful in the analyses of effects to threatened and endangered aquatic and riparian species and their critical habitats. Analyses undertaken by WestLand Resources (2012)

but not included in the three iterations of the BA, in SWCA (2012), or the FEIS, correlated extent of surface flow in lower Cienega Creek with depth-to- groundwater in adjacent wells. Their results, partially based on averages in June, show there would be small decreases (<2 percent of average) in length of streamflow. Also, the extent of streamflow and proportional reduction in extent of streamflow could be greater than two percent in drier times. Pima County performed a similar analysis, finding that a 0.1-foot decline in groundwater elevation would lead to a loss of 434 linear feet (3.4 percent) of stream flow in June (Powell *et al.* 2014). They also estimated a 0.25-foot decline would lead to a loss of 1,085 linear feet of stream flow in June. We did not use these studies in our analysis, as they did not emerge in their as-written state from the technical reviews conducted by the USGS (USGS 2014a, USGS 2014b), themselves a part of the SIR and SBA preparation process. The conversion ultimately employed in the SIR and May 2015 SBA (and therefore in this BO) uses an empirical relationship (linear regression) developed from paired field measurements of stream flow and groundwater level, with consideration given to the USGS (2014a and 2014b) reviews of Powell *et al.* (2014) and WestLand (2012) . This linear regression approach involves determining the correlation between observed groundwater levels in wells and flow in the adjacent stream. If sufficient relatedness exists, a slope-intercept equation can be used to convert any groundwater elevation of interest (specifically, a groundwater drawdown) into a corresponding stream flow. The second part of the 95th percentile analysis incorporates the possible range of outcomes associated with this linear regression.

Taking the variability in these two parameters into account (model drawdown and drawdown/stream flow conversion), the intent is to create a single range of stream flow effects that can be analyzed with the knowledge that 95 percent of all models that were chosen to run fall within this range.

The 95th percentile analysis was included in the SIR and May 2015 SBA specifically to address our stated need to understand the quantitative probability associated with stream flow effects resulting from the differing outcomes of the three groundwater models. In some cases, where the 95th percentile range is narrow and consistent (i.e., many locations along Cienega Creek), this is a useful approach that lends both certainty and accuracy to the analysis of drawdown-driven stream flow effects. In other cases, the 95th percentile range is extremely wide and does little to reduce the uncertainty in outcomes (e.g., Empire Gulch). In the latter situation, we will exhibit a precautionary approach by emphasizing the higher values (i.e., greater adverse effects of mining activities on threatened and endangered species and their critical habitats).

The upper end of the 95th percentile is not the situation that is most probable to occur. Statistically, the "best-fit models" are the model runs that are best calibrated to real-world observations and could be considered the most probable to occur. However, even though all three best-fit models are reasonable representations of the hydrology of the Rosemont area, their interpretations cannot all be correct. For instance, the Tetra Tech model incorporates a hypothesized dike in Davidson Canyon, which impedes drawdown in that direction and instead increases drawdown in the area of Empire Gulch and Upper Cienega Creek, while the Montgomery model does not include this hypothesized dike and therefore exhibits greater drawdown on Lower Cienega Creek. Selecting any one of the best-fit models as the sole description of hydrologic impacts risks picking a wrong interpretation and underestimating

impacts to hydrology elsewhere.

While not the most probable model scenarios, the sensitivity analyses are still considered to be reasonable representations of reality because they accommodate all reasonably-possible variations in aquifer properties. An additional risk of selecting just a single best-fit model is that the evaluation of impacts to groundwater elevations (and then, to streams) could be less than that predicted for a wide range of other reasonable model results.

The selection of the upper end of the 95th percentile analysis reduces these risks. When this approach is taken, the effects described by the upper end of the 95th percentile represent a situation in which 97.5 percent of the other possible outcomes (given the same model assumptions) are less impactful than the effects analyzed in this BO[6]. This is a conservative and cautious approach. It does not represent the most probable outcome, but it does provide reasonable certainty that the real-world effects of mine drawdown experienced in these ecosystems are unlikely to be worse than those described in this consultation.

Our analyses of the effects of the proposed action will therefore rely primarily on the 95th percentile analyses from the May 2015 SBA, which reflect a reasonable certainty that the effects will occur. We will disclose, where necessary, of our use of higher-range 95th percentile predictions. Tables A-1 through A-8 illustrate the various hydrologic effects of the proposed action.

The FWS has been asked to provide a biological opinion that looks at the effects of the proposed action on threatened and endangered species and their critical habitats. In this case, this is difficult because the effects of mining activities may take place hundreds of years into the future. Predicting effects this far out is practically impossible. So, we have chosen the most cautious approach to predicting effects into the future in order to ensure our analysis adequately considers whether the effects of the action do or do not jeopardize affected species and/or destroy or adversely modify their critical habitats.

While the analysis contained in this section is quantitative, it reflects predicted impacts from relatively small amounts of groundwater drawdown, often fractions of a foot, that are occurring decades into the future. The conclusion of groundwater experts consulted by USFS is that such small amounts of drawdown are difficult for any groundwater model to accurately predict. It is important to understand that the detailed predictions contained in this section are meant to inform the decision and to show what could potentially happen if the model predictions were to occur as modeled; however, this does not change the overall uncertainty.

Lastly, the use of the terms “precaution” or “precautionary” in the preceding paragraphs and throughout this BO is related to our statutory requirement to ensure that the proposed action is not likely to result in jeopardy to threatened and endangered species and/or destruction or

6 Statistically, the 95th percentile analysis contains all possible outcomes except those in the lower 2.5 percent and those in the upper 2.5 percent. When the upper end of the 95th percentile is selected as the value to use in the analysis, the only impacts that would be greater than the selected value are those that lie in the upper 2.5 percent. The remaining impacts – those that are analyzed in the BO – represent 97.5 percent of the possible outcomes.

adverse modification of critical habitat. To accomplish this, we must conduct our analyses to avoid concluding that the action had no effect (or minimal effects) on a listed species or its habitat when, in fact, there was an effect (or a large effect). This approach minimizes the likelihood of making a false negative conclusion with high consequences (i.e. falsely concluding jeopardy and/or destruction or adverse modification of critical habitat will not occur when in fact, they will).

Our analyses also must use the "best scientific and commercial data available," and in cases where information is incomplete or not entirely definitive (as is the case with the 95th percentile approach), clearly articulate the rationale for reaching a conclusion (thus avoiding being found to have made an arbitrary or capricious conclusion). At times, this approach to the potential for error may lead to different conclusions than would a more traditional scientific approach to hypothesis testing, but it is in compliance with direction from the Act and the courts to provide the benefit of the doubt to the species.

Lastly, our use of a precautionary approach is warranted because of the irreversibility of the proposed actions possible effects at the higher end of the 95th percentile analyses.

Key Reaches

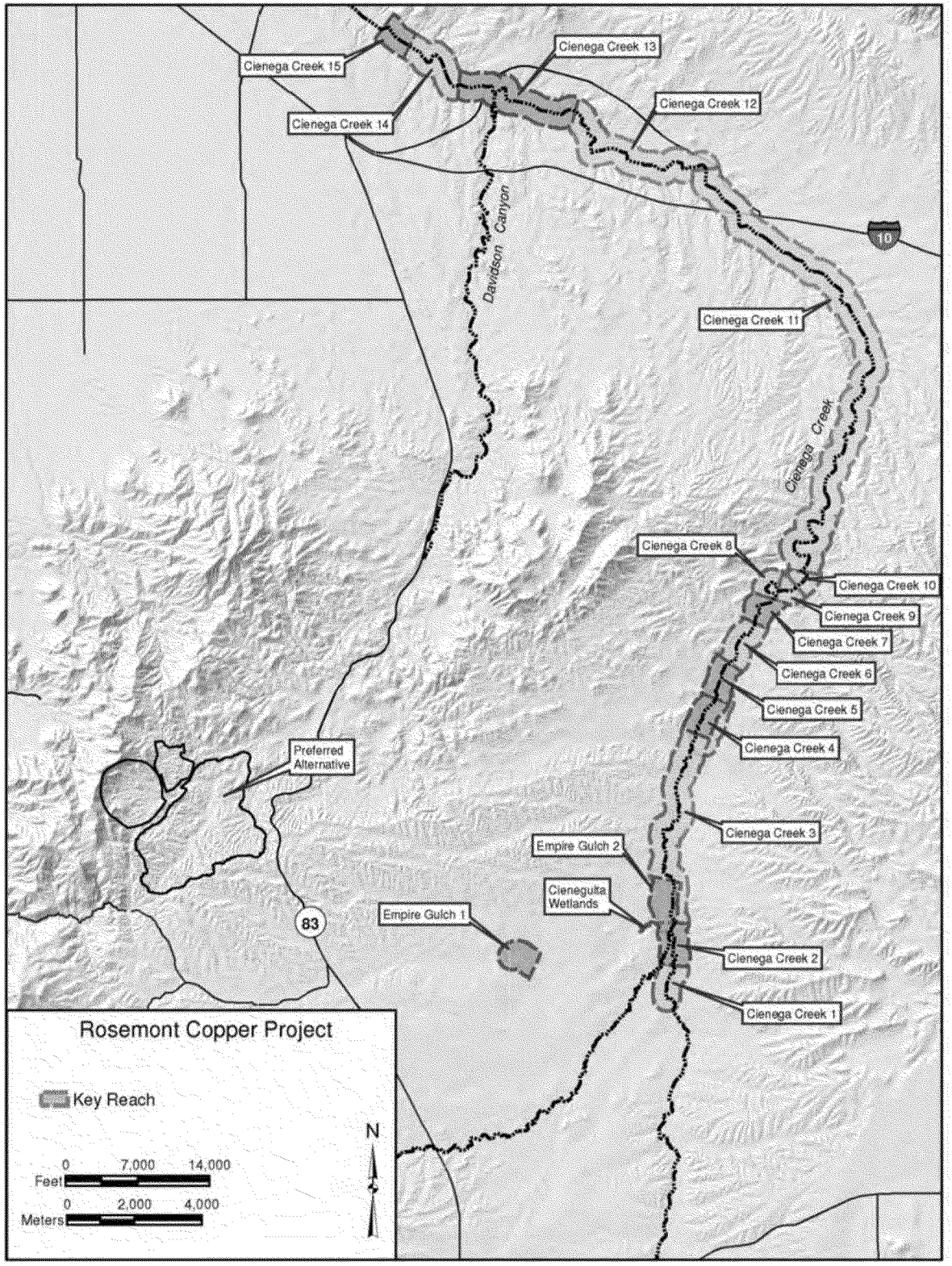
During discussions between May and November 2014, a combined group of agency specialists divided Cienega Creek and Empire Gulch into multiple reaches. Physical and biological characteristics of these reaches were then summarized, and reaches were selected that were considered key areas of biological importance to threatened and endangered species and their critical habitat. These key reaches tend to be areas with consistent presence of water, especially during the critical low-flow months of May/June. The refined aquatic analysis focuses on nine key reaches of Cienega Creek and Empire Gulch. These are shown in Figure A-1, below, and include the following:

- Cienega Creek Reach 2. Approximately 0.75 mile long, located on Upper Cienega Creek, within the Las Cienegas National Conservation Area (NCA), immediately upstream from Gardner Canyon.
- Cienega Creek Reach 4. Approximately 0.8 mile long, located on Upper Cienega Creek, within the Las Cienegas NCA, immediately upstream of Mattie Canyon.
- Cienega Creek Reach 5. Approximately 0.8 mile long, located on Upper Cienega Creek, within the Las Cienegas NCA, downstream of Mattie Canyon and containing the USGS Sonoita stream gage.
- Cienega Creek Reach 7. Approximately 0.6 mile long, located on Upper Cienega Creek, within the Las Cienegas NCA, at the beginning of the Narrows.
- Cienega Creek Reach 13. Approximately 2.5 miles long, located on Lower Cienega Creek, within the Pima County Cienega Creek Natural Preserve (CCNP), upstream and downstream of Davidson Canyon confluence.
- Cienega Creek Reach 15. Approximately 0.5 mile long, located on Lower Cienega Creek, within the Pima County CCNP, upstream of Pantano Dam.
- Empire Gulch Reach 1. Approximately 0.3 mile long, located within the Las Cienegas NCA immediately downstream from the Upper Empire Gulch Springs, near the Empire Ranch

Headquarters.

- Empire Gulch Reach 2. Approximately 1 mile long, located within the Las Cienegas NCA immediately upstream of the Cienega Creek confluence.
- Cieneguita Wetlands. Located on the Las Cienegas NCA, within the floodplain of Empire Gulch, near the confluence of Empire Gulch and Cienega Creek.

Figure A-1 (SBA Figure 1): Map of Key Reaches



The hydrology of each key reach was individually assessed in the SIR and May 2015 SBA; key analysis assumptions are included in May 2015 SBA Table 3. While the refined aquatic analysis focuses on these nine reaches, it should not be assumed that impacts will not occur in the other non-key reaches. To the contrary, because these key reaches represent the most stable portions of Cienega Creek and Empire Gulch, any effects to these reaches, and the threatened and endangered species occurring in and near them, can be expected to occur elsewhere as well.

The May 2015 SBA's focus on key reaches, adopted in this consultation, does not imply that impacts will only occur at these locations, nor does it preclude impacts elsewhere in the system. There are four other areas where impacts could occur that are not explicitly addressed by the May 2015 SBA approach:

1. The key reaches were selected because they represent core areas of biological importance. Because these key reaches represent the most stable portions of Cienega Creek and Empire Gulch, any impacts observed to these reaches can be expected to occur elsewhere in the system as well, along reaches that are intermittent rather than perennial, and typically exhibit greater fluctuation in the presence of water. These other reaches often already experience drying during critical low flow months and during drought cycles, and accordingly there is less dependence on these areas by aquatic species. Nevertheless, if impacts are being experienced in key reaches, it can be assumed that the usual drying trends along other reaches would be more pronounced and severe than under current conditions.
2. For wetlands, only Cieneguita Wetlands was explicitly identified and analyzed as a key reach. There are numerous other wetlands in the Cienega Creek/Empire Gulch system, as identified in the FEIS: "The BLM has also conducted wetland inventories within the Las Cienegas NCA and has identified more than 30 perennial or seasonal wetlands. Most of these occur on the Cienega Creek flood plain immediately upstream and downstream of the confluence with Empire Gulch, including named wetland complexes such as Cieneguita Wetlands, Spring Water Wetlands, and Cinco Ponds Wetlands. Another complex, the Cold Spring Wetland, occurs upstream of the Mattie Canyon confluence on Cienega Creek" (FEIS: 496). For those on-channel wetlands adjacent to the flowing stream itself, the approach is similar to that used in the FEIS: "Impacts to these wetland complexes are not analyzed individually but are assumed to be part of the analysis of impacts to stream flow and riparian vegetation" (FEIS: 496). In other words, the analysis of stream flow and of standing pools contained in the May 2015 SBA is directly applicable to wetland areas alongside the stream channel itself; if the presence of water is impacted in the flowing stream or pools; it will be impacted in these on-channel wetlands as well.
3. Other off-channel wetlands were considered for analysis of mine-driven drawdown, but unlike the selection of key reaches, these wetlands did not appear to carry the same importance as the Cieneguita Wetlands (i.e. no threatened or endangered species or critical habitat), nor were any identified during the multi-agency collaboration to select key reaches. For instance, during field visits between May and November 2014 the Cinco Ponds Wetlands were visited but were largely dry. Nor were these wetlands a location for reintroduction of threatened or endangered species. Furthermore, Cieneguita Wetlands is closer to the mine than other identified wetlands and has a higher likelihood of being impacted (it sits within the floodplain of lower Empire Gulch), and supports threatened and endangered species.
4. Gardner Canyon was explicitly analyzed for impacts in the FEIS, but no key reaches were

identified in Gardner Canyon during the multi-agency collaboration, and therefore no key reaches are explicitly analyzed in the May 2015 SBA. A key assumption in the FEIS was that Gardner Canyon exhibited perennial stream flow. Based on field reconnaissance and discussions with BLM personnel, this does not appear to be the case. Gardner Canyon would be more correctly identified as an intermittent flow system. Therefore, Gardner Canyon should be considered along with other reaches, as described in No. 1 above. Nothing in the May 2015 SBA analysis should be construed to diminish the importance of any riparian and aquatic habitat that does exist within Gardner Canyon, or anywhere else in the system. The use of key reaches is a simplifying technique meant to focus analysis on critical locations, not a method meant to encompass all impacts to the system.

In summary, we feel the selection of key reaches serves as a reasonable benchmark by which to evaluate effects to threatened and endangered species because the reaches are distributed throughout the affected portions of Cienega Creek and Empire Gulch where those species and critical habitats exist.

Methodology for Prediction of Impacts to Stream Flow

Analysis of potential impacts to stream flow requires a hydrograph, based on stream flow measurements in the field, for each key reach. For the FEIS, only a single hydrograph was used. The refined analysis makes use of five different hydrographs, representing different flow conditions along Cienega Creek and Empire Gulch. For each key reach, the hydrograph is then modified in three ways if applicable:

1. Make changes to measured hydrograph in order to extrapolate to a different key reach. Cienega Creek Reach 4 is the only hydrograph extrapolated in this manner.
2. Make changes to hydrograph due to groundwater drawdown occurring in the key reach. This step requires a method of converting drawdown (in feet) to loss in stream flow (in cubic feet per second (cfs) or gallons per minute (gpm)); the exact nature of this conversion varies by key reach.
3. Change to hydrograph due to loss of upstream surface flow, if applicable.

The specific methods to be applied to each key reach are summarized in May 2015 SBA Table 3.

The method of converting groundwater drawdown into stream flow reductions is different in the FEIS from the refined analysis included in the SIR and in the May 2015 SBA. In the FEIS analysis, this translation was accomplished by directly assuming any drawdown of groundwater would appear identically in the stream channel (i.e., 1 foot of drawdown in the aquifer would equal 1 foot of lowering of the water surface of the flowing stream). The additional information obtained between May and November 2014 (see the discussion of groundwater well and stream flow regression analysis, above) allows a different approach to determining the relationship between groundwater levels and stream flow. Several data sets are now available for Empire Gulch and Cienega Creek that pair stream flow measurements (as measured in gpm or cfs) with groundwater levels (as measured in feet below land surface). SBA Table 4 describes the linear regression analyses for key reaches CC2, CC13, CC15, and EG1.

These data sets have been used to define a statistical relationship between groundwater level and stream flow. This empirical stream flow/groundwater level relationship replaces the assumed 1:1 stream depth/groundwater level relationship found in the FEIS. The relationships derived from these data sets are summarized in May 2015 SBA Table 4.

The SIR and May 2015 SBA employed a hydrograph-based approach. A hydrograph is a plotting of stream flow over a given interval of time. The hydrograph approach is useful because it allows analysis of impacts not just on average annual flows, but observed conditions in these aquatic systems, including seasonal low flows (May/June), drought conditions, and year-to-year variability.

Once drawdown caused by mining is applied to the natural hydrograph, a series of hydrologic metrics is calculated for each key reach, for each time step. These metrics include the following:

- Average annual days with zero stream flow
- Average annual days with extremely low stream flow[7]
- Flow status (i.e., perennial, intermittent, ephemeral[8])
- Flow reductions (in gpm)

The following time steps were analyzed: end of mining (which depends on the year in which mining begins, possibly as soon as 2016), and 10, 20, 50, 100, and 150 years after end of mining.

Methodology for Prediction of Mine-Related Impacts to Standing Pools

One refinement of the aquatic analysis is the inclusion of impacts to standing pools, in addition to stream flow. At least some pools are likely supported by groundwater, and during those times of the year when stream flow potentially could cease, it is useful to know whether standing water would remain in the channel or whether the amount of water in pools would be decreased due to groundwater withdrawals caused by mining activities. This is important because many of the species being analyzed in this BO rely on water in pools to serve as refugia during times when stream flow declines to the extent that pools are not connected by surface flows. During November and December 2014, field surveys were conducted of all key reaches, with the intent of collecting information on standing pools. During these surveys, all pools were identified, their locations mapped, and characteristics recorded. The locations of all pools identified during the field surveys are shown in May 2015 SBA Figures 12a through 12e. Measurements included total length, width at multiple locations, depth at multiple locations, and presence of inflow/outflow of surface water from the stream.

A three-dimensional approximation of each pool was created using the Surfer software package. Using this three-dimensional model, the depth, volume, and pool surface area were calculated for each of the incremental drawdown scenarios.

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7 An extremely low stream flow is any discharge that is less than the minimum streamflow observed in the past at a given site. A flow less than those observed in the past represents an adverse change from baseline conditions.
8 For this analysis, consistent with the FEIS and SIR, the following definitions are used: perennial (0 to 30 days with zero stream flow); intermittent (31 to 350 days with zero stream flow); ephemeral (more than 350 days with zero stream flow).

A summary of the baseline pool characteristics as measured or calculated in November and December 2014 is shown in May 2015 SBA Table 5. The pertinent measures of pool geometry do not depend on the presence of water, as the measurements are made of the substrate, banks, and inlet and outlet elevations. Conducting the surveys during the winter thus did not create a bias towards winter stream flows.

Climate Change Scenario

Analysis of both stream flow and standing pools includes scenarios for mine drawdown, as well as mine drawdown in combination with climate change. This analysis was performed by USFS done in an attempt to measure the effects to key reaches caused by climate change.

Climate change is expected to have three primary consequences related to stream flow hydrology and riparian ecosystems: decreased precipitation, change in precipitation patterns, and increased temperature. The USFS compared precipitation and temperature trends during the ongoing drought with predictions of climate change effects. The Climate Change Stress Estimate section of the SIR (pages 85 through 87) contains a detailed description of the USFS analysis, and is incorporated herein via reference. The USFS ultimately determined that precipitation over the past several years is within the same range predicted from climate change by the year 2100. Therefore, it was assumed those effects would likely already be evident in the baseline trends of stream flow, aquatic habitat extent (wet/dry mapping), and possibly riparian vegetation.

However, temperature trends during the ongoing drought have not been in the same range as those expected from climate change by the year 2100. An estimate of hydrologic changes due to continued increases in temperature was made. This estimate is described more fully in the SIR (pages 85 through 87). For the stream flow analysis, estimated stream flow reductions due to climate change would vary by reach, ranging from a reduction of 3.3 gpm in Cienega Creek Reach 2 to a reduction of 44 gpm in Cienega Creek Reach 13. For the standing pool analysis, estimated reductions in groundwater level would not vary by reach due to lack of detailed information for each reach, but an average reduction in groundwater level of 0.4 foot is estimated to result from future climate change.

ANALYSIS RESULTS

Stream Flow Analysis

Table 6 in the May 2015 SBA provides an index to the stream flow analysis results. The tables with the results of the stream flow analysis (tables D-1 through D-13) are provided in full in May 2015 SBA Appendix D and in Tables A-1 through A-8 in this BO. Graphical representations of the results are included in May 2015 SBA Appendix E.

Summary of Stream Flow Analysis Results

The following tabular summary of results is based on the 95th percentile analysis, which encompasses 95 percent of all models that were chosen to run, and provides a consistent and

concise way of summarizing results. It should not be construed as ignoring those results that fall outside this range. For instance, the high end of the sensitivity analyses typically falls outside the 95th percentile range; however, these results are still fully disclosed in tables D-1 through D-13 in Appendix D of the May 2015 SBA. Note that the following discussion refers only to those periods of time up to 150 years after closure of the mine.

The 95th percentile summary of stream flow results appearing in Tables A-1 through A-4 discloses that, at certain locations and time intervals, there is a potential range of results; lower and higher. We primarily discuss the results of the higher-end of the 95th percentile analyses of all models in order to evaluate a less-likely, although theoretically-possible, set of effects for the respective Key Reaches. We note that upper Empire Gulch exhibits widely divergent results for the potential effects; effects range from no measurable effect to complete dewatering at later time-steps. Precaution again dictates the analysis of the worst-case scenario for Empire Gulch.

In brief, the proposed action will result in diminished stream flows as well as increased frequency of extremely low and no-flow periods. Key Reach CC15 in Cienega Creek will transition from perennial to intermittent. In the extreme case of upper Empire Gulch EG1, dewatering may be so severe that the stream transitions from perennial to ephemeral flow. This prediction is tempered by the great uncertainty resulting from the use of modeling scenarios with highly divergent results at the latter site.

Regardless, any appreciable (i.e. measurable) loss of stream flow, regardless of its cause (mining or climate change) constitutes an adverse effect on threatened and endangered aquatic species and, as applicable, proposed and final critical habitat. Subsequent species-specific analyses will tier to the hydrological information found in this section, but also include analyses of the degree to which the modeled flow losses diverge from the present-day baseline conditions. Changes from the present-day baseline condition represent the incremental effects (of mining as well as climate change) over time.

Table A-1 (BA Table D-10): Results of stream flow analysis for 95th percentile range – predicted stream flow loss (gpm)							
Key Reach	Scenario	End of Mine	10 Years	20 Years	50 Years	100 Years	150 Years
CC2	Mine Only	0	0-4.8	0-4.8	0-4.8	0-4.8	0-6.9
CC2	Climate Change	4.3	4.3	4.3	4.3	4.3	4.3
CC2	Mine and Climate Change	4.3	4.3-9.1	4.3-9.1	4.3-9.1	4.3-9.1	4.3-11.2
CC4	Mine Only	0-0.1	0-8.5	0-8.5	0-9	0-10.3	0-13.2
CC4	Climate Change*	16.1	16.1	16.1	16.1	16.1	16.1
CC4	Mine and Climate Change	16.1-16.2	16.1-24.6	16.1-24.6	16.1-25.1	16.1-26.4	16.1-29.3
CC5	Mine Only	0-0.1	0-8.5	0-8.5	0-9	0-10.3	0-13.2
CC5	Climate Change*	59.1	59.1	59.1	59.1	59.1	59.1
CC5	Mine and Climate Change	59.1-59.2	59.1-67.6	59.1-67.6	59.1-68.1	59.1-69.4	59.1-72.3
CC7	Mine Only	0-0.1	0-8.5	0-8.5	0-9	0-10.3	0-13.2
CC7	Climate Change*	102.1	102.1	102.1	102.1	102.1	102.1
CC7	Mine and Climate Change	102.1-102.2	102.1-110.6	102.1-110.6	102.1-111.1	102.1-112.4	102.1-115.3
CC13	Mine Only	0-0.4	0-3.9	0-3.9	0-3.9	0-3.9	0-3.9
CC13	Climate Change	44	44	44	44	44	44
CC13	Mine and Climate Change	44-44.4	44-47.9	44-47.9	44-47.9	44-47.9	44-47.9
CC15	Mine Only	0-0.8	0-15.4	0-15.4	0-15.4	0-15.4	0-15.4
CC15	Climate Change*	56	56	56	56	56	56
CC15	Mine and Climate Change	56-56.8	56-71.4	56-71.4	56-71.4	56-71.4	56-71.4
EG1	Mine Only	0-2.3	0-4.2	0-6.5	0-28.4	0-33.4	0.3-49.1
EG1	Climate Change	3.3	3.3	3.3	3.3	3.3	3.3
EG1	Mine and Climate Change	3.3-5.6	3.3-7.5	3.3-9.8	3.3-31.7	3.3-36.7	3.6-52.4
EG2	Mine Only	0-0.1	0-0.3	0-0.3	0-0.6	0-1.4	0-2.2
EG2	Climate Change	3.3	3.3	3.3	3.3	3.3	3.3
EG2	Mine and Climate Change	3.3-3.4	3.3-3.6	3.3-3.6	3.3-3.9	3.3-4.7	3.3-5.5
* Includes climate change reductions from all applicable upstream reaches as well							

Table A-2 (SBA Table D-11): Results of stream flow analysis for 95th percentile range – number of days with zero flow per year							
Key Reach	Scenario	End of Mine	10 Years	20 Years	50 Years	100 Years	150 Years
CC2	Climate Change	0	0	0	0	0	0
CC2	Mine and Climate Change	0	0	0	0	0	0
CC4	Mine Only	0	0	0	0	0	0
CC4	Climate Change	0	0	0	0	0	0
CC4	Mine and Climate Change	0	0	0	0	0	0
CC5	Mine Only	0-2	2-3	2-3	2-3	2-3	2-3
CC5	Climate Change	5	5	5	5	5	5
CC5	Mine and Climate Change	5	5-8	5-8	5-8	5-8	5-9
CC7	Mine Only	0-2	2-3	2-3	2-3	2-3	2-3
CC7	Climate Change	23	23	23	23	23	23
CC7	Mine and Climate Change	23	23-28	23-28	23-28	23-31	23-31
CC13	Mine Only	0	0	0	0	0	0
CC13	Climate Change	23	23	23	23	23	23
CC13	Mine and Climate Change	23	23	23	23	23	23
CC15	Mine Only	0	0	0	0	0	0
CC15	Climate Change	37	37	37	37	37	37
CC15	Mine and Climate Change	37	37-50	37-50	37-50	37-50	37-50
EG1	Mine Only	0	0	0-6	0-307	0-339	0-365
EG1	Climate Change	0	0	0	0	0	0
EG1	Mine and Climate Change	0	0-6	0-26	0-333	0-339	0-365
EG2	Mine Only	0	0	0	0	0	0
EG2	Climate Change	0	0	0	0	0	0
EG2	Mine and Climate Change	0	0	0	0	0	0

Table A-3 (SBA Table D-12): Results of stream flow analysis for 95th percentile range – number of days with extremely low flow[1] per year

Key Reach	Scenario	End of Mine	10 Years	20 Years	50 Years	100 Years	150 Years
CC2	Mine Only	0	0-6	0-6	0-6	0-6	0-6
CC2	Climate Change	6	6	6	6	6	6
CC2	Mine and Climate Change	6	6-11	6-11	6-11	6-11	6-11
CC4	Mine Only	0	0-6	0-6	0-6	0-6	0-6
CC4	Climate Change	6	6	6	6	6	6
CC4	Mine and Climate Change	6	6-11	6-11	6-11	6-11	6-11
CC5	Mine Only	3	3-3	3-3	3-3	3-4	3-4
CC5	Climate Change	23	23	23	23	23	23
CC5	Mine and Climate Change	23	23-28	23-28	23-28	23-31	23-31
CC7	Mine Only	3	3-3	3-3	3-3	3-4	3-4
CC7	Climate Change	60	60	60	60	60	60
CC7	Mine and Climate Change	60	60-68	60-68	60-68	60-68	60-73
CC13	Mine Only	0-8	0-8	0-8	0-8	0-8	0-8
CC13	Climate Change	46	46	46	46	46	46
CC13	Mine and Climate Change	46	46-61	46-61	46-61	46-61	46-61
CC15	Mine Only	0	0-9	0-9	0-9	0-9	0-9
CC15	Climate Change	57	57	57	57	57	57
CC15	Mine and Climate Change	57	57-72	57-72	57-72	57-72	57-72
EG1	Mine Only	0-19	0-26	0-58	0-339	0-359	6-365
EG1	Climate Change	26	26	26	26	26	26
EG1	Mine and Climate Change	26	26-64	26-102	26-339	26-365	26-365
EG2	Mine Only	0-6	0-6	0-6	0-6	0-6	0-19
EG2	Climate Change	26	26	26	26	26	26
EG2	Mine and Climate Change	26	26	26	26	26	26

Note: The magnitude of what constitutes extremely low flow varies by key reach and is defined as a modeled flow less than that observed during the critical summer low flow season. The defined low-flow discharges are as follows: EG1 (6 gpm); EG2 (6 gpm); CC2 (28 gpm); CC4 (56 gpm); CC5 (44 gpm); CC7 (44 gpm); CC13 (22 gpm); and CC15 (17 gpm).

Table A-4 (Table D-13): Results of stream flow analysis for 95 percentile range – flow status							
Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	P	P	P	P	P	P
CC2	Climate Change	P	P	P	P	P	P
CC2	Mine and Climate Change	P	P	P	P	P	P
CC4	Mine Only	P	P	P	P	P	P
CC4	Climate Change	P	P	P	P	P	P
CC4	Mine and Climate Change	P	P	P	P	P	P
CC5	Mine Only	P	P	P	P	P	P
CC5	Climate Change	P	P	P	P	P	P
CC5	Mine and Climate Change	P	P	P	P	P	P
CC7	Mine Only	P	P	P	P	P	P
CC7	Climate Change	P	P	P	P	P	P
CC7	Mine and Climate Change	P	P	P	P	P-I	P-I
CC13	Mine Only	P	P	P	P	P	P
CC13	Climate Change	P	P	P	P	P	P
CC13	Mine and Climate Change	P	P	P	P	P	P
CC15	Mine Only	P	P	P	P	P	P
CC15	Climate Change	I	I	I	I	I	I
CC15	Mine and Climate Change	I	I	I	I	I	I
EG1	Mine Only	P	P	P	P-I	P-I	P-E
EG1	Climate Change	P	P	P	P	P	P
EG1	Mine and Climate Change	P	P	P	P-I	P-I	P-E
EG2	Mine Only	P	P	P	P	P	P
EG2	Climate Change	P	P	P	P	P	P
EG2	Mine and Climate Change	P	P	P	P	P	P

Notes: P = Perennial (<30 no-flow days per year); I = Intermittent (30–350 no-flow days per year); E = Ephemeral (>350 no-flow days per year)
L = Low End of All Sensitivity Analyses; TT = Tetra Tech Base or Best-Fit Model; M = Montgomery Base or Best-Fit Model; MY = Myers Base or Best-Fit Model; H = High End of All Sensitivity Analyses
- Indicates no data available for this model/time step

STREAM FLOW STATUS

The analyses appearing below rely primarily on the 95th percentile analyses, as stated in the Sources of Uncertainty section, above. These results appear in their entirety in Tables A-1, A-2 and A-4 in this BO.

It is important to note that the present-day, no-mine condition serves as the baseline; the analyses in the Stream Flow Analysis section do not consider climate change-related flow losses to represent an ongoing and evolving representation of a climate change-influenced baseline against which mine-only effects are assessed. In other words, all effects, whether the result of anticipated climate change or mine drawdown, are described in terms of their divergence from pre-project conditions (though we note the present-day conditions have been influenced by climate change). The mine-only results represent the proposed action's effects to the discharge of groundwater to springs, fluvial systems, and other wetlands, and thus form the basis for our analyses of the manner and extent to which aquatic and riparian species are affected and, in the case of animals, incidentally taken. The mine plus climate change scenarios represent the future state of the hydrology to inform our conclusions regarding jeopardy for the affected species and/or the destruction or adverse modification of the affected proposed and final critical habitats as well as future consultations on other Federal actions.

The May 2015 SBA's stream flow loss analyses are expressed in gallons per minute (gpm). The narrative analyses appearing below, however, primarily emphasize increases in zero-flow and extremely-low flow days; these values effectively express the degree of alteration relative to today's baseflow hydrology, which has direct relevance to the habitat occupied by threatened and endangered aquatic species.

For this analysis, consistent with the FEIS and SIR, the following definitions are used: perennial (0 to 30 days with zero stream flow); intermittent (31 to 350 days with zero stream flow); ephemeral (more than 350 days with zero stream flow).

Upper Cienega Creek – Key Reaches CC2 and CC4

These reaches show no days with zero flow under current baseline conditions. Under the higher range of the 95th percentile analyses, the mine's effects by themselves are anticipated to result in stream flow losses in reach CC2 ranging from no change at the end of mining, up to 4.8 gpm at 10 to 100 years post-mining, and up to 6.9 gpm at 150 years. Reach CC4 experiences greater effects over the long term: for the higher range of the 95th percentile values, the mine may result in loss of only 0.1gpm at the end of mining but this loss increases to 8.5 gpm at 10 and 20 years, 9 gpm at 50 years, 10.3 gpm at 100 years, and 13.2 gpm at 150 years. These effects result in no increase in zero-flow days, and the stream remains perennial.

Climate change alone is anticipated to result in flow losses of 4.3 gpm and 16.1 gpm at all time-steps from 10 to 150 years at CC2 and CC4, respectively. These climate change-based flow losses by themselves are also not sufficient to cause any increase in zero-flow days, and the stream remains perennial.

The mine effects in combination with climate change shows potential stream flow losses in reach CC2 ranging from no change (the baseline 4.3 gpm) to from 9.1 to 11.2 gpm (at the end of mining to 150 years later, respectively) under the higher range of the 95th percentile analyses. Reach CC4 could experience greater effects from mining plus climate change. The higher end of the 95th percentile ranges from 24.6 gpm loss at 10 years to 29.3 gpm at 150 years. These combined effects still result in a perennial stream with no increase in zero-flow days.

Upper Cienega Creek – Key Reaches CC5 and CC7

The mine-only drawdown data for CC5 indicate an anticipated flow loss of 0.1 gpm at the end of mining, 8.5 gpm at 10 and 20 years post-mining, 9 gpm at 50 years, 10.3 gpm at 100 years, and 13.2 gpm at 150 years, all under the higher end of the 95th percentile analyses. Under the 95th percentile analysis, flow losses in CC5 are greater in magnitude and will reach 59.1 gpm from climate change alone at all time-steps. Under the higher end of the 95th percentile analyses, mining combined with climate change may increase flow losses to 59.2 gpm at 10 years and up to 72.3 gpm at 150 years.

At CC7, and also under the 95th percentile analysis, mining, by itself, may result in anticipated flow losses ranging from 0.1gpm at the end of mining to as high as 13.2 gpm at 150 years later. Key reach CC7 flow losses from climate change alone may be 102.2 gpm at all time-steps. Under the higher end of the 95th percentile analyses, mining plus climate change will increase flow losses to 102.2 gpm at the end of mining up to 115.3 gpm at 150 years. Mining is again an appreciable, though not dominant, factor in the CC7 flow losses.

Reaches CC5 and CC7 exhibit an average of 2 days with zero stream flow per year under present-day baseline conditions. Mine drawdown alone, assuming no influence from climate change, would change this to 2 or 3 days per year under the 95th percentile analyses. Future climate change absent the mine's impacts would result in 5 additional days with zero stream flow per year in CC5, and 23 additional days with zero stream flow per year in CC7.

In combination, and under the 95th percentile analyses, mine drawdown plus climate change would result in 5 to 9 days with zero stream flow per year in CC5, and from 23 to 31 days with zero stream flow per year in CC7. Flow status in CC5 would remain perennial under the proposed mine-plus climate change scenarios; flow status in CC7 also largely remains perennial for most scenarios, but by 100 years after mine closure, the higher range of the 95th percentile analysis indicates a possible shift to intermittent flow for the mine-plus-climate change scenario.

Lower Cienega Creek – Key Reaches CC13 and CC15

Key reaches CC13 and CC15 are both located within the Pima County Cienega Creek Natural Preserve (CCNP), the ecological condition of which has been exhaustively investigated by Pima County. The techniques employed by Powell *et al.* (2014) to measure the effects of the proposed action on the extent of aquatic habitat were incorporated, in a modified form (specifically, the use of actual stream flow data, rather than its natural log, in regression analyses) to the preceding hydrological analyses. A prior investigation, Powell *et al.* (2013), investigated trends in various hydrologic parameters and determined that lower Cienega Creek flow was in a downward trend,

meaning further flow losses will steepen the decline.

In brief, all water resources evaluated by Powell *et al.* (2013) within the Pima County CCNP displayed a decline over time. Streamflow and discharge were among the parameters that showed the greatest decline; between 1990 and 2011, the mean value of these two measures declined by 68 percent and 83 percent, respectively. Similarly, the geographic extent of surface water flow decreased from a high of 9.5 miles in the 1980s to a low of 1.1 miles in 2011, a decline of 88 percent during that time. The change was less pronounced, but still significant, from 1999-2011 during which time it declined by 63 percent. Changes in depth to groundwater varied among wells, but declines were as much as 44 percent at one site (Jungle Well) from 1994-2011.

This consultation employs the hydrologic methodologies stated in the SIR and May 2015 SBA. Of these, the higher-end 95th percentile analyses of the effects of mine drawdown alone, absent climate change, range from 0.4 gpm to 3.9 gpm at the end of mining at CC13 and from 0.8 gpm to 15.4 gpm at the same time intervals at CC15. The 95th percentile analyses indicate that reach CC 13 and CC 15 could experience flow losses of 44 and 56 gpm at each time step, respectively, solely from the effects of climate change. Adding the effects of the mine drawdown to climate change increases flow losses at CC13 and CC15 to 47.9 and 71.4 gpm at 150 years, respectively.

The May 2015 SBA's 95th percentile analyses for these reaches show that mine drawdown alone would result in no increase in zero stream flow at any time-step at either CC13 or CC15. Climate change by itself would result in 23 additional days exhibiting zero stream flow per year at every time step in CC13, and 37 additional days with zero stream flow at every time step in CC15. In combination, mine drawdown plus climate change would result in 23 days with zero stream flow per year in CC13 (no change from the climate change-only results), and from 37 to 50 days with zero stream flow per year in CC15 (up to 13 additional days relative to climate change alone). Reach CC13 would not change flow status from perennial. Climate change pushes reach CC15 from perennial to intermittent flow status, regardless of mine drawdown. Mine drawdown, however, may increase the intermittency.

The causes for the declining hydrology of lower Cienega Creek noted by Powell *et al.* (2013) are likely to include drought and potentially, upstream water uses such as private wells. Drought may be the result of a changing climate and thus, its effects have been explicitly incorporated into the May 2015 SBA's analyses. The effects of water uses associated with future upstream development have not been modeled or analyzed, and their expansion may result in some unspecified additional decline in stream discharge.

Upper Empire Gulch – Key Reach EG1

Reach EG1 may experience appreciable effects due to mine drawdown. The 95th percentile results, however, are characterized by large variations in outcomes and timing, unlike the relatively narrow results for reaches on Cienega Creek (CC1-CC15). The finite chance that the more-severe effects will occur requires us to evaluate them.

Under the higher range of the 95th percentile analyses, mine drawdown alone may cause flow losses from 2.3 gpm at the end of mining, ramping up steeply to 28.4 gpm at 50 years, and

reaching as high as 49.1 gpm at 150 years. Climate change, as modeled, would result in steady EG1 flow losses of 3.3 gpm from the end of mining through all time steps to 150 years. The higher range of the 95th percentile analyses for mine drawdown plus climate change results in 5.6 gpm of flow loss at the end of mining, which reaches 52.4 gpm at 150 years.

Mine drawdown is the dominant factor in the high-range, 95th percentile analyses of flow loss, which are of a magnitude sufficient to cause dewatering of the stream. The number of days with zero flow caused by mine-driven drawdown in upper Empire Gulch is anticipated to appreciably increase. At 150 years after mine closure, the 95th percentile range for mine drawdown alone shows a range that is anywhere from no change in days with zero stream flow (perennial flow status), to 365 days with zero stream flow (ephemeral flow status; complete loss of baseflow and flowing only in response to runoff). Climate change by itself is not anticipated to cause any additional zero flow days, though the effects of mine drawdown plus climate change differ somewhat from mine effects alone. Under the higher end of the 95th percentile analyses, mining and climate change are anticipated to cause 6 days of zero flow as early as 10 years after mining, 26 days at 20 years, 333 days at 50 years, 339 days at 100 years, and year-round dewatering at 150 years.

Climate change by itself is not anticipated to cause any change in upper Empire Gulch's flow status; reach EG1 would remain perennial. At the higher range of the 95th percentile range, mine drawdown may cause this reach to shift from perennial to intermittent flow by 50 years after mine closure and to ephemeral flow by 100 years after mine closure. Mine drawdown with climate change yields the same results.

Lower Empire Gulch – Key Reach EG2

Discharges in lower Empire Gulch appear to be relatively less sensitive to mine drawdown relative to upper Empire Gulch (EG1, above). The higher end of the 95th percentile, mine-only modeling scenario predicts that lower Empire Gulch will experience flow losses ranging from 0.1 gpm at the end of mining to 2.2 gpm at 150 years later. Climate change is anticipated to result in 3.3 gpm losses at all time-steps. The higher end of the 95th percentile analyses for the mine combined with climate change predict flow losses ranging from 3.4 gpm to 5.5 gpm at the end of mining and 150 years, respectively. Climate change is the larger effect.

WATER QUALITY

For the purpose of this analysis, water quality refers primarily to dissolved oxygen levels, crucial for the persistence of aquatic life. Temperature exerts an influence on dissolved oxygen, and is therefore considered to be a predictive measure of dissolved oxygen. The BLM has monitored temperature and dissolved oxygen along with stream flow at their monitoring locations on Empire Gulch and Cienega Creek; trend analyses for these parameters are included in SIR Appendix C. While the USFS determined in the SIR that the relationships between temperature and dissolved oxygen were not strongly predictive, as shown in SIR Table 3 (page 52), there is a statistically significant relationship between reductions in stream flow, increases in temperature, and decreases in dissolved oxygen. Reduced stream flow will result in a reduced volume of water

which, during flow-flow, high-air temperature season (typically May and June), will cause a concomitant decrease in dissolved oxygen.

The analysis of water quality is therefore expressed in terms of the days of extremely low flow. Please note that the use of the term "extremely" in the context of low flows is the result of its use in the SIR and May 2015 SBA and is intended only to differentiate near-zero flows from flows that are simply less than typically observed. The magnitude of what constitutes extremely low flow varies by key reach and is defined as a modeled flow less than that observed during the critical summer low flow season. The defined low-flow discharges are as follows: EG1 (6 gpm); EG2 (6 gpm); CC2 (28 gpm); CC4 (56 gpm); CC5 (44 gpm); CC7 (44 gpm); CC13 (22 gpm); and CC15 (17 gpm). The defined low-flow discharges vary among the key reaches and are as follows: EG1 (6 gpm); EG2 (6 gpm); CC2 (28 gpm); CC4 (56 gpm); CC5 (44 gpm); CC7 (44 gpm); CC13 (22 gpm); and CC15 (17 gpm) (Garrett pers. comm.) Again, our analysis will focus primarily on the 95th percentile analysis of the frequency of discharges below these values. Low-flow frequency is displayed in Table A-3, above.

Again, we primarily discuss the results of the higher-end of the 95th percentile analyses of all models in order to evaluate a less-likely, although theoretically-possible, set of effects for the respective Key Reaches. Our narrative analyses for upper Empire Gulch (Key Reach EG-1) will discuss both low-range and high-range results while still placing greater precautionary, analytical emphasis on the worst-case scenario.

Under present-day conditions, during periods of low seasonal stream flow (May/June), portions of the aquatic environment along Cienega Creek and Empire Gulch can experience high water temperatures and low concentrations of dissolved oxygen (DO). These same trends would be expected to continue under future climate change and be further exacerbated by mine drawdowns during days where stream flow is predicted to fall to levels lower than those experienced currently.

In brief, the proposed action would result in increasing numbers of extremely low-flow days at most sites. In particular, Key Reach EG1 in Empire Gulch may experience either little change from current conditions or total dewatering due to mine-driven aquifer drawdown; precaution dictates we give relatively greater weight to the more severe potential outcome.

Upper Cienega Creek – Key Reaches CC2 and CC4

Upper Cienega Creek (key reaches CC2 and CC4) experience no days with extremely low flows under present-day, baseline conditions. With respect to water quality impacts in both reach CC2 and CC4, climate change by itself would result in up to 6 days of extremely low flows per year at each time step. The 95th percentile analysis of mine drawdown predicts an anticipated outcome of up to 6 days of extremely low flows, at the conclusion of mining. In other words, upon closure, the mine results in no incremental increases in extremely low-flow days beyond those precipitated by climate change.

Beginning at 10 years post-closure, mine-related drawdowns plus climate change would result in extremely low flow days ranging up to 11 days per year (up to 5 additional days per annum

relative to climate change alone). This indicates a relatively greater, though still minor, mine-related contribution to water quality effects over time. Climate change remains the greater effect.

Upper Cienega Creek – Key Reaches CC5 and CC7

With respect to water quality impacts under the 95th percentile analyses, these reaches currently exhibit an average of 3 days with extremely low stream flow per year under current conditions. The effects of mine drawdown for Key Reach CC5 will increase by only 1 day (to 4 days annually) by 100 years after mining. Climate change is anticipated to have a more drastic effect, and by itself will increase the occurrence of extremely low flow days to 23 days per year for all post-mine time steps at CC5. The 95th percentile, higher range mine-plus-climate change values range from 28 days at the 10-, 20-, and 50-year time steps to 31 days at the 10- and 150-year time steps. Climate change is the greater effect.

Within CC7, and at the higher-end of the 95th percentile analyses, mine drawdowns alone are anticipated to result in only a single extra day of extremely low flows by 100 years, as was noted for reach CC5, above. Climate change by itself will increase the number of extremely low flow days from 3 days a year under current conditions to 60 days at all post-mine time steps. The high-range, 95th percentile climate change-plus-mine modeling results increase from 68 days at 10 to 100 years to 73 days at 150 years. Thus, the suite of 95th percentile analyses indicates a moderate mine-only contribution of drawdown-related effects.

As is the case with CC2 and CC4, current low-flow conditions during May and June already result in high water temperatures and low DO within the aquatic environment along Cienega Creek. These adverse conditions are expected to increase in frequency during a changing climate and possibly to an even greater extent due to the effects of mine-related groundwater drawdowns.

Lower Cienega Creek – Key Reaches CC13 and CC15

Key reaches CC13 and CC15 do not experience extremely low flows under current conditions. Mining is anticipated to increase this to 8 days in CC13 and 9 days in CC15 by 10 years (and throughout the post-mining period to 150 years). Climate change is anticipated to increase the occurrence of extremely low-flow days at CC13 and CC 15 to 46 to 57 days at all time-steps, respectively. Mine drawdown and climate change combined would result in 61 days of extremely flow at CC13 and up to 72 days at CC15. Again, these represent the higher values from the 95th percentile analysis. Climate change is the greater effect.

As stated previously, these conditions will increase the incidence of poorer water quality that adversely affects aquatic life in the Pima County CCNP.

Upper Empire Gulch – Key Reach EG1

Upper Empire Gulch already experiences low flows and compromised water quality during May and June. Under the higher range values in the 95th percentile analyses for mine drawdown, upper Empire Gulch is anticipated to steadily increase from 19 days of extremely low flow per

year at the end of mining, increasing steeply to 339 days at 50 years, 359 days at 100 years, and year-round at 150 years. Note that the 150-year low-flow analysis is subsumed within the 150-year zero-flow data discussed above; upper Empire Gulch is anticipated to be completely dewatered.

In these analyses, mine drawdown is the dominant factor in the anticipated effects. Climate change alone will only increase the incidence of extremely low-flow days to 26 per year from the end of mining to 150 years later. Modeled high-range, 95th percentile water quality effects for the mine plus climate change reach 64 days at 10 years, 102 days at 20 years, 339 at 50 years, and year-round at 100 and 150 years.

Again, it must be noted that the values discussed above actually include both extremely low stream flow and zero stream flow and need to be considered in conjunction with the days with zero stream flow metric. In the case of reach EG1, the 365 days of extremely low flow at the 100- and 150-year intervals are actually days with zero stream flow.

We are aware of the highly-divergent modeling results for this site (see contrast between low-range and high-range results in Table A-3, for example). Again, the wide range of these data make definitive conclusions uncertain, but precaution dictates we give greater weight to possibility that upper Empire Gulch will experience severe hydrologic effects.

Lower Empire Gulch – Key Reach EG2

Lower Empire Gulch does not experience extremely low flows under current conditions. Mining, under the 95th percentile analyses, is modeled to increase this to 6 days annually from the end of mining to 100 years, and up to 19 days at 150 years. Climate change will result in an additional 26 days of extremely low flows at lower Empire Gulch; mining plus climate change will not increase this number either under the 95th percentile analysis or the higher range of the sensitivity analysis. This indicates a relatively greater, though still minor, mine-related contribution to water quality effects over time. Climate change is the greater effect.

Under current conditions, during periods of low seasonal stream flow (May/June), portions of the aquatic environment along Cienega Creek and Empire Gulch can experience high water temperatures and low concentrations of dissolved oxygen. These same trends would be expected to continue and be exacerbated during days where stream flow is predicted to fall to levels lower than those experienced currently.

Standing Pool Analysis

Table 7 in the May 2015 SBA provides an index to the standing pool analysis results. The tables with the results of the standing pool analysis (tables D-14 through D-26) are provided in full in the SBA's Appendix D, and also appear in this BO as Tables A-5 through A-8, below. Graphical representations of the results are included in the SBA's Appendix F.

The 95th percentile summary of stream flow results appearing in Tables A-5 through A-8, like Tables A-1 through A-4, above, also disclose that, at certain locations and time intervals, there is

a potential range of results; lower and higher. We primarily discuss the results of the higher-end of the 95th percentile analyses of all models in order to evaluate a less-likely, although theoretically-possible, set of effects for the respective Key Reaches. Our narrative analyses for upper Empire Gulch (Key Reach EG-1) will, however, discuss both low-range and high-range results. This is appropriate given the widely divergent values for the potential effects; effects range from no measurable effect to complete dewatering at later time-steps. Regardless of this disclosure, precaution still dictates the analysis of the worst-case scenario for Empire Gulch.

Table A-5 (SBA Table D-23): Results of refugia pool analysis for 95th percentile range – number of pools remaining under no-flow conditions							
Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	22	22	22	22	22	22
CC2	Climate Change	19	19	19	19	19	19
CC2	Mine and Climate Change	19	19	19	19	19	19
CC4	Mine Only	16	16	16	16	16	16
CC4	Climate Change	15	15	15	15	15	15
CC4	Mine and Climate Change	15	15	15	15	15	15
CC5	Mine Only	19	19	19	19	19	19
CC5	Climate Change	19	19	19	19	19	19
CC5	Mine and Climate Change	19	19	19	19	19	19
CC7	Mine Only	15	15	15	15	15	15
CC7	Climate Change	15	15	15	15	15	15
CC7	Mine and Climate Change	15	15	15	15	15	15
CC13	Mine Only	8	8	8	8	8	8
CC13	Climate Change	7	7	7	7	7	7
CC13	Mine and Climate Change	7	7	7	7	7	7
CC15	Mine Only	4	4	4	4	4	4
CC15	Climate Change	3	3	3	3	3	3
CC15	Mine and Climate Change	3	3	3	3	3	3
EG1	Mine Only	5	5	5	2-5	2-5	0-5
EG1	Climate Change	5	5	5	5	5	5
EG1	Mine and Climate Change	5	5	5	2-5	1-5	0-5
EG2	Mine Only	11	11	11	11	11	11
EG2	Climate Change	10	10	10	10	10	10
EG2	Mine and Climate Change	10	10	10	10	10	10
CGW	Mine Only	3	3	3	3	3	3
CGW	Climate Change	3	3	3	3	3	3
CGW	Mine and Climate Change	3	3	3	3	3	3

Table A-6 (SBA Table D-24): Results of refugia pool analysis for 95 percentile range – median* depth of pools							
Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	1.1	1.1	1.1	1.1	1.1	1.1
CC2	Climate Change	1.9	1.9	1.9	1.9	1.9	1.9
CC2	Mine and Climate Change	1.9	1.9	1.9	1.9	1.9	1.9
CC4	Mine Only	2.5	2.4-2.5	2.4-2.5	2.4-2.5	2.4-2.5	2.4-2.5
CC4	Climate Change	2.4	2.4	2.4	2.4	2.4	2.4
CC4	Mine and Climate Change	2.4	2.4	2.4	2.4	2.4	2.4
CC5	Mine Only	2.9	2.9	2.9	2.9	2.9	2.9
CC5	Climate Change	2.5	2.5	2.5	2.5	2.5	2.5
CC5	Mine and Climate Change	2.5	2.5	2.5	2.5	2.5	2.5
CC7	Mine Only	2.9	2.9	2.9	2.9	2.9	2.8-2.9
CC7	Climate Change	2.5	2.5	2.5	2.5	2.5	2.5
CC7	Mine and Climate Change	2.5	2.5	2.5	2.5	2.5	2.4-2.5
CC13	Mine Only	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9
CC13	Climate Change	0.5	0.5	0.5	0.5	0.5	0.5
CC13	Mine and Climate Change	0.5	0.5	0.5	0.5	0.5	0.5
CC15	Mine Only	1.4	1.4	1.4	1.4	1.4	1.4
CC15	Climate Change	1.7	1.7	1.7	1.7	1.7	1.7
CC15	Mine and Climate Change	1.7	1.7	1.7	1.7	1.7	1.7
EG1	Mine Only	1.0-1.2	0.9-1.2	0.7-1.2	0.8-1.2	0.4-1.2	N-1.2
EG1	Climate Change	0.8	0.8	0.8	0.8	0.8	0.8
EG1	Mine and Climate Change	0.6-0.8	0.5-0.8	0.3-0.8	0.4-0.8	0.2-0.8	N-0.8
EG2	Mine Only	1.9	1.9	1.9	1.9	1.8-1.9	1.7-1.9
EG2	Climate Change	1.6	1.6	1.6	1.6	1.6	1.6
EG2	Mine and Climate Change	1.5-1.6	1.5-1.6	1.5-1.6	1.5-1.6	1.5-1.6	1.4-1.6
CGW	Mine Only	3.6	3.6	3.6	3.5-3.6	3.4-3.6	3.2-3.6
CGW	Climate Change	3.2	3.2	3.2	3.2	3.2	3.2
CGW	Mine and Climate Change	3.2	3.2	3.2	3.1-3.2	3.0-3.2	2.8-3.2
N - Indicates that no pools are predicted to remain * The median is calculated only from those pools predicted to remain.							

Table A-7 (SBA Table D-25): Results of refugia pool analysis for 95 percentile range – median* percent remaining volume of pools

Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	99	88-99	88-99	88-99	88-99	84-99
CC2	Climate Change	52	52	52	52	52	52
CC2	Mine and Climate Change	52	50-52	50-52	50-52	50-52	50-52
CC4	Mine Only	100	97-100	97-100	97-100	97-100	96-100
CC4	Climate Change	62	62	62	62	62	62
CC4	Mine and Climate Change	62	61-62	61-62	61-62	60-62	60-62
CC5	Mine Only	99	97-99	97-99	97-99	97-99	97-99
CC5	Climate Change	67	67	67	67	67	67
CC5	Mine and Climate Change	67	66-67	66-67	66-67	66-67	66-67
CC7	Mine Only	100	98-100	98-100	97-100	95-100	93-100
CC7	Climate Change	67	67	67	67	67	67
CC7	Mine and Climate Change	67	66-67	66-67	65-67	64-67	63-67
CC13	Mine Only	99-100	88-100	88-100	88-100	88-100	88-100
CC13	Climate Change	18	18	18	18	18	18
CC13	Mine and Climate Change	18	17-18	17-18	17-18	17-18	17-18
CC15	Mine Only	100	89-100	89-100	89-100	89-100	89-100
CC15	Climate Change	53	53	53	53	53	53
CC15	Mine and Climate Change	51-53	51-53	51-53	51-53	51-53	51-53
EG1	Mine Only	64-100	40-100	30-100	4-100	0-100	N-90
EG1	Climate Change	33	33	33	33	33	33
EG1	Mine and Climate Change	24-33	17-33	11-33	0-33	0-33	N-31
EG2	Mine Only	99-100	97-100	97-100	94-100	87-100	81-100
EG2	Climate Change	59	59	59	59	59	59
EG2	Mine and Climate Change	58-59	57-59	57-59	56-59	53-59	49-59
CGW	Mine Only	98-100	92-100	90-100	75-100	52-100	38-100
CGW	Climate Change	38	38	38	38	38	38
CGW	Mine and Climate Change	37-38	36-38	36-38	33-38	28-38	21-38

N - Indicates that no pools are predicted to remain
* In this case, 100 percent indicates that the pool retains all of its original volume; lower percentages indicate the percentage left of the original volume. For instance, a statistic of 80 percent would mean that the pool retains 80 percent of its original volume, and has lost or shrunk by 20 percent. The median is calculated only from those pools predicted to remain.

Table A-8 (SBA Table D-26): Results of refugia pool analysis for 95 percentile range – median* percent remaining surface area of pools

Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	99	92-99	92-99	92-99	92-99	89-99
CC2	Climate Change	57	57	57	57	57	57
CC2	Mine and Climate Change	57	55-57	55-57	55-57	55-57	55-57
CC4	Mine Only	100	98-100	98-100	98-100	98-100	97-100
CC4	Climate Change	68	68	68	68	68	68
CC4	Mine and Climate Change	68	67-68	67-68	67-68	67-68	67-68
CC5	Mine Only	99	98-99	98-99	98-99	98-99	98-99
CC5	Climate Change	75	75	75	75	75	75
CC5	Mine and Climate Change	75	74-75	74-75	74-75	74-75	74-75
CC7	Mine Only	100	98-100	98-100	98-100	96-100	94-100
CC7	Climate Change	71	71	71	71	71	71
CC7	Mine and Climate Change	71	69-71	70-71	69-71	68-71	67-71
CC13	Mine Only	99-100	91-100	91-100	91-100	91-100	91-100
CC13	Climate Change	29	29	29	29	29	29
CC13	Mine and Climate Change	29	28-29	28-29	28-29	28-29	28-29
CC15	Mine Only	100	92-100	92-100	92-100	92-100	92-100
CC15	Climate Change	63	63	63	63	63	63
CC15	Mine and Climate Change	63	61-63	61-63	61-63	61-63	61-63
EG1	Mine Only	78-100	61-100	47-100	7-100	2-100	N-93
EG1	Climate Change	52	52	52	52	52	52
EG1	Mine and Climate Change	38-52	26-52	14-52	2-52	2-52	N-48
EG2	Mine Only	100	98-100	98-100	97-100	93-100	89-100
EG2	Climate Change	73	73	73	73	73	73
EG2	Mine and Climate Change	73	72-73	72-73	70-73	67-73	64-73
CGW	Mine Only	99-100	94-100	93-100	81-100	64-100	52-100
CGW	Climate Change	51	51	51	51	51	51
CGW	Mine and Climate Change	51	50-51	49-51	45-51	38-51	29-51

N - Indicates that no pools are predicted to remain
* In this case, 100 percent indicates that the pool retains all of its original volume; lower percentages indicate the percentage left of the original volume. For instance, a statistic of 80 percent would mean that the pool retains 80 percent of its original volume, and has lost or shrunk by 20 percent. The median is calculated only from those pools predicted to remain.

Summary of Standing Pool Analysis Results

The following summary of results is based, like the stream flow and water quality analyses above, on the 95th percentile analyses provided in the May 2015 SBA.

It is again noted that the present-day, pre-proposed action condition serves as the baseline; the analyses in the Standing Pool Analysis do not consider future anticipated climate change-related losses to represent an ongoing and evolving representation of a climate-change influenced baseline because we view climate change as an effect (though not of the proposed action). In other words, all effects, whether the result of anticipated climate change or mine drawdown, are described in terms of their divergence from pre-project conditions. The percent losses described throughout the Pool Analysis subsections therefore refer to losses from a fixed, present-day baseline, not incremental losses between time steps or the increments between future climate change and drawdown-related losses. Again, we reiterate that all effects, whether the result of anticipated climate change or mine drawdown, are described in terms of their divergence from pre-project conditions. Furthermore, the mine plus climate change scenarios represent the future state of the hydrology to inform our conclusions regarding jeopardy for the affected species and/or the destruction or adverse modification of the affected proposed and final critical habitats as well as future consultations on other Federal actions.

It should also be noted that the tables summarizing results use summary statistics, such as the median depth, volume, or area for all pools in a key reach. To ensure that use of these statistics does not mask[9] the full range of results, results for individual pools are also included in Appendix G of the May 2015 SBA.

In brief, the proposed action will result in varying reductions in the numbers, depth, volume, and surface area of pools. The percentages of losses (and/or percentages retained) for volume and surface area represent the median value for all pools in the reach, and reflect the percentage loss (and/or percentage remaining) of the original volume or surface area. As is the case with the stream flow and water quality analyses, above, Key Reach EG1 in Empire Gulch may experience either little effect or a near-total loss of aquatic ecological function; we have exercised precaution and given greater weight to the latter, worse-case analysis.

Also note that for median depth, median percent remaining pool volume and median percent remaining pool area, the larger magnitude of effect is associated with the lower-range number in those 95th percentile analyses that report a range of values. Precaution also dictates that we give these greater adverse effects more analytical weight.

9 As stated in the May 2015 SBA, selection of summary statistics exhibits shortcomings. In this case, the use of median values to summarize the results for an entire key reach can lead to some non-intuitive mathematical outcomes. This is because the median is only calculated using those pools still in existence, and does not incorporate pools that have dried up completely. For example, the median depth of pools in reach CC2 under current conditions is 1.1 feet, which is calculated using a total of 22 pools. Climate change stress causes three pools to disappear. Each of the individual remaining pools is modelled to drop 0.4 foot due to climate change, but when the median is calculated using the those remaining 19 pools, the median is 1.9 feet, which is deeper than under current conditions.

Pool Analysis

Upper Cienega Creek – Key Reaches CC2 and CC4

Upper Cienega Creek in reach CC2 currently possesses 22 pools with a median depth of 1.1 ft. (ranging from 0.3 to 7.8 ft.). Upper Cienega Creek in reach CC4 currently possesses 16 pools with a median depth of 2.5 ft. (ranging from 0.3 to 9.7 ft.).

Mine drawdown under the 95th percentile analyses, by itself, does not change the number of pools present in either CC2 or CC4. Climate change reduces the number of pools from 22 to 19 for reach CC2, and from 16 to 15 for reach CC4. Mining and climate change combined result in no additional effect to the number of pools.

The 95th percentile modeling results for mine drawdown, climate change, and both scenarios combined do not indicate any change in median percent remaining pool depth in CC2 and only 0.1 ft. of lost depth from mine drawdown in CC4.

Under the 95th percentile analyses for CC2, median remaining pool volume under the mine-only scenario may drop to 84 percent by 150 years. Climate change has greater effects to pool volume, leaving 52 percent remaining at all time-steps. The combination of mining and climate change may result in as little as 50 percent of pool volume remaining at 10 through 150 years.

Under the 95th percentile analyses for CC4, median remaining pool volume under the mine-only scenario may drop to 97 percent from 10 to 100 years following mining and 96 percent at 150 years. Climate change has greater effects to pool volume, leaving 62 percent remaining at all time-steps. The combination of mining and climate change may result in as little as 62 to 60 percent of pool volume remaining at 10 to 150 years, respectively.

The 95th percentile analyses of the percent remaining pool surface area again indicates that greater surface area losses in CC2 begin at the cessation of mining and increase over time. Mine drawdown may leave 89 percent area remaining at 150 years while climate change leaves as little as 57 percent at the same time step. Combined, as little as 55 percent of the initial pool area may remain 150 years after mining.

Upper Cienega Creek – Key Reaches CC5 and CC7

Upper Cienega Creek in reach CC5 currently possesses 19 pools with a median depth of 2.9 ft. (ranging from 1.7 to 8.3 ft.). Upper Cienega Creek in reach CC7 currently possesses 15 pools exhibiting a median depth of 2.9 ft. (ranging from 1.1 to 6.3 ft.).

The 95th percentile analyses indicate the number of pools in CC5 (19) or CC7 (15) will not be reduced by mine drawdown, climate change, or both effects combined. Median pool depth in CC5 will be similarly unaffected, but CC7 may lose 0.1 ft. of pool depth from mine drawdown at 150 years.

Mine drawdown may leave 97 percent of pool volume remaining in CC5 at 150 years while

climate change may leave 67 percent remaining at the same time step. In CC7, mine drawdown by itself may leave 93 percent of pool volume remaining in CC5 at 150 years while climate change may leave 67 percent of pool volume remaining. Combined, mining and climate change are anticipated to result in 66 percent of the current CC5 pool volume and 63 percent of the current CC7 pool volume remaining at the 150-year time step.

Similarly, the 95th percentile results for median remaining pool surface area display greater effects from climate change than from mining alone. At 150 years, mine drawdown is anticipated to leave 98 percent of the pool surface area remaining in CC5 and 94 percent in CC7. Climate change will leave 75 percent in CC5 and 71 percent in CC7 at 150 years. Combined mining and climate change will result in 74 percent and 67 percent median pool surface area remaining at 150 years in reaches CC5 and CC7, respectively.

Lower Cienega Creek – Key Reaches CC13 and CC15

Lower Cienega Creek in reach CC13 currently possesses 8 pools with a median depth of 0.9 ft. (ranging from 0.4 to 3.1 ft.). Lower Cienega Creek in reach CC15 currently possesses 4 pools with a median depth of 1.4 ft. (ranging from 0.3 to 2.3 ft.).

Under the 95th percentile analysis, mine drawdown by itself does not change the number of pools present in key reaches CC13 and CC15. Climate change by itself reduces the number of pools from 8 to 7 for reach CC13, and from 4 to 3 for reach CC15. Mine drawdown and climate change, when combined, also do not substantially change the median pool depth (0.1-ft. change).

In CC13, the mine alone is anticipated to leave as little as 88 percent of pool volume remaining beginning as soon as 10 years after mining. Climate change has even greater effects, leaving as little as 18 percent of pool volume remaining 10 years post-mining. Together, the mine and a changing climate are anticipated to leave as little as 17 percent of pool volume remaining at 150 years. In CC15, mine drawdown will have similar effects (89 percent remaining). Climate change will affect CC15 to a lesser extent than CC13, though it will still leave just 53 percent pool volume remaining at all intervals from 10 to 150 years. Mining and climate change combined are anticipated to leave as little as 51 percent pool volume remaining in CC15 over time.

The 95th percentile, mine-only effect out to 150 years is the retention of 91 percent of median surface area in CC13. Climate change effects are of a greater magnitude in CC13; just 29 percent will remain by 150 years post-mining. Mining and climate change combined will leave as little as 28 percent of pool surface area remaining in key reach CC13 at 150 years out.

In key reach CC15, mining alone will leave at least 92 percent of median pool area intact throughout the modeled period (10 to 150 years). Climate change will leave 63 percent in place out to 150 years post-mining. Combining climate change and mining modestly decreases the median remaining pool area to 61 percent, beginning at 10 years and extending out to 150 years post-mining.

Upper Empire Gulch – Key Reach EG1

Upper Empire Gulch in Key Reach EG1 currently possesses 5 pools exhibiting a median depth of 1.2 ft. (ranging from 0.9 to 3.0 ft.).

Similar to the stream flow analysis, the 95th percentile range of pool results for reach EG1 encompasses a wide range of outcomes. Unlike the reaches on Cienega Creek, the range of possible outcomes for EG1 pools is quite large, as is the range of potential timing for impacts to occur.

At 150 years after mine closure, the 95th percentile range for mine drawdown alone shows an estimate that ranges from all pools remaining in the reach to no pools remaining. At the higher range of the 95th percentile range, pools begin to disappear by 50 years after mine closure. At the low end of the 95th percentile range, all pools remain even 150 years after mine closure. Climate change has very little effect on the number of pools, even in combination with mine drawdown. Mining plus climate change yields results similar to the effects of mining alone, although as few as one pool could remain by 100 years post mining (the mine alone could leave just two).

Mining alone may result in steady declines in the median depth of pools under the 95th percentile analysis, with depths potentially reaching zero (complete dewatering) at the higher end of the analysis range by 150 years. Climate change has a steady adverse effect on median pool depth (0.8 ft.) at all time-steps. Climate change combined with the mine's drawdown results, again at the higher range, in steadily increasing losses of pool depth over time, culminating in dewatering by 150 years.

Pool volume exhibits appreciable losses under the higher end of the 95th percentile analyses. The mine by itself could leave as little as 64 percent of the volume intact by the end of mining, progressing steadily until pools are absent at 150 years. Climate change is anticipated to result in the loss of two-thirds (33 percent volume remaining) at all times steps. Climate change with the mine in place may have immediate and severe effects on pool volume; ranging from as little as 24 percent remaining at the end of mining to no remaining volume (dewatering) at 50 years.

The effects of the mine, by itself and at the higher end of the 95th percentile analyses, on the percent remaining pool surface area are similar in scope to the effects on volume described above, with steadily increasing losses occurring from the end of mining through 150 years. The effects reach a 53 percent loss at 20 years (47 percent remaining), only 7 percent remaining at 50 years, just 2 percent remaining at 100 years, and total loss of pools at 150 years. Climate change is anticipated to remove 48 percent of pool surface area by itself, so the effects of the mine plus climate change effects may be severe. At the higher end of the 95th percentile analyses, 38, 26, 14, 2, 2, and 0 percent of pool surface area remains at the end of mining, at 10, 20, 50, 100, and 150 years, respectively.

As with the analysis of effects to streamflow, above, aquatic species occurring in pools in upper Empire Gulch are anticipated to experience appreciable additive adverse effects from the proposed action beyond the effects of climate change, and may ultimately be extirpated from the site.

Lower Empire Gulch – Key Reach EG2

Lower Empire Gulch in Key Reach EG2 currently possesses 11 pools, the depths of which range from 0.2 to 4.9 ft. The median depth of these 11 pools is 1.9 ft.

Mine drawdown does not change the number of pools present in reach EG2; climate change reduces the number of pools from 11 to 10 (a 9 percent loss of numbers of pools, with 90 percent retained). Combined, mining and climate change retain the potential for the loss of only one pool.

Mine drawdown does changes the pool depth to a small degree (0.2 ft. at 150 years). Pool volume could be reduced by 19 percent (81 percent remaining) at 150 years from mining alone while climate change is anticipated to result in a 41 percent loss of pool volume (59 percent remaining) throughout the modeled time period. Mining and climate change together may leave as little as 58 percent volume remaining (42 percent lost) at the end of mining, increasing modestly to 49 percent (51 percent lost) at 150 years.

The 95th percentile analyses of the losses of median pool surface area in EG2 are similar in magnitude. The mine alone is anticipated to leave 89 percent of pool surface area intact (11 percent lost) at 150 years, with all other time-steps at a less than 10 percent loss (greater than 90 percent retained). Climate change is the predominant factor in surface area losses in EG2 pools, leaving 73 percent at all modeled intervals. Together, climate change and mine drawdown will leave 64 percent of pool surface area intact (and 36 percent lost) at 150 years.

Pools in lower Empire Gulch are anticipated to experience measurable adverse effects, although lower in magnitude relative to upstream reaches.

Cieneguita Wetlands – Key Reach CGW

The Cieneguita Wetlands (Key Reach CGW) is composed of 3 pools with depths ranging from 1.7 to 3.9 ft.; the median depth is 3.6 feet.

Similar to reach EG1, the 95th percentile range of results for the Cieneguita Wetlands encompasses a wide range of results. The number of pools does not change, either by mine drawdown alone or in combination with climate change.

Pool depth changes slightly due to mine drawdown by itself; 150 years after mine closure, median pool depth from reduces from 3.6 to 3.2 feet (11 percent loss of depth, 89 percent remaining). Pool volume does change substantially, albeit with large variations in some results. At the higher end of the 95th percentile analyses, the mine, by itself, reduces pool volume to 75 percent (25 percent lost) by 50 years, 52 percent (48 percent lost)by 100 years, and 38 percent (62 percent lost) by 150 years. Climate change by itself reduces pool volume to 38 percent of original volume (62 percent lost) at 150 years, and in combination with mine drawdown, pools are reduced to as little as 21 percent of original volume (79 percent of original volume lost).

Under the higher end of the 95th percentile analyses, mine drawdown alone is anticipated to decrease pool surface area modestly at the end of mining, and likewise at 10 and 20 years post-mining (99, 94, and 93 percent remaining pool surface area, respectively). Mine-only effects ramp up to 81 percent surface area remaining at 50 years, 65 percent at 100 years, and 52 percent at 150 years (19, 35, and 48 percent lost pool surface area, respectively). Climate change, under the same scenario, is predicted to leave 51 percent pool volume remaining (a 49-percent loss) in CGW throughout the modeled period (end of mining to 150 years). Effects are anticipated to be greatest when mine drawdown is considered in combination with climate change. The 100- and 150-year time step predictions are that as little as 38 and 29 percent of pool surface area, respectively, will be retained (meaning that 62 to 71 percent of pool volume will be lost at the 100- and 150-year time steps, respectively).

Summary of Effects to Aquatic Ecosystems

Climate change is anticipated to adversely affect aquatic ecosystems via increased temperatures, reduced precipitation, and altered patterns of precipitation. The proposed action contributes incremental effects that will, at varying levels, further diminish surface flows, the dimensions of pool habitat, and reduce water quality, resulting in significant degradation of the aquatic ecosystem on which the Gila chub, Gila topminnow, desert pupfish, Huachuca water umbel, Chiricahua leopard frog, and northern Mexican gartersnake depend.

Upper Empire Gulch (EG1) may suffer the most appreciable effects, with the potential to be subject to over 300 days of zero flow by 50 years post-mining. The number, depth, volume, and surface area of upper Empire Gulch's pools may all be appreciably reduced, primarily due to mine effects, thus significantly degrading the aquatic habitat available in the reach.

The main stem of Cienega Creek (key reaches CC2, CC4, CC5, CC7, CC13, and CC15) will variously experience measurable losses of discharge, increases in the occurrence of zero flow and extremely low flows, and reductions in the number, depth, volume, and surface area of pools, with the magnitude varying by site. The manner and degree to which these changes effect the Gila chub, Gila topminnow, desert pupfish, Huachuca water umbel, Chiricahua leopard frog, northern Mexican gartersnake, and applicable proposed and final critical habitats are detailed in the respective species' effects analyses below. Regardless of the ultimate determinations regarding the effects of the proposed action and its conservation measures on the affected species and critical habitats, the relatively minor mine drawdown-related effects (and the mine effects plus the relatively greater climate change effects) in the main stem of Cienega Creek still represent significant degradations of the aquatic ecosystem.

Background for Subsequent Analyses and Definition of Baseline

The hydrologic data appearing in the preceding section and upon which a portion of the riparian ecosystem, Gila chub, Gila topminnow, desert pupfish, Huachuca water umbel, Chiricahua leopard frog, northern Mexican gartersnake, yellow-billed cuckoo, and southwestern willow flycatcher-specific analyses employ hydrologic data based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable.

These 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

This statement will be reiterated in the respective effects analyses for the Gila chub, Gila topminnow, desert pupfish, Huachuca water umbel, Chiricahua leopard frog, northern Mexican gartersnake, yellow-billed cuckoo, and southwestern willow flycatcher to ensure our approach has been made clear.

Effects to Riparian Ecosystems

This section revises and supplants our October 30, 2013, BO's analysis of the effects of the proposed action on riparian ecosystems. The southwestern willow flycatcher is an obligate riparian bird, the western yellow-billed cuckoo is strongly associated with riparian and adjoining upland areas, the northern Mexican gartersnake is strongly aquatic (although it does range well into upland areas when foraging), 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.

General Effects to Riparian Ecosystems

The proposed action will affect riparian systems to varying degrees 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. 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 first described by SWCA (2012), was summarized in the Effects to Aquatic Ecosystems section on the October 30, 2013, Final BO, and later appeared in the FEIS (2: 294-295).

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 changes in the species composition 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 (percent) at base groundwater level to 5 percent 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 percent 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.

The preceding narrative is, to an extent, based on hypothetical effects associated with modeled groundwater declines. This approach was employed in the October 30, 2013, Final BO, but subsequent improvements in the SIR and SBA's hydrologic impact analysis as well as the incorporation of additional riparian community data have resulted in a revised, more quantitative analysis, as described below.

Methodology for Prediction of Impacts to Riparian Vegetation

In the FEIS, impacts to riparian vegetation were based on an extensive review of available literature about the responses of riparian vegetation to hydrologic changes. The FEIS analysis focused primarily on the continued presence of the hydroriparian corridor along Cienega Creek and Empire Gulch. The October 30, 2013, Final BO had already indicated, and discussions between May and November 2014 confirmed that even small changes in vegetation health could trigger negative feedback loops with large consequences (i.e., loss of root mass, leading to channel erosion and downstream siltation of pools). The SIR ultimately included a refined analysis of the proposed action's effects to riparian ecosystems; the new analyses are discussed in detail in the SIR in the Refinements to Analysis of Impacts to Riparian Vegetation (page 64), and are incorporated herein by reference. Further, the SIR riparian analysis was quantified to the extent possible, with a focus on capturing changes from smaller increments of drawdown.

The SIR and SBA's analyses of effects to riparian vegetation also took into account current ongoing negative trends related to the aquatic ecosystem. As described in the Summary of Impacts to Riparian Vegetation section, these ongoing trends are, on the whole, a more useful predictor of future conditions than the few predictive measures available from reviewed literature.

Summary of Impacts to Riparian Vegetation

The October 30, 2013, BO contained a detailed discussion of riparian vegetation classes and their extent within the action area (incorporated herein via reference), but this was followed with a largely qualitative effects analysis based on modeled groundwater drawdowns. The revised hydrological analyses appearing in the SIR and May 2015 SBA differ from prior analyses in that quantitative stream flow and pool data have been calculated from the drawdown data.

We reiterate that current conditions represent the baseline, and that the analyses of effects to aquatic ecosystems and the species that occur in them (Gila chub, Gila topminnow, desert pupfish, northern Mexican gartersnake, Chiricahua leopard frog, and Huachuca water umbel) consider the hydrology-related effects of both mine drawdown and climate change as impacts to the present-day baseline. Unfortunately, it is still not possible to definitively quantify the full suite of effects to woody riparian vegetation, particularly with respect to the effects of climate change.

The analysis of effects to the hydroriparian habitat for yellow-billed cuckoo and southwestern willow flycatcher diverge from the aquatic ecosystem approach described in the preceding paragraph. While the hydrologic effects of climate change were modeled, we are unable to

predict the full suite of effects of climate change on riparian ecosystems. While we do anticipate that reduced flows will adversely affect the extent and vigor of riparian vegetation, the hydrologic modeling contained in the SIR and May 2015 SBA do not address future temperatures, rainfall patterns, or other factors we anticipate will affect riparian vegetation. For this reason, the analyses of riparian-related effects to southwestern willow flycatcher are based largely on the mine-only drawdowns and their impact on hydroriparian vegetation. Climate change will be addressed in a largely qualitative manner. As stated in the May 2015 SBA, a reasonable assessment is to assume that negative trends in woody riparian habitat observed during the current drought are likely to continue into the future due to climate change.

Ongoing Trends in Riparian Vegetation

Trends in riparian vegetation at Cienega Creek result from changes in channel morphology, past and present management actions, the ongoing drought, and other activities within the basin. Cattle were excluded in the Pima County CCNP in 1988 and excluded from year-round residence on the Las Cienegas NCA in 1990. As a result, riparian areas have gone from bare, open areas to cottonwood (*Populus fremontii*)–willow (*Salix gooddingii*) gallery forests. Bodner and Simms (2008:figures 17–22) used repeated photo points to document the expansion of riparian forests within the Las Cienegas NCA, and used aerial photography to illustrate the widening of riparian forests from 1972 to 2002 (2008:figure 23), and Powell (2013:figure 3) shows the succession of vegetation within the Pima County CCNP from 1988 to 2003. Cienega Creek and its tributaries on Las Cienegas NCA support approximately 20 linear miles of riparian forest and marshland, which is often flanked by sacaton (*Sporobolus wrightii*) flats or mesquite bosque vegetation communities; additionally, many miles of xeroriparian and shrub communities occur (Bodner and Simms 2008). Within the Las Cienegas NCA, the Riparian Area Condition Evaluation (RACE) for Cienega Creek and its tributaries showed a marked increase in the percentage of linear miles of riparian habitat rated satisfactory – from 46 percent in 1989 to 93 percent in 2000 (Bodner and Simms 2008). For all areas of Las Cienegas NCA combined, comparing 1993 with 2006, there are more mature trees, saplings, and seedlings per acre; overall, ash and cottonwood density increased, though cottonwood to a lesser extent than ash, and willow density decreased; and different locations at Las Cienegas NCA have shifting age classes and species composition over time (Bureau of Land Management 2007). Additionally, some marshy areas are trending toward "woody swamp" vegetation community, likely because of reduced disturbance (Bodner and Simms 2008).

These apparent positive trends must be considered within the context of changed land management practices. Prior to the establishment of the CCNP in 1996, there were extensive cattle grazing activities on the site. Once cattle were removed from the system, vegetation height and volume increased significantly, but likely plateaued in the early 2000s (unpublished data). Vegetation often responds positively to removal of cattle (Krueper *et al.* 2003), but since 2005 there has only been a slight increase in the extent of cottonwood canopies in the Pima County CCNP (Powell 2013), though these analyses did not address the density of vegetation within the canopy.

Moreover, in contrast to long-term trends showing overall increase in riparian forest extent and health due to changes in land management, there are other, downward trends that are specific to

the recent drought. Lower Cienega Creek continues to show the impacts of sustained drought on a shallow groundwater-dependent system (Pima Association of Governments 2015). Leenhouts *et al.* (2006) stated that stream flow permanence is also a useful predictor of riparian vegetation condition and type, meaning that surveys of the wetted length of a stream can help inform effects analyses for riparian ecosystems. Wet/dry surveys of Cienega Creek from June 2015 (the low-flow season, when hydrologic data are least likely to be influenced by rainfall runoff) showed only 0.88 miles of flow, just nine percent of the full 9.5 miles of flow extent observed in June of the mid-1980s (Pima Association of Governments 2015, Pima County 2015).

By most measures, the ongoing drought began in the late 1990s. During riparian monitoring from 1998 to 2005, BLM has shown a shifting in species composition, with ash (*Fraxinus velutina*) coming to dominate many reaches in place of cottonwoods or willow. Bodner and Simms (2008) speculate that this may be due to the system reaching a climax community, the effects of reduced disturbance (e.g., from cattle or fire), or the effects of drought or lowering of the water table. The vegetation surrounding Cienega Creek consists of mostly native plants, with some Bermuda grass (*Cynodon dactylon*), Johnsongrass (*Sorghum halepense*), and tamarisk (*Tamarix* spp.) occurring (Bodner and Simms 2008), and with tamarisk abundances increasing in recent years (Powell 2013).

Powell (2013) states that since 2005, there has only been a slight increase in the extent of cottonwood canopies at the Pima County CCNP, and the extent and vigor of the mesquite bosque vegetation community has apparently declined. The current drought is blamed for a thinning of cottonwood canopy at the Pima County CCNP (Powell 2013: Figure 40; Powell *et al.* 2014: Figure 12) and death of cottonwoods at the Pima County CCNP (Pima Association of Governments 2014). On Las Cienegas NCA downstream of the "Cienega Ranch" wetlands, Simms (2014) noted and photographed segments of Cienega Creek that currently have low and declining riparian function, likely due to drought and loss of groundwater. Simms (2014d: Appendix B) provided photographs of head cutting and bank erosion attributed to loss of riparian plants due to dry conditions. These areas show a loss of soil stability due to the loss of root systems, and they currently have a channel that is bordered by deer grass (*Muhlenbergia rigens*) in poor health and dead and dying willow trees, reportedly indicating that these areas are transforming as seepwillow (*Baccharis salicifolia*) comes in to replace cottonwood, willow, and ash (Simms 2014). Further, a head cut at the Pima County CCNP has resulted in the loss of cottonwood and mesquite (Powell 2013: Figure 34).

The drought has not only been likely to have caused the aforementioned thinning of cottonwood canopy and death of cottonwoods at the Pima County CCNP (Pima Association of Governments 2014), it has also likely to have caused the decline in the mesquite bosque vegetation community that borders the mesic/hydroriparian vegetation along the creek margins (Powell *et al.* 2014). Between 2005 and 2011, most of the vegetation away from the active channel at the Pima County CCNP was observed to have declined. Although mesquite occurs farther from the stream bed than cottonwood and willow trees where it can tolerate greater depth to groundwater, mortality is occurring where the water table has declined beyond the depth at which mesquite roots can reach.

In January 2015, in order to better quantify the anecdotal observations from other sources, the

Coronado NF requested that Rosemont Copper evaluate whether the ongoing drought has had noticeable effects on the extent and density of the riparian corridors along Cienega Creek and Empire Gulch using analysis of satellite imagery. WestLand Resources conducted an assessment of Landsat imagery between 1995 and 2014 using a technique known as Normalized Difference Vegetation Index (NDVI) (WestLand Resources Inc. 2015f). Using this technique, the color of pixels in the satellite image is correlated with vegetation density (the darker the pixel, the more vegetation is assumed to be present). This technique reflects the overall relative amount of vegetation present, and how that amount changes year to year. WestLand concluded that "a plot of NDVI values for each segment through time shows that there was no apparent trend in the data from 1995 through 2014" (WestLand Resources Inc. 2015).

The quantitative approach pursued in Westland (2015) exhibits an analytical flaw that renders it no more reliable than the field observation-based, less-quantitative observations of Powell (2013) and Pima Association of Governments (2014). Our basis for this lies in part with the fact that the WestLand (2015) results do not appear to correlate well with field-based observations of declining stream length (Pima Association of Governments 2015), declining occurrence of velvet mesquite (Powell 2013), a shift from cottonwood/willow to ash from 1988 to 2005 (Bodner & Simms 2008), and an increase in tamarisk (Powell 2013). More importantly, the WestLand (2015) study design could not have detected the habitat selected by yellow-billed cuckoos and the seasonal characteristics and phenology of riparian sites in which they breed.

The NDVI analysis methodology used by WestLand (2015) limited its imagery analysis to the months of May and June to minimize potential seasonal bias, presumably to minimize variation in greenness associated with the variable timing of the onset of monsoon season precipitation. A phenological analysis by Wallace *et al.* (2013) found, however, that yellow-billed cuckoo occupancy of a given habitat patch does exhibit a seasonal bias; occupancy is correlated with the greenness of that patch and sites with yellow-billed cuckoos present are dominated by landscapes that achieve a maximum greenness well into July (largest peak at day-of-year 217; July 25th). These results support a scenario in which cuckoos migrate northwards, following the greening of riparian corridors and surrounding landscapes in response to monsoon precipitation (typically initiating in July), but then select a nesting site based on optimizing the near-term foraging potential of the surrounding habitat. Therefore, by analyzing only May and June imagery, the WestLand (2015) findings did not incorporate the late-July greenness crucial to yellow-billed cuckoo occupancy described by Wallace *et al.* (2013).

Maximum greenness is highly likely to include both woody riparian vegetation, shrub, and ground cover. Hammond (2011) found that yellow-billed cuckoo habitat exhibits higher shrub area than sites without western yellow-billed cuckoos (Hammond 2011). Wallace *et al.* (2013) suggested that the condition and dynamics of so-called accessory vegetation in the understory and/or adjacent landscapes are important features of selected cuckoo nesting habitat. Later-season woody shrub and herbaceous species cover, which is likely to be more shallow-rooted and more vulnerable to drought, could not have been detected by Westland (2015). Drought effects, already ongoing, will be worsened by mine drawdown. An understanding of these effects as a result of field observations was crucial to our effects analyses for both the yellow-billed cuckoo and southwestern willow flycatcher.

In summary, riparian trends differ between investigations, finding variously that:

- There was an increase in linear stream miles in satisfactory condition from 1989 to 2000 (Bodner & Simms 2008)
- There was an increase in vegetation (more trees per acre) from 1993 to 2006 (Bodner & Simms 2008)
- Riparian forests widened between 1972 and 2002 (Bodner & Simms 2008)
- There was an extreme decline in wetted stream length during June from the mid-1980s to 2015 (Pima Association of Governments 2015)
- There was a slight increase in the extent of Fremont cottonwood trees between 2005 and 2013 (Powell 2013)
- There was a decline in the extent of velvet mesquite between 2005 and 2013 (Powell 2013)
- There was a shift in species from cottonwood/willow to ash from 1988 to 2005 (Bodner & Simms 2008)
- Powell (2013) noted an increase in tamarisk in recent years (no timeframe specified)
- Simms (2014) reports that portion of Cienega Creek are experiencing a current (no timeframe specified) decline in riparian function
- A head cut within the Pima County CCNP was noted by Powell (2013)
- Between 2005 and 2011, most vegetation away from the active channel had declined (Powell 2013)
- WestLand (2015) found no apparent trend in NDVI during May and June over the period of 1995 to 2014

Comparing the findings of these investigations, the apparent overall trends in the Cienega Creek system are:

- Through the mid-2000s, due to land management changes (grazing), vegetation and riparian health have demonstrably increased in the system;
- By the mid-2000s, a decline in riparian function has become apparent, likely due to ongoing drought conditions;
- A decline in the overall width and amount of riparian corridor has not been observed, but decline in wetted stream length has been documented and observations of declining riparian function and vegetation health have been made at various locations.

These trends are not contradictory, as they pertain to different time periods. Past changes in land management likely resulted in increases in riparian vegetation, which is likely to have resulted in increased occurrences of riparian obligate birds such as the yellow-billed cuckoo and southwestern willow flycatcher. Subsequent declines in riparian health are likely to have contributed to declines in habitat available for these species. And while we anticipate that climate change will continue to negatively affect riparian ecosystems in the Cienega Creek system over the long term, it does preclude interim expansions of riparian vegetation during the occasional periods of relatively higher precipitation as would be expected under a more-variable, future climate.

Lastly, the preceding analyses referred primarily to the recruitment, retention, and succession of

woody, broadleaf riparian trees. These effects will be analyzed in this BO's respective effects analyses for the yellow-billed cuckoo and southwestern willow flycatcher. Shallow-rooted, aquatic, and/or emergent herbaceous plants – including Huachuca water umbel - are relatively more sensitive to small drawdowns. A more-specific analysis of these effects appears in the Huachuca water umbel section of this BO.

Effects of Mine Drawdown

While the literature reviewed during the preparation of the May 2015 SBA was not sufficient to analyze small incremental changes in vegetation due to small changes in groundwater, the analysis did provide some basis to evaluate the relative importance of stresses and impacts. In the 95th percentile analyses appearing in the Effects to Aquatic Ecosystems section (see Tables A-1 through A-3), the mine drawdown does not exceed 0.2 foot along Cienega Creek. This level of drawdown is half of what is estimated from climate change (0.4 foot), and the available literature reviewed during the preparation of the May 2015 SBA indicated such an increment was unlikely to lead to substantial shifts in woody vegetation health along Cienega Creek. Literature indicates that stream flow permanence is also a useful predictor of riparian vegetation condition and type (Leenhouts *et al.* 2006). As described in the May 2015 SBA's Summary of Stream Flow Analysis Results section, mine drawdown is not expected to change the flow status along most reaches of Cienega Creek to a point that would be expected to drastically alter the riparian corridor (i.e., a shift from perennial to intermittent flow). For Cienega Creek, the FEIS disclosed: "[It] would not be likely to result in widespread changes to riparian vegetation, even up to 1,000 years after mine closure. However, while total conversion from a hydroriparian to a xeroriparian corridor is unlikely, there is likely to be contraction of the hydroriparian area, with conversion occurring at the transitional margins of the habitat." This is similar to the effects described in the SIR riparian analysis. These effects are evaluated in the Effects of the Proposed Action – Huachuca Water Umbel (herbaceous), and Yellow-Billed Cuckoo Effects of the Proposed Action – Yellow-Billed Cuckoo (woody), below.

Upper Empire Gulch, on the other hand, is almost certain to experience major shifts in riparian vegetation due to mine drawdown, regardless of climate change stresses. Scenarios differ widely regarding when this transition might begin to occur. In order to implement a precautionary approach for subsequent effects analyses, we have elected to emphasize the higher end of the 95th percentile scenarios described in the Effects to Aquatic Ecosystems section (see narrative and Tables A-1 through A-3). In that regard, the higher-range values of the 95th percentile analyses predict a rapid onset of adverse effects (10 years post-mining) followed by a steady progression through drying conditions until total dewatering (zero flow) occurs at 150 years post-mining. We would anticipate these effects to result in losses of broadleaf woody riparian species and extirpation of aquatic and emergent vegetation.

Summary of Effects to Riparian Ecosystems

The drawdown-driven flow losses in Cienega Creek do not appear to be capable of precipitating large-scale mortality of woody riparian vegetation, but we do anticipate incremental losses of vigor, belt width, recruitment, and retention (see the analysis of effects to yellow-billed cuckoo, below). Flow losses in upper Empire Gulch may be more severe, and reach magnitudes capable

of causing the woody riparian community to transition to a more xeric species composition. Herbaceous and emergent plants are likely to be extirpated as upper Empire Gulch becomes ephemeral.

We cautioned in our October 30, 3013, BO that reductions in the length of wetted channel do 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 and/or where springs discharge water from the regional aquifer. 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 the recruitment of broadleaf riparian trees.

A longitudinal contraction in surface flows could also be accompanied by a narrowing of the riparian strand, a movement of the strand towards the thalweg, and/or a transition to more xeric types (i.e. tamarisk, desert broom, etc.). These effects are analyzed in greater detail in the yellow-billed cuckoo effects analysis, below.

We are concerned with the potential for a lateral contraction in riparian vegetation. Drawdowns in the alluvial aquifer are expected to result in increasing relative depths to groundwater for riparian vegetation situated further from the thalweg and consequently, uphill. Our concern is with the hydroriparian trees that are situated landward relative to the stream and which may already be at their practical limit in terms of being rooted in the alluvial aquifer. These trees are at a greater risk of drawdown-related effects. Alternately, these trees may senesce and fail to be replaced.

The diminished lateral extent of shallow groundwater could 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 of Cienega Creek above the confluence with 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. This hypothetical condition will further diminish the health of the already-narrowed riparian community.

Lastly, the effects of mine drawdown will be in addition to those modeled for climate change. We note that the climate change modeling conducted for the SIR and May 2015 SBA was a projection of hydrologic data associated with recent drought conditions, and not an actual modeling of future temperature and precipitations scenarios. Recruitment of Fremont cottonwood and Goodding's willow depends heavily on the formation of moist, mineral seedbeds by channel migration and on the timing of floods. The influence of climate change on pioneer riparian communities such as these will depend largely on how temperature and precipitation regimes change (Price *et al.* 2005, Friggens *et al.* 2013). If future climates are warmer and drier than at present (i.e., even more-severe drought), then we anticipate appreciable reductions in the representation of cottonwood/willow dominated communities along Cienega

Creek and Empire Gulch. And again, mine drawdown will precipitate an earlier onset and/or exacerbation of these effects.

GILA CHUB

Status of the Species – Gila Chub

Gila chub (*Gila intermedia*) was listed as endangered with critical habitat on November 11, 2005 (FWS 2005). 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 endangered or likely to become extinct throughout all or a significant portion of its range (FWS 2005).

Gila chub generally spawn in late spring and summer; however, 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. Bestgen (1985) concluded that temperature was the most significant environmental factor triggering spawning.

Gila chub is considered a habitat generalist (Schultz and Bonar 2006), and commonly inhabits pools in smaller streams, cienegas, and artificial impoundments throughout its range in the Gila River basin at elevations between 609 and 1,676 meters (2,000 to 5,500 feet) (Miller 1946, Minckley 1973, Rinne 1975, Weedman *et al.* 1996).

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, Minckley 1973). Gila chub now occupies an estimated 10 to 15 percent of its historical range, and is limited to about 25 small, isolated, and fragmented populations throughout the Gila River basin in Arizona and New Mexico (Weedman *et al.* 1996, FWS 2005a, FWS 2015).

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. Although groundwater levels have historically been variable in this area, there is an increasing trend in water use in parts of the action area, which is likely to initiate or contribute to a downward trend in groundwater levels. 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; and more frequent severe climatic events (such as storms, droughts, wildfires, etc.).

We incorporate by reference the environmental baseline information from the 2013 Rosemont BO, the May 2015 SBA, and the SIR. The past effects of climate change are part of the species' present-day environmental baseline, but future climate change is not considered to represent an evolving baseline through time. The modeled adverse effects of climate change into the future are discussed in the effects of the action section to allow an easier comparison with the effects solely resulting from the mine.

The draft Gila chub recovery plan (FWS 2015) contains the following recovery criteria:

1. Maintain and protect all remnant populations in the wild (Cienega Creek).
2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU. Cienega Creek is a recovery unit that has not been replicated yet.
3. Manage or eliminate threats of predation and competition with nonnative fishes and associated habitat-related modifications or loss.
4. Improve and develop new State regulations or agreements that conserve or improve quality Gila chub habitat.
5. Work with stakeholders to improve and conserve existing and newly established Gila chub populations and their habitats and ensure that appropriate management plans or agreements are in place.
6. Promote conservation of Gila chub in Mexico and on Tribal lands by forming partnerships and supporting research, outreach, and conservation management.
7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.

Description of the Action Area

The action area for Gila chub encompasses all occupied or likely-to-be occupied reaches of stream and other waters within the Cienega Creek watershed, as these will be subject to the proposed actions effects to groundwater and surface flow hydrology. Sonoita Creek Ranch is also in the action area (this parcel is one of the proposed mitigation measures in the HMMP), because the proposed action includes the release of Gila chub there. This area is described in detail in the Status of the Species and Critical Habitat within the Action Area section, below. The narrative 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. We incorporate by reference the Environmental Baseline of the 2013 Rosemont BO, SBA3, and the SIR.

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 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.

The Pima County Final Multiple Species Conservation Plan (Pima County 2015) commits Pima County to pursue the following management actions and conservation commitments for the Gila chub (and Gila topminnow)(Pima County 2015):

- 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 ADEQs 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 2015) to minimize loss of habitat for these species;
- Implement monitoring as described in Appendix N (Pima County 2015), 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 FWS 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).

Status of the Species and Critical Habitat within the Action Area

The action-area status of the Gila chub was described in our 2013 Rosemont BO, and 2008 and 2012 BOs that addressed effects of Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas NCAs, 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 those BOs were completed (FWS 2008, 2012, 2013). We incorporate by reference the status of the species in the action area from the 2013 Rosemont BO.

Sampling by AGFD in 2012 and 2015 found no Gila chub in the Pima County CCNP (Timmons and Upton 2013; Timmons, pers. comm., October 13, 2015). Gila chub were last seen in the Pima County CCNP in 2014 (Caldwell 2014). These locations are within the action area.

Recent surveys suggest that Gila chub continue to be abundant in upper Cienega Creek (Rosen *et al.* 2013; Simms 2014d, Simms and Ehret 2014). Surveys in 2007 and later demonstrate that Gila chub have recolonized 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, and no other records exist that chub occur there.

Hatch (2015) analyzed fish counts conducted by the BLM from 2005 through 2012, and based on these counts estimated positive mean growth rates for this species in two populations in Cienega

Creek. Positive mean growth rates indicate that this specific population on Cienega Creek is tending to increase, not shrink.

However, because of the variability inherent in fish count data, the population data have substantial uncertainty, which can be analyzed by looking at the probability distribution of the data. By evaluating this probability distribution, it was determined that the lower bound of the 95 percent confidence intervals include growth rates that are negative. This means that even though mean growth rate is positive, the possibility still exists for long-term population decline due to environmental stresses. The probability that the extirpation threshold [which is defined in Hatch (2015) as a catch per unit of 1 fish over a 24-hour period] is reached was calculated for this species above Spring Water Canyon (CC1, CC2, and the southern portion of CC3) as 0.46, meaning that there is about a 46 percent chance that this specific population would be functionally extirpated in the future. It should be noted that extirpation is not the same as extinction; extirpation refers only to the local population analyzed by this study. Below Spring Water Canyon (northern portion of CC3 and CC4 through CC6) the probability is 0.8228, meaning there is about an 82 percent chance this species would become functionally extirpated.

These estimates are only probabilistic and cannot be interpreted as certainty; these estimates take into account this species' fitness in its environment but cannot fully account for random and unknown variability in the environment, future conditions that may be different from those experienced in the past, or density-dependent processes that may affect this species. It should be noted that the analysis only describes the sensitivity of this particular fish population to environmental change, but does not consider the cause of those stresses. The conclusion that this fish species is sensitive to environmental stresses—whether natural or manmade—and that local populations could face extirpation because of those stresses, is consistent with the status of Gila chub as endangered, with limited habitat, and reduced populations.

The unfinished Foster and Simms report (2005) attempted to estimate the chub population by upper and lower reaches of Cienega Creek on the Las Cienegas NCA. Though there were issues with the number of recaptures in the upper reach in this mark-recapture study, they did estimate numbers of Gila chub. The sampling was done in 2005, which was when the pools in the headwaters were often fishless due to low dissolved oxygen. Foster and Simms (2005) estimated the total abundance of catchable chub to be 4,810 in the lower reach, 1,481 chub in the upper reach, for a total of 6,291 chub in Cienega Creek on Las Cienegas NCA.

In the recently-released draft Gila chub recovery plan (FWS 2015), Cienega Creek is a management unit within the Santa Cruz recovery unit. They consider the Cienega Creek Gila chub population to be a priority 2 population for replication because it has not been replicated, has a high number of threats, and is a high priority population. BLM has already proposed establishing new Gila chub populations on Las Cienegas NCA (BLM 2012).

On Las Cienegas NCA, Gila chub may be released into 13 sites: Clyne Pond, Maternity Wildlife Pond, Oil Well Wildlife Pond, Bill's Wildlife Pond, Cieneguita Wetland Ponds, Gaucho Wildlife Pond, Cottonwood Wildlife Pond, Cinco Pond, Empire Wildlife Pond, Spring Water Wetland Pond, Nogales Spring, Little Nogales Spring, and Apache Spring Wildlife Pond. Of these 13 sites, Oil Well, Spring Water, Gaucho, Bill's, Cieneguita, Cottonwood, Maternity, and Empire

are in the action area. Of sites in the action area, only Spring Water and Cieneguita are supported by groundwater. Thus, Cieneguita and Spring Water Wetlands are the only of these sites that may be affected by the proposed action.

Non-native species that are problematic for Gila chub, including crayfish, green sunfish *Lepomis cyanellus*, common carp *Cyprinus carpio*, bluegill *Lepomis macrochirus*, and largemouth bass *Micropterus salmoides* (Rosen *et al.* 2013; FWS files), have been found in the Cienega Creek watershed at one time or another. At present, green sunfish, western mosquitofish (*Gambusia affinis*), and crayfish are known to be present in the watershed.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following Gila chub-specific analyses are based were described in both the Effects of the Proposed Action section (below) and the Effects to Aquatic Ecosystems section (above).

The majority of the hydrologic data employed in this BO are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes (given the modeling assumptions) exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following Gila chub-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

Effects of the Action - Gila Chub

Information from the 2013 Rosemont BO that has not changed will not be repeated here. No direct effects result from the mine. Indirect effects caused by groundwater draw down from the mine will negatively impact stream flow and pool metrics. Impacts from the mine only are small

when compared to the effects of climate change. However, the impacts from the mine only, do cause impacts to aquatic habitats that negatively impact the Gila chub. We incorporate by reference the effects of the action from the 2013 Rosemont BO. Only changes will be discussed below.

The aforementioned changes in groundwater elevations, stream flow, and pool metrics, predicted by the models and, when applicable, the inferred and modeled losses of surface flows supported by surface or near-surface groundwater elevations, are measurable. However, their precise impacts on aquatic ecosystems and riparian vegetation are difficult to quantify with certainty. As in the SBA3 and SIR, our analysis focuses on the key reaches that were identified. Since many of the key reaches are the best watered, impacts to the key reaches are likely to be less than the other, less well watered reaches. "While the refined aquatic analysis focuses on these nine reaches, it should not be assumed that impacts will not occur in the other non-key reaches. On the contrary, because these key reaches represent the most stable portions of Cienega Creek and Empire Gulch, any impacts to these reaches can be expected to occur elsewhere as well (SBA, page 45)."

These modeled decreases in groundwater elevation due to the mine would occur over 150 years, and would cause changes in aquatic and riparian vegetation extent or health, and the reduction in stream flow would impact Gila chub and designated critical habitat (e.g., lower water level, reduced quality and quantity of habitat, more extensive dry reaches). As a result of groundwater drawdown, the amount or volume of water within perennial pools would decrease, and Gila chub in Cienega Creek (and in general) show a preference for pools (Minckley 1973, Rinne 1976, Weedman *et al.* 1996, Schultz and Bonar 2006).

Discharges to groundwater are not expected to exceed water quality standards; if they occur, the cone of depression associated with the mine pit is predicted to capture water contaminants and prevent their movement to streams in the action area. In addition, the ADEQ has issued their 401 water quality certification for the project and has determined that the project is not expected to violate surface water quality standards. Therefore, no impacts to Gila chub or designated critical habitat due to potential water contaminants are anticipated 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) of the mainstem and tributaries (Mattie Canyon and Empire Gulch) are designated as critical habitat.

Three different indirect effects are associated with mine: reductions in stream flow, reductions in pool metrics, and reduced water quality. The impacts from the mine only (an effect of the proposed action), climate change only (also an effect, though not of the proposed action), and the mine plus climate change (the total effect to Gila chub) are presented in this section, to facilitate their comparison.

Furthermore, we note that the total effect of mine plus climate change is relevant to our findings regarding jeopardy to a species and destruction and adverse modification of critical habitat whereas the effect of mine drawdown alone informs the amount or extent of take we anticipate will occur.

Stream Flow Effects

To reiterate, we do not consider climate change to be part of an evolving environmental baseline over time; future climate change is analyzed as an effect on present-day conditions (the definitive baseline for our analyses) to which the effects of the mine are compared and added. Thus, the impacts from climate change and the mine together are included as part of our jeopardy analysis.

To determine the current baseline flow for the key reaches in June, we used the information in Table GC-1, which is based on SBA Table 3, for measured flow, and not modeled flow. For each data set, we attempted to identify and remove flow values that were likely associated with runoff from storm events. This was done in order to focus on only the baseflow in June, which represents the critical hydrologic metric for then aquatic ecosystem.

The mean June flow of 60 gpm for CC2 was calculated from the seven monthly measurements taken by the BLM. The mean monthly flow for CC4 is twice that of CC2 (USFS 2015). Reach CC5 has the upper Cienega Creek gauge (09484550). We subtracted the flow of 26 June 2008 of 5,386 gpm from the gauge, because it was an outlier that increased the mean by 14 gpm (13%). We used 371 measurements instead of 372. The mean monthly June flow of 159 gpm for CC13 was derived from measurements taken by PAG, with the high years of 2004 to 2007 removed from the calculation (Table GC-1). The mean monthly June flow at CC13 for all years is 426 gpm. The mean monthly June flow at CC13 for 2004 to 2007 is 881 gpm (554% of calculated mean of 159). We calculated the mean monthly June flow using the PAG measurements from 2001 to 2003 and 2008 to 2014 (159 gpm). By contrast, the mean monthly March flow for all 14 years was 88 gpm. We believe that our calculated mean monthly June flow for CC13 of 159 gpm is reasonable. The mean monthly June flow for CC15 is calculated from the gauge at the del Lago Diversion (09484600). There were 402 daily flows (mean 375 gpm, 260% of calculated mean); we subtracted nine flood flows with more than 1,000 gpm that were outliers to arrive at our mean flow of 144 gpm (n=393). Also note that these analyses review decreases in June streamflow even though June did not always have the lowest monthly flow, and increases in zero-flow and extremely-low flow days; these values effectively express the degree of alteration to baseflow hydrology at the most critical time of the year for wholly aquatic species. For this analysis, consistent with the FEIS and SIR, the following definitions are used for temporal flow: perennial (0 to 30 days with zero stream flow); intermittent (31 to 350 days with zero stream flow); ephemeral (more than 350 days with zero stream flow). Removal of outliers is common practice in the use of descriptive statistics.

Table GC-1. Determining recent baseline June flow (gpm) by key reach for Cienega Creek and Empire Gulch, Arizona. See Figure A-1 for a map of key reaches.

REACH	INFORMATION SOURCE	# measurements	Flow (gpm)
CC2	BLM 2006-2014, June measurements in Appendix F	7	60
CC4	From CC2, doubled	7	120
CC5	Gauge 2001-2014, all June[3] measurements Subtract outlier 6/26/2008 5386 gpm[4]	Every June day 6/1/2001 to 6/12/2014	121 107[4]
CC7	“		121

CC13	PAG 2001-2014[1]	10	159
CC15	Gauge[2]	Every June day 1/1/2001 to 6/12/2014[2], minus 9 flows >1,000 gpm	144
EG1	BLM: 6/21/2007-6/23/2014	7	12
EG2	From EG1		12

See SIR Appendix F spreadsheet, all June measurements, as modified by DKD
[1] Mean for June 2001-2014 is 426 gpm. Mean for June 2004-2007 is 881. Used mean for 2001-2003 and 2008-2014 = 159. The mean for all 14 years for March is 88.
[2] Mean for June is 375. Subtracting the 3 flows >10,000 yields a mean of 182. Subtracting the 9 flows >1,000 yields a mean of 144.
[3] Of the 12 complete years recorded, June was the month with the least flow 6 times.
[4] Outlier, removed. Mean flow is then 107 instead of 121pgm.

Standing Pool Analysis

Table 7 in the SBA provides an index to the standing pool analysis results. The tables with the results of the standing pool analysis (tables D-14 through D-26) are provided in full in SBA Appendix D. Graphical representations of the results are included in SBA Appendix F. Table GC-2, below, summarized the key data used in the standing pool analyses in this BO. To determine percent change, we totaled all values for that reach (e.g. the total volume of all pools in reach CC2 currently is 19,886 ft^3). While we use percentages to describe losses, the analysis of effects focused on actual amounts of water (pool depth, volume, area) lost, and impacts to individual pools.

The following summary of results is based on the 95th percentile high analysis, which provides a consistent, conservative, and concise way of summarizing results. Note that the following discussion refers only up to 150 years after closure of the mine. It should be noted that the SBA tables summarizing results use summary statistics, such as median depth, volume, or area for all pools in a key reach. Summary statistics obfuscate what is happening to individual pools. Loss or a large reduction in any of the parameters to a pool, are likely to make that pool uninhabitable for fish, at least periodically. To address this, we calculated total values for each key reach for mine only and mine plus climate change. To ensure that use of these statistics does not mask[10] the full range of results, results for individual pools are also included in Appendix G of the SBA. We also analyzed the results by looking at the percent loss of water quantity variable (flow, and pool volume, depth, area) by quartiles. By aggregating individual pools by the amount of water quantity loss, we get a clearer picture of impacts from the mine only, and the mine combined with climate change.

10 As stated in the SBA, selection of summary statistics exhibits shortcomings. In this case, the use of median values to summarize the results for an entire key reach can lead to some non-intuitive mathematical outcomes. This is because the median is only calculated using those pools still in existence, and does not incorporate pools that have dried completely. For example, the median depth of pools in reach CC2 under current conditions is 1.1 feet, which is calculated using a total of 22 pools. Climate change stress causes three pools to disappear. Each of the individual pools has dropped 0.4 foot due to climate change, but when the median is calculated using the remaining 19 pools, the median is 1.9 feet, which is deeper than current conditions.

In brief, the proposed action will result in varying reductions in the numbers, depth, volume, and surface area of pools. Climate change will cause even greater reductions in pool metrics.

Quartile analysis

Using percent quartiles to look at losses to stream flow, and pool volume, depth, and surface area by reach presents a clearer picture of the magnitude of impacts to these water quantity variables (Table GC-2). Here, we look at the effects to Cienega Creek only, using the current baseline, compared to 150 years post-closure. Empire Gulch is not currently used by chub, though lower Empire Gulch (reach EG2) could be. Cieneguita Wetlands has three ponds; looking at those ponds separately is an adequate analysis.

In looking at the impacts from the mine only, no losses to June flow or pool depth are greater than 24 percent (76 percent depth remaining). However, three of the 83 pools in Cienega Creek that were measured lose more than 24 percent of their surface area from mine impacts (less than 76 percent remaining). Impacts to pool volume include one pool going dry at 150 years post closure; a very small pool in reach CC2. All seven pools losing at least 25 percent of their volume (with up to 75 percent remaining) from impacts from the mine are in reach CC2, and small.

The combined effects of the mine and climate change 150 years post mine closure are much greater than impacts from the mine only. Eight of the 13 pools that lose all volume are all small, with none having more than 17ft^3 of volume, and all being less than one-foot-deep. The other five pools that appear to dry, are all small; four of them are in reach CC13. Conversely, of the nine pools in Cienega Creek with at least 1,000ft^3 of volume, all but two maintain at least two thirds of their volume 150 years post closure (one-third of their volume remaining). All of these large pools are projected to be at least 5 feet deep then.

The combined impacts of the mine and climate change 150 years after mine closure cause four of the six key reaches in Cienega Creek to lose at least 24 percent (and retain up to 76 percent) of their June flow. Three of those four key reaches lose at least half their June flow, with one reach (CC7) being projected to have zero flow. CC7 appears vulnerable due to the large loss of stream flow projected from climate change (SBA Table D6, SIR Table 22).

Table GC-2. Percent loss of water quantity variables by quartile. Cienega Creek, Arizona, using current baseline compared to 150 years post-closure. Flow is number of reaches (n=6), other variables show number of pools (n=83). CC = climate change.

Quartile loss	Flow		POOL volume		POOL depth		POOL area	
	Mine only	Mine + CC	Mine only	Mine + CC	Mine only	Mine + CC	Mine only	Mine + CC
>24%	0	4	7	71	0	27	3	63
>49%	0	3	1	30	0	17	0	27
>74%	0	1	1	22	0	8	0	18
100	0	1	1	13	0	6	0	6

Water quality

The greatest concern regarding water quality is with dissolved oxygen. Contaminants from the mine site are only a concern for fishes in Cienega Creek below the confluence with Davidson Canyon, and only if water quality permits are not followed. Water temperature is also a concern.

Fishes require oxygen dissolved in water to survive and thrive. Dissolved oxygen tends to be lower in summer and with higher water temperatures, and lower with reduced (or zero) flow and mixing (Mason *et al.* 2007). Higher water temperatures also facilitate decay of detritus, which also requires and uses dissolved oxygen. Groundwater inflow to streams tends to be low in dissolved oxygen, though may have enough dissolved oxygen for low-oxygen tolerant fishes to survive general anoxic conditions. Pools during low flow periods, especially without flow between pools, only rely on photosynthesis and gaseous surface exchange for oxygen. Since fish consume more oxygen with higher water temperatures, June with its lowest flows of the year and highest temperatures is especially problematic for fish survival in Cienega Creek. Low dissolved oxygen has a host of negative impacts to fishes, including but not limited to: decreased food consumption, decreased fry survival, and decreased swimming speed and increased movement, which can make fish more susceptible to predators (Stewart *et al.* 1967, Dahlberg *et al.* 1968, Dowling and Wiley 1986).

Measurements of stream flow and dissolved oxygen made by BLM at reach CC2 display a positive correlation between those variables (SIR Figure C18). The significance is <0.001, but the r^2 is 0.19, meaning that stream flow is not the only variable controlling dissolved oxygen. Dissolved oxygen decreased with reductions in stream flow by about 0.28 parts per million (ppm) for every 10-gpm reduction in this reach. Dissolved oxygen in reach EG1 exhibited no correlation with stream flow (SIR Figure C16).

Some dissolved oxygen measurements made by BLM were already below the tolerance threshold for Gila chub, and even Gila topminnow (0 ppm at CC2). Oxygen concentrations are not uniform throughout a water body, and fish can detect oxygen levels, enabling them to move towards waters with higher concentrations of dissolved oxygen. Fishless pools that were likely caused by low levels of dissolved oxygen have already been observed in Cienega Creek (Bodner *et al.* 2007). Drier times of the year are of most concern, when there is little actual flow (flowing water has more dissolved oxygen), and water in the stream is restricted to pools. Lower amounts of dissolved oxygen are certain to occur with lower streamflow caused by the mine, and lower streamflow and higher temperatures caused by climate change.

Since we have few measurements of dissolved oxygen in Cienega Creek to analyze, our analysis of water quality is expressed in terms of the days of extremely low flow predicted by modeling. While days of zero flow are certainly more problematic, days of extremely low flow will likely present similar challenges to fishes, so we focus on them here. Again, our analysis is based on the higher range of the 95th percentile analyses, though the full range of 95th percentile values appear in various tables.

In brief, the proposed action will result in increasing numbers of extremely low-flow days at most sites, and climate change plus the mine increases low and zero flow days even more

(Tables D3, D5, D11, D12). Key Reach EG1 in Empire Gulch may experience either little change from present-day baseline conditions effect or total dewatering; precaution dictates we give relatively greater weight to the more adverse potential outcome.

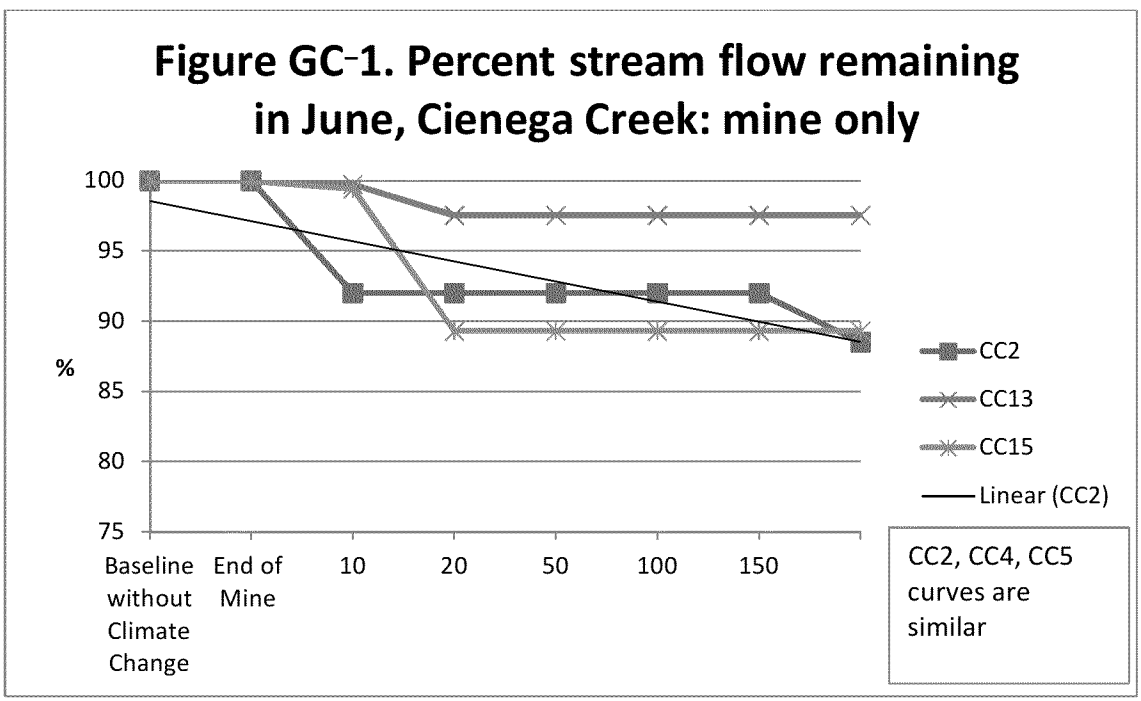
Upper Cienega Creek

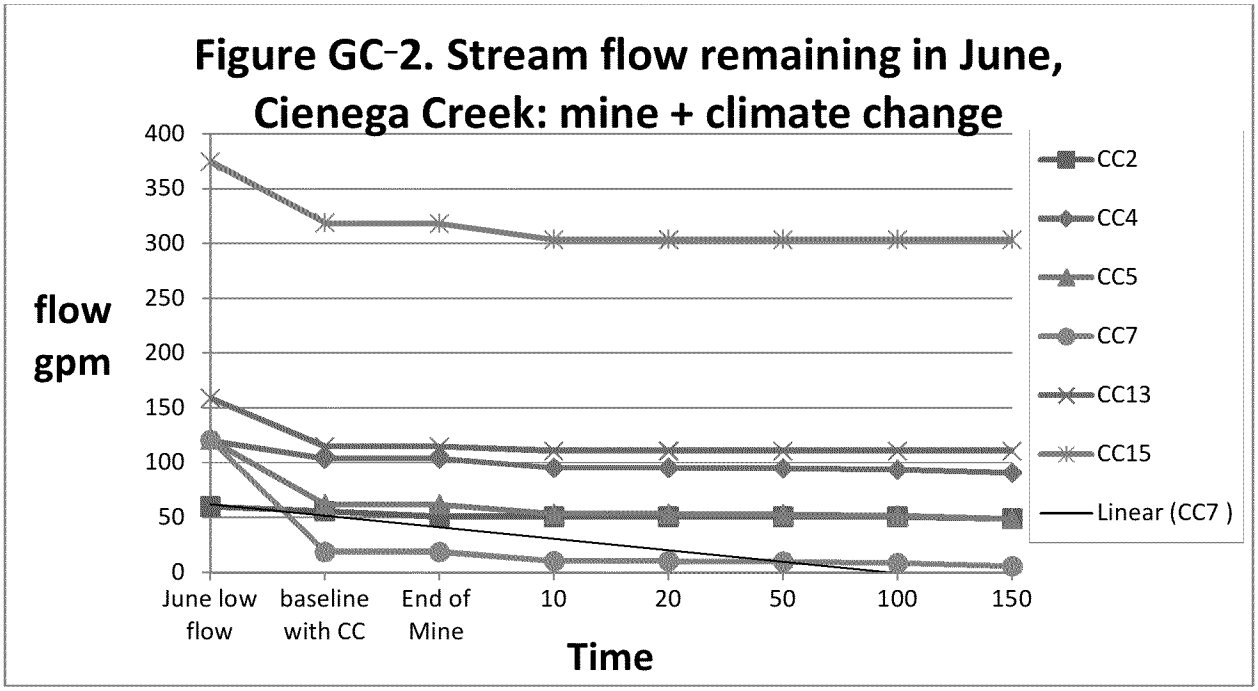
Upper Cienega Creek is that portion of the stream in Reaches 1 to 7 (see Figure A-1 in the Effects to Aquatic Ecosystems section). Gardner Canyon and Empire Gulch, along with Mattie Canyon, are the major tributaries in this reach. The USGS Cienega Creek stream gage (0948550) is situated near the narrows between Reach 7 and 8 (see Figure A-1). Indirect effects from the mine to Gila chub, such as groundwater drawdowns and changes in riparian community composition, are likely to occur within the action area in upper Cienega Creek.

Upper Cienega Creek – Key Reaches CC2 and CC4

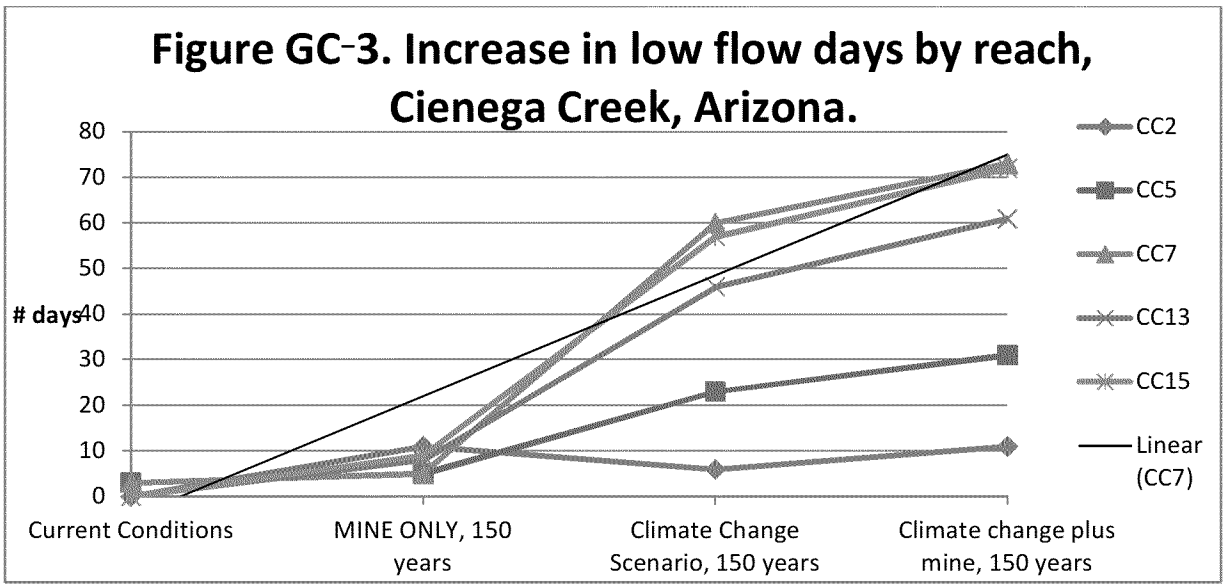
For mine impacts only, these reaches remain perennial, with stream flow losses ranging from no change to from 9.1 to 13.2 gpm (at the end of mining to 150 years later, respectively; SBA Table D10) under the higher range of the 95th percentile analyses. These two reaches maintain 89 percent of their June flow (losing 11 percent), respectively, at 150 years (Figure GC-1).

For impacts of the mine combined with expected climate change impacts to stream flow in these reaches, the loss in reach CC2 is 11.2 gpm and in reach CC4 is 29.3 gpm at 150 years (Figure GC-2). When looking at flow loss as a percentage of baseline at 150 years after mine closure, the June flow of CC2 is 81 percent (a 19-percent loss) of the current baseline (Figure GC-4). June flow of CC4 is 76 percent of current baseline (a 24-percent loss).





With respect to water quality impacts, climate change by itself would result in 0 to 6 days of extremely low flows per year (Figure GC-3), 150 years after the conclusion of mining. Mine-related drawdowns plus climate change would result in 6 days of extremely low flows at the end of mining and at 10 to 150 years following closure, the extremely low flow days would range from 6 to 11 per year (from 0 to 5 additional days per annum). A review of 95th percentile, mine-only data in SBA Table D-10 indicates that climate change drives the frequency of extremely low-flow days early in the post-mine period (10 to 50 years), while the mine's relative contribution to the effects increases at 100 to 150 years. No zero flow days occur at these reaches under any scenario.



Under present-day baseline conditions, during periods of low seasonal stream flow (May/June), portions of the aquatic environment along Cienega Creek and Empire Gulch can experience high water temperatures and low concentrations of dissolved oxygen (DO). These same trends would be expected to continue and be exacerbated during days where stream flow is predicted to fall to levels lower than those experienced currently.

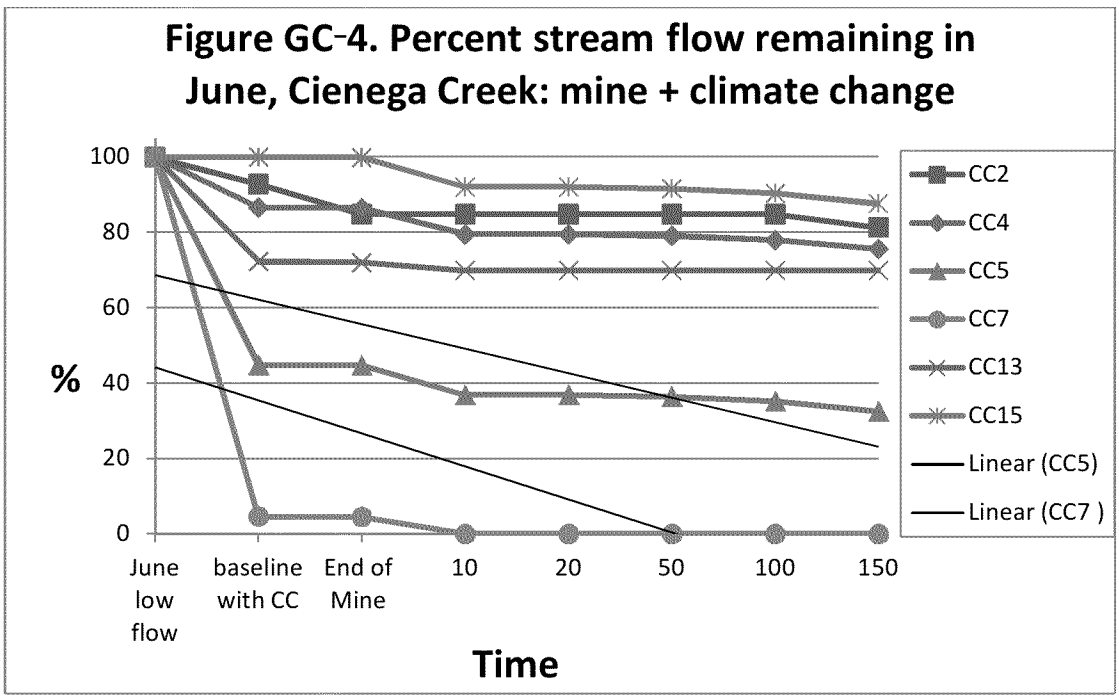
Mine drawdown under the high 95th percentile analyses does not change the number of pools present in these reaches; climate change reduces the number of pools from 22 to 19 for reach CC2, and from 16 to 15 for reach CC4. Mine drawdown by itself also does not substantially change the pool depth, pool volume, or surface area: pool depth does not change from current conditions; volume reduces to 98 percent (a 2-percent loss) of original volume and area for reach CC2 and 98 percent (also a 2-percent loss) of original volume for reach CC4 (Table GC-4). Pool area is reduced 3 percent in reach CC4from mine drawdown (retaining 97 percent of surface area). These effects to pools are modest due to the impacts of the mine after 150 years post-closure, but measurable, and will be considered in the analysis of effects to aquatic species. When climate change impacts are added to effects from the mine, pool volume is substantially impacted, reducing pool volume by 45 percent of original in reach CC2 and 32 percent in reach CC4 (55 percent volume remaining.

Table GC-3. Summary of water quantity effects by reach from mine closure to 150 years. Stream flow and pool geometry are described in terms of percent losses. Percent flow loss is derived from one value for each reach, as explained in the SBA and SIR. Pool numbers are described in terms of absolute losses of pools in Key Reaches. CC = climate change.

Reach	Flow		Pool volume		Pool depth		Pool area		# Pools	
	Mine only	Mine + CC	Mine only	Mine + CC	Mine only	Mine + CC	Mine only	Mine + CC	Mine only	Mine + CC
CC2	11	19	2	45[1]	0	14	2	12	22	19
CC4	11	24	2	32	0	14	3	31	16	15

CC5	12	68	1	29	0	13	1	27	19	19
CC7	12	100	5	29	3	15	5	27	15	15
CC13	2	30	8	69	0	34	8	63	8	7
CC15	11	50	5	45	0	28	4	35	4	3
Cienega Creek only	10	48	3	34	1	34	3	25	84	78
EG1	100	100	100	100	100	100	100	100	5	0
EG2	18	46	12	34	8	23	12	29	11	10
CGW	N/A		67	81	13	26	58	76	3	3

Pool volume, depth, and surface area percentages were calculated by summing all actual individual pool measurements in a reach, and then comparing it to the predicted value at 150 years post-closure for the mine, and the mine plus climate change.
[1] For example, the measured volume of all pools in reach CC2 is 19,886 ft^3 and the calculated for the effects of the mine and climate change 150 years post-closure is 10,905 ft^3, which is a 45% reduction in pool volume for reach CC2.



Upper Cienega Creek – Key Reaches CC5 and CC7

These reaches currently exhibit an average of two days with zero stream flow per year under present-day baseline conditions; mine drawdown would change this to 2 or 3 days per year under the 95th percentile analyses. Climate change absent the mine's impacts would result in 5 days with zero stream flow per year in CC5, and 23 days with zero stream flow per year in CC7. In combination, mine drawdown plus climate change would result in 5 to 11 days with zero stream flow per year in CC5, and from 23 to 31 days with zero stream flow per year in CC7. Flow status would remain perennial under the proposed mine-plus climate change scenarios; flow status in

CC7 also largely remains perennial for most scenarios, but by 10 years after mine closure, the higher range of the 95th percentile analysis indicates a possible shift to intermittent flow for the mine-plus-climate change scenario.

Losses to the June flow from mine impacts only at 150 years post-closure for both reaches is 13.2 gpm. The percent of flow remaining at 150 years is also the same for both reaches, at 88 percent (a 12-percent loss).

When the predicted stream flow losses from climate change are added to losses from the mine, a more problematic picture emerges. In reach CC5, 72 gpm are lost at 150 years, leaving 32 percent of the baseline June flow (a 68-percent flow loss). Reach CC7 does not fare well in the climate change only scenario, losing 102 gpm at 150 years. Combined with predicted loss at 150 years from the mine, CC7 loses 115 gpm of June flow. Since the June baseline flow is 107 gpm, the stream would be intermittent with isolated pools (Figure GC-4).

Mine drawdown, with or without climate change, does not change the number of pools present in these reaches (19 in CC5 and 15 in CC7; Table GC3). Mine drawdown alone also does not substantially change the percentage of pool depth, pool volume, or surface area lost (0-5%) (95 to 100 percent retained) (Table GC-3; SBA Tables D-24, 25, and 26, respectively). Pool volume, at 150 years, reduces to 99 percent (a 1 percent loss) of original volume for reach CC5 and 95 percent of original volume for reach CC7.

Under the 95th percentile analyses, climate change plus the mine reduces pool depth by 13 and 15 percent respectively, and pool surface area is reduced 27 percent. Climate change plus the mine reduces pool volumes by 29 percent of original volume in both reaches (with 61 percent retained).

The groundwater modeling results do not discuss the potential for groundwater drawdowns at Mattie Canyon; the site is outside of the 5-foot drawdown perimeter discussed in the FEIS (2: 294-295). However, since lower Mattie Canyon is close to the stream gage, 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.

Lower Cienega Creek

Lower Cienega Creek will experience the accumulation of effects of groundwater drawdown and surface flow diminishment throughout the affected portion of its watershed. The effects to Barrel Canyon and Davidson Canyon Wash represent incremental, additive effects to the water yielded to lower reaches of Cienega Creek, though we are aware that the SIR and May 2015 SBA did not consider surface flow connection between upstream reaches and CC13 and CC15.

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 (SIR: 31) 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 which are crucial to conserving Gila chub.

The reduction in lower Cienega Creek subflow from the Barrel Canyon and Davidson Canyon Wash systems will occur in addition to surface flow reductions in other upstream areas of Cienega Creek and the influence of climate change over time. 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 (FEIS V1:126, Table 12)] 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 appreciably less than 5.6 percent, because flood flow hydrology will remain largely intact in the eastern portions of the Cienega Creek watershed (including Empire Gulch, Gardner Canyon, and Mattie Canyon). "Flood flow hydrology" includes peak flows, and declining and ascending limbs. There are also instantaneous peak flows.

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, but is not anticipated to have a large effect on sediment supply given the remaining, unaffected sediment supply present within channels and tributaries (Patterson and Annandale 2012, Rosemont Copper Company 2012, FEIS p. 464-467). 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 constitute 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.

Gila chub have been recorded in Reach 13 and 15 of Cienega Creek (below the confluence with Davidson Canyon); there appears to be marginally suitable habitat (Timmons, AGFD, pers. comm., October 13, 2015) and it is designated critical habitat, and has an upstream source population of Gila chub. Therefore, it is reasonably certain that Gila chub will occur in the action area during the timeframe of the action. Effects in this area begin during mine operation, and continue well after mine closure. Any loss of flow, wetted perimeter, and pool depth is an effect on Gila chub.

Analyses undertaken by Westland Resources (2012) but not included in the three iterations of the BA, in SWCA (2012), or the FEIS, correlated extent of surface flow in lower Cienega Creek with depth-to- groundwater in adjacent wells. Their results, partially based on averages in June, show there would be small decreases (<2% of average) in length of streamflow. Also, the extent of streamflow and proportional reduction in extent of streamflow could be greater than two percent in drier times. Pima County performed a similar analysis, finding that a 0.1-foot decline in groundwater elevation would lead to a loss of 434 linear feet (3.4%) of stream flow in June (Powell *et al.* 2014). They also estimated a 0.25-foot decline would lead to a loss of 1,085 linear feet of stream flow in June. We did not use these studies in our analysis, as they did not emerge intact from the rigorous SIR and SBA preparation process, nor the technical reviews conducted by the USGS (USGS 2014a, USGS 2014b). We instead employed the results of the regression analyses contained in the SIR and May 2015 SBA.

Lower Cienega Creek – Key Reaches CC13 and CC15

The 95th percentile analyses for these reaches show that climate change by itself would result in 23 additional days with zero stream flow per year at every time step in CC13, and 37 additional days with zero stream flow at every time step in CC15. In combination, mine drawdown plus climate change would result in 23 days with zero stream flow per year in CC13 (no change from climate change-only results), and from 37 to 50 days with zero stream flow per year in CC15 (zero to 13 additional days). Reach CC13 would not change flow status from perennial; however, climate change pushes reach CC15 from perennial to intermittent flow status, regardless of mine drawdown. At 150 years post closure, effects of the mine cause 8 low-flow days in CC13, and 9 low-flow days in CC15.

Losses to the June flow from only mine impacts at 150 years post-closure is 3.9 gpm for CC13 and 15.4 gpm for CC15. The percent of flow remaining at 150 years is 98 percent for CC13 and 89 percent for reach CC15 (2 and 11 percent flow losses, respectively).

In reach CC13, 47.9 gpm are lost from the mine and climate change at 150 years, and CC15 loses 72.6 gpm. When looking at flow loss as a percentage of baseline, at 150 years after mine closure, the June flow of CC13 is 70 percent and CC15 is 50 percent of the current baseline (30 percent and 50 percent of flow retained, respectively) (Figure GC-4).

Under the 95th percentile analysis, mine drawdown does not change the number of pools present in these reaches (SBA Table D-23); climate change by itself reduces the number of pools from 8 to 7 for reach CC13, and from 4 to 3 for reach CC15. Mine drawdown also does not substantially change the pool depth, pool volume, or surface area (Table GC3; SBA Tables D-24, D-25, and D-26, respectively): pool depth does not change from current conditions (Table D-24); volume reduces to 92 percent (8 percent loss) of original volume for reach CC13 and 95 percent (5 percent loss) of original volume for reach CC15 (Table D-25).

Climate change plus the mine reduces pool volumes to 31 percent of original volume for CC13 and 55 percent of original volume for CC15 (reductions of 69 and 45 percent, respectively). Pool depth is reduced by 34 and 28 percent (66 and 72 percent retained), respectively, and pool surface area is reduced by 63 and 35 percent (37 and 65 percent retained) respectively.

Key reaches CC13 and CC15 do not experience extremely low flows under present-day baseline conditions; climate change is anticipated to increase this to 46 to 57 days at all time-steps, respectively (Figure GC-3). The influence of the mine will, at the high-range 95th percentile value, increase this to up to 61 and 72 days at 150 years post-closure, respectively. A review of the 95th percentile, mine-only data from Table D-10 in the SBA indicates these effects are primarily driven by climate change, not drawdown. Again, mine drawdown effects are of less magnitude than climate change, but increase over time. Once again, these conditions will increase the incidence of water quality that adversely affects aquatic life. All of the decrease in water quantity described above will reduce the amount of habitat that is available for Gila chub.

Empire Gulch

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 by reducing those two metrics. However, since Gila chub are not known to occur in Empire Gulch, nor are there records of their occurrence, 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 period of effects of the proposed action that Gila chub could naturally move into lower 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.

<u>Upper Empire Gulch – Key Reach EG1</u>

Similar to the stream flow analysis, the 95th percentile range of results for reach EG1 encompasses a wide range of outcomes. Unlike the reaches on Cienega Creek, the range of possible outcomes is quite large, as is the potential timing for impacts to occur. At 150 years after mine closure, the 95th percentile range for mine drawdown alone shows a range that is anywhere from no pools remaining, to all pools remaining in the reach. At the higher range of the 95th percentile range, some pools begin to disappear by 20 years after mine closure. To illustrate the variability in predictions, at the low end of the 95th percentile range, all pools remain even 150 years after mine closure. Climate change has very little effect on the number of pools, even in combination with mine drawdown. We assume that all pools in EG1 will be lost from groundwater drawdown from operation of the mine, consistent with our use of the higher range of the 95th percentile range. As with the analysis of effects to streamflow, above, aquatic species occurring in pools in upper Empire Gulch are anticipated to experience appreciable adverse effects through reductions in water volume, though none are expected for the Gila chub.

Climate change alone will increase the incidence of extremely low-flow days to 26 per year from the end of mining to 150 years later (Figure GC-3). Modeled water quality effects, similar to

stream flows, exhibit wide variation at this site. The low-range values are also 26 days throughout the modeled time period but the high-range values diverge to 64 days at 10 years, 102 days at 20 years, 339 at 50 years, and year-round at 100 and 150 years. Here, the precautionary analysis of the higher range of the 95th percentile analyses displays similarly adverse numbers at longer intervals (339 at 50 years, and year-round at 100 and 150 years).

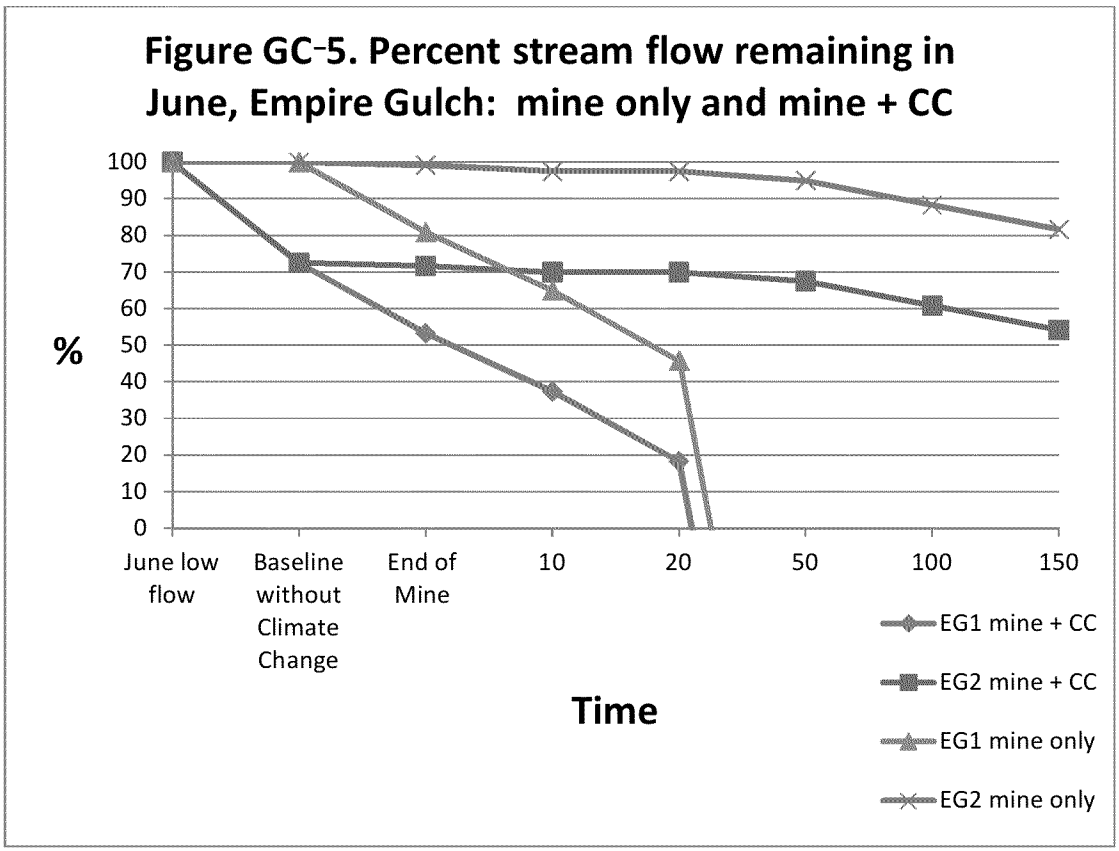
A review of 95th high percentile, mine-only data in SBA Table D-12 indicates the proposed action is the largest contributor to the large effects. Again, the wide range of these data make conclusions uncertain, but precaution dictates we give greater weight to the possibility that upper Empire Gulch will dry.

Empire Gulch already experiences low flows and compromised water quality during May and June. Climate change alone will exacerbate this trend, but the drawdown resulting from the mine will have appreciable adverse effects ranging up to complete dewatering.

Lower Empire Gulch – Key Reach EG2

Even though Gila chub have not been recorded anywhere in Empire Gulch, it is possible chub could occur there in the future by moving upstream from Cienega Creek. Discharges in lower Empire Gulch appear to be insensitive to mine drawdown, with no days of zero flow noted under any modeling scenario (95th percentile or the higher range of the 95th percentile analyses). This equates with no change from the baseline, and flow status would remain perennial.

Losses to the June flow from only the mine at 150 years post-closure is 2.2 gpm for EG2. The percent of flow remaining at 150 years is predicted to be 82 percent (18 percent of flow lost) (Figure GC-5). Reach EG2 loses 5.5 gpm from effects from the mine and climate change combined at 150 years, leaving 54 percent (46 percent lost) of the baseline June flow (12 gpm).



Mine drawdown does not change the number of pools present in reach EG2; climate change reduces the number of pools from 11 to 10 (91 percent of poll numbers retained, 9 percent lost). Median pool depth reduces from 2.6 feet (SIR Table 30) to 1.6 feet (SIR Table 40) (61 percent remaining, 39 percent lost) based on changes from present-day conditions. Median pool depth may change from 1.9 ft at the end of mining to 1.7 ft at 150 years (an 11 percent loss with 89 percent depth retained). Climate change is anticipated to have no effect to pool depth in EG-2. Mine drawdown plus climate change may change pool depth from 1.6 feet at the end of mining to 1.4 at 150 years (88 percent depth remaining, 12 percent lost). Overall, mine drawdown-related pool volume will be 88 percent of original (present-day) pool volume after 150 years (12 percent of volume lost). From the end of mining, pool volume in EG-2 may experience losses of up to 1 percent (99 percent remaining) to as much as a 19 percent loss (81 percent remaining) by 150 years post-closure. Climate change is expected to have greater effects, causing 41 percent losses of pool volume (59 percent remaining) at all time-steps. Combined, mine drawdown and climate change may leave 58 percent of pool volume intact (41 percent lost) at the end of mining, ranging up to as little as 49 percent (51 percent lost) by 150 years. Climate change in combination with mine drawdown reduced pool to 54 percent of original (present day) pool volume after 150 years (46 percent lost). Pools in lower Empire Gulch are anticipated to experience measurable adverse effects, though lower in magnitude relative to upstream reaches. Mine drawdown-driven pool surface area losses in EG2 range from no effect at the end of mining to as much as an 11 percent loss (89 percent remaining) at 150 years. Climate change effects are more pronounced, with 27 percent losses (and 73 percent remaining) at all time-steps. Mining and climate change combined may result in the same 27 percent losses (and 73 percent

remaining) of pool surface area at the end of mining, but may increase to as much as a 36 percent loss of area (64 percent remaining) by 150 years later.

Under current conditions, during periods of low seasonal stream flow (May/June), portions of the aquatic environment along Cienega Creek and Empire Gulch can experience high water temperatures and low concentrations of dissolved oxygen (Simms and Ehret 2014). These same trends would be expected to continue and be exacerbated during days where stream flow is predicted to fall to levels lower than those experienced currently. Higher water temperatures and more occurrences of low dissolved oxygen will reduce the suitability of the area for Gila chub.

Cieneguita Wetlands – Key Reach CGW

Similar to reach EG1, the 95th percentile range of results for the Cieneguita Wetlands encompasses a wide range of results for mine only. The number of pools does not change, but rather, pool depth changes; after 150 years after mine closure, median pool depth reduces from 3.1 to 2.3 feet. Pool volumes change significantly, with the three Cieneguita pools losing 67 percent of their volume due to impacts from the mine after 150 years (33 percent remaining).

Climate change in combination with mine drawdown reduces pool volume to 19 percent of original volume (81 percent loss from original volume). Pool depth loses 26 percent (and retains 74 percent), and pool surface area declines by 76 percent (retaining 24 percent).

Summary

Area groundwater levels have historically been variable, and the environmental baseline shows trends of increasing water use in parts of the action area, which are likely to initiate or contribute to a downward trend in groundwater levels. 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, and more frequent severe climatic events (such as storms, droughts, wildfires, etc.). Modeling has confirmed that impacts to groundwater from the mine, and thus to surface water (stream flow, pool area, pool volume, pool depth), are reasonably certain to occur in designated critical habitat and areas occupied by Gila chub, and thus will negatively affect Gila chub. Reductions in stream flow and in pool volume, depth, and surface area due to the mine will reduce the amount of habitat that is available to Gila chub.

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 to update groundwater 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 additional conservation measures if monitoring shows groundwater drawdown greater than what was modeled. If this were to occur, reinitiation

of consultation would likely be necessary. Groundwater is our surrogate measure of take for all three of the fish species.

The most current version of the conservation measures is provided in the Description of the Proposed Conservation Measures section of this BO. Because the effects of the action to Gila chub will be long-term and off-site, effective conservation measures can only be realized off-site. The conservation measures discussed below are outside the footprint of the mine, although one is in the action area. Other than the monitoring mentioned above, the 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 the 2013 Rosemont BO and in this BO.

The Cienega Creek Conservation package includes the acquisition of water rights and funding for conservation projects. Flow at Pantano Dam is currently captured at an existing in-channel grate-covered diversion. Flow will continue to be captured in this manner, then released into the stream channel at a hydrologically-appropriate location below the dam. Gila topminnow and longfin dace have been observed right above the dam, on the dam (dead), 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. Although Gila chub have not been found within several miles of the dam, the possibility exists they could occur below the dam, given the time-frame of analysis and the mitigating effects of Cienega Creek Watershed Conservation Fund. The City of Tucson and Pima County (2009) expect that up to 3,000 linear feet of riparian and aquatic habitat would form below the dam. 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 perennial 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 through protection of water rights and creation of new habitat. 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). Additional Cienega Creek water rights will also be transferred to an appropriate entity, which may help protect instream flow.

The Sonoita Creek Ranch conservation measure includes maintenance of the two ponds and conveyance channels. The water comes from Monkey Spring, with about 590 AFA of the spring's total 785 AFA of certificated surface water rights appurtenant to Sonoita Creek Ranch (the remainder is appropriated by another water right holder).

Sonoita Creek Ranch is near Patagonia; by virtue of its inclusion as a conservation measure, it is in the action area. Management of the property for conservation purposes, including maintaining the ponds and channels and removing nonnative aquatic species from th at system, will be funded by Rosemont.

Sonoita Creek Ranch includes two ponds that are, and will continue to be, maintained with water discharged from Monkey Spring. The water conveyance structures bringing water to the ponds, between the ponds, and out of the ponds may also provide habitat for native fish. Based on conversations with Rosemont, the reestablishment of Gila chub and Gila topminnow is reasonably certain to occur after nonnatives are removed from them (in coordination with

appropriate agencies). Because this parcel is outside of the main action area, this action represents recovery in lieu of threat removal (FWS 1994). The status of Gila chub should be improved by actions taken at Sonoita Creek Ranch by the creation of additional populations in the ponds. Establishment of new chub populations would partially implement recovery task 2.2 of the Draft Gila Chub Recovery Plan (FWS 2015). Rosemont has measured flow into the ponds over the last eight months, and it averages 16.2 gallons/month (Rosemont 2016). That flow equates to about 596 AFA. Also, the source of Monkey Spring appears to be the regional aquifer, which should be somewhat buffered from local groundwater pumping and climate change. However, flow from Monkey Spring could decrease over time, reducing the amount of water available for the ponds, but it is likely the ponds can be adequately maintained with less flow.

The harmful nonnative species management and removal conservation measure should benefit existing populations of Gila chub in Cienega Creek and in the San Rafael Valley, and any populations that may be established in those watersheds. This conservation measure, while not removing the indirect effects of the mine on groundwater, allows for recovery of listed species in lieu of threat removal and protects one of the PCEs of critical habitat. In addition, actions implemented on National Forest System lands preferentially receive funding under this conservation measure, although other partners and landowners and managers can take part in management actions against nonnative aquatic species. Because nonnative aquatic species are one of the greatest threats to native fish conservation (Meffe *et al.* 1983, Meffe 1985, Brooks 1986, Marsh and Minckley 1990, Stefferud and Stefferud 1994, Weedman and Young 1997; FWS 2002, 2008; Minckley and Marsh 2009), removing them from the landscape and potential fish habitat provides a benefit to native fishes. Cienega Creek currently has no nonnative fishes; if certain nonnative fishes were to become established in the creek, it could be catastrophic for the native aquatic vertebrates there (including Gila chub). Removing nonnative aquatic fish from the nearby watershed minimizes the chance that nonnative fish could find their way into Cienega Creek, or to occupied habitats in the San Rafael Valley. Removal of nonnative aquatic fish in the San Rafael Valley could open up habitats for the release of Gila chub.

The Cienega Creek Watershed Conservation Fund, harmful nonnative species management and removal, and Sonoita Creek Ranch conservation measures are essential to partially offset expected effects to Gila chub and their habitat.

Summary of Effects – Gila Chub

- Although groundwater levels have historically been variable in this area, the environmental baseline and cumulative effects show trends of increasing water use in parts of the action area, which are likely to initiate or contribute to a downward trend in groundwater levels;
- 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 climatic events (such as storms, droughts, wildfires, etc.);
- Impacts to groundwater due to the mine, and thus to surface water (stream flow, pool area, pool volume, pool depth), are reasonably certain to occur (based on the modeling utilized in this analysis) in designated critical habitat and areas occupied by Gila chub, and thus will negatively affect Gila chub;
- The proposed conservation measures will not preclude anticipated effects to surface water from occurring nor entirely mitigate those effects;
- Within 50 to 150 years post-closure, substantial decreases to wetted stream perimeter and water depth are anticipated to occur;
- Cienega Creek is one of 22 extant populations of Gila chub range-wide (FWS 2015) and Cienega Creek is relatively stable, with no nonnative fishes present;
- The effects of the proposed action do not represent movement beyond a tipping point that would preclude the recovery of the species, nor will the proposed action result in the destruction or adverse modification of the species' critical habitat; and
- While the proposed conservation measures will not preclude the anticipated indirect effects due to the mine to surface waters and Gila chub from occurring, the Cienega Creek Watershed Conservation Fund, the Harmful Nonnative Species Management and Removal program, the Cienega Creek water rights transfer, and the acquisition and enhancement of Sonoita Creek Ranch conservation measures will allow partial conservation in lieu of threat removal, thus minimizing the adverse effects of the proposed action.

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, increased movement of nonindigenous species, 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. Recreational use of Pima County lands, while restricted, is also a cumulative effect. Lastly, the right-of-way vegetation 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 in the Santa Cruz River basin. 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 will increase as the population increases, in line with current trends. In most of Arizona‘s developed areas, groundwater is pumped out faster than the aquifer can recharge (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 well quantified within the action area.

Conclusion – Gila Chub

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by

selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusion of non-jeopardy and no destruction or adverse modification, below, would remain valid.

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 nor destroy or adversely modify designated critical habitat. 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 (and Corps, as appropriate) will compare observed drawdown to modeled drawdown. Groundwater drawdown greater than modeled will be evaluated and may require reinitiation of section 7 consultation;
3. The Cienega Creek Watershed Conservation Fund projects will, for the short-term at least, protect and potentially increase habitat for Gila chub by funding management and restoration actions in the watershed, protecting water rights, creating some habitat for Gila chub, and minimally protecting critical habitat in the Lower Santa Cruz/Cienega Creek Critical Habitat Unit (Unit 5;
4. Projects funded through the Cienega Creek Watershed Conservation Fund are likely to increase ecosystem resiliency in the face of the expected groundwater drawdown from Rosemont Mine, and impacts from climate change, thereby reducing and delaying impacts to Gila chub habitat;
5. The severance and transfer of downstream senior water rights to upstream reaches of Cienega Creek is proposed to occur. If successfully executed, these *in situ* water rights may be employed to protect against future diversions of surface water by junior appropriators;
6. The two ponds at Sonoita Creek Ranch will provide new habitat for Gila chub from a reliable water source (Monkey Spring);
7. The Cienega Creek Watershed Conservation Fund and pond component of the Sonoita Creek Ranch conservation measures are anticipated to partially offset expected effects to Gila chub and their habitat;
8. Indirect effects to Gila chub from groundwater drawdown are difficult to predict at the distances from the drawdown (Rosemont Mine), and are not anticipated to occur until after mine closure;
9. Groundwater drawdown is 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
10. Conservation and recovery actions have taken place successfully since species listing, and continue to occur, with more actions in planning. Therefore, we believe the status of the species is improving (Crowder and Robinson 2015, Robinson and Crowder 2015, FWS 2015);
11. The anticipated relatively small magnitude of the proposed action's effects to Gila chub and the implementation of conservation measures (as described in Conclusions 2 - 6 above), lead to the conclusion that the recovery potential of Gila chub and the species critical habitat will not be greatly diminished;

12. The harmful nonnative species management and removal conservation measure will help ameliorate the threats of nonnative aquatic species in the Cienega Creek watershed and San Rafael Valley by removing problematic aquatic nonnative species. It may also make available additional habitat to create additional populations Gila chub in sites where problematic aquatic nonnative species are removed;
13. Cienega Creek is one of 22 extant populations of Gila chub range-wide (FWS 2015);
14. The effects of the proposed action are not a tipping point that would preclude the recovery of the species, as delineated below.

The draft Recovery Plan (FWS 2015) has criteria that are useful for determining jeopardy, though they are subject to revision following the public participation and peer review processes. Before considering Gila chub for down- or de-listing, all available remnant populations within each recovery unit are maintained in a protected stream (including Cienega Creek), and trends of recruitment and population size indices are considered stable or positive over the most recent rolling 10-year period. In addition, the draft recovery plan defines a stable (viable) population as one containing at least 5000 reproductive adults. Cienega Creek may not currently support 5,000 reproductive adults (Foster and Simms 2005) but if Cienega Creek was precluded from supporting that number of breeding fish, it would seriously hamper recovery of Gila chub.

Since the impacts of the proposed action affect only one natural Gila chub population and the action area is small compared to the range of the species, and Gila chub are expected to still be present in Cienega Creek 150 years after mine closure, it is unlikely that a tipping point away from recovery would be reached. While the action area does include an important population of the species, the effects of the action are not anticipated to be large enough to cause the loss of the population, and it is similarly unlikely that a tipping point away from recovery would be reached. We believe that Gila chub will still be present in Cienega Creek 150 years after closure of the mine since adequate water will be present. We believe this even with the higher temperatures and lower dissolved oxygen levels that will be present then.

The adverse effects that do occur in the action area do not reach the scale where recovery of the species would be delayed or precluded. Adverse effects are anticipated to be of a similar small scale, and are unlikely to destroy or adversely modify the critical habitat in the action area to the extent that recovery would be delayed or precluded for many of the reasons found in the conclusion and discussion above.

Based on the above analyses and summary, it is the FWS's biological opinion that the proposed action will not alter the ability of this critical habitat to retain its PCEs and to function properly. As such, Gila chub designated CH will remain functional to serve its intended conservation role for the species. Therefore, we conclude that the proposed action is not likely to either 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 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 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). 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 – Gila Chub

We anticipate that the proposed action will result in incidental take of Gila chub as enumerated in Table GC-4. Any reduction in stream discharge resulting from groundwater drawdowns attributable to the proposed action will reduce the extent and/or quality of aquatic habitat required by Gila chub, thus harming the species. We are therefore reasonably certain that take will occur.

Incidental take of Gila chub in Cienega Creek will be difficult to detect for the reasons listed below. Thus we will use a surrogate measure of take, the justification for which also appears below. The incidental take is expected will be monitored and defined in the form of harm through the loss of habitat from groundwater drawdown, and harm and kill from water diversion and management at Pantano Dam.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (e.g., long-lived, territorial species such as the desert tortoise). However, it is impossible to quantify the number of individual Gila chub taken because: (1) dead or impaired individuals are almost impossible to find (and are readily consumed by scavengers and predators) and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species will change over time through disease, natural population variation, natural habitat loss, or the active creation of habitat through management; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity.

Gila chub are subject to an existing monitoring program in the Cienega Creek watershed on the Las Cienegas NCA. The currently used sampling techniques, however, do not result in population estimates, only relative abundance as catch-per-unit-effort. The sampling techniques used on Las Cienegas NCA are only sensitive enough to be statistically significant if the population doubles or is halved (Bodner *et al.* 2007). Monitoring in reaches downstream from the Las Cienegas NCA (Marsh and Kesner 2011) is similarly unsuited to determining population trends. Gila chub population estimates can theoretically be acquired, but are difficult, time consuming, stressful to the fish (to the point of harm), and expensive. In addition, the number of Gila chub in any population are normally extremely variable during a year due to an r-selected (high fecundity, short generation time, wide dispersal of offspring) reproductive strategy, common in highly variable environments such as desert streams.

It is reasonable to assume that the abundance of Gila chub is correlated with the extent of suitable aquatic habitat provided by surface flows in the affected streams (see Status of the Species and Critical Habitat within the Action Area section). Baseflows maintain stream discharge when surface runoff is low or nonexistent, and these baseflows result from groundwater discharge. The discharge of groundwater to springs and streams is related to the elevation and gradient that regional groundwater exhibits relative to those surface waters. Decreases in groundwater elevation affect this gradient and thus, reduce the discharge of groundwater to streams (see Effects to Aquatic Ecosystems section). Reduced discharge equates with reduced habitat availability which could ha rm the species. Groundwater elevations, which can be readily measured, are therefore effective surrogate measures for the incidental take of Gila chub.

The Effects to Aquatic Ecosystems section of this BO as well as the analysis of effects for the Gila chub, above, discuss the specific relationship between the proposed action, changes in groundwater elevation, the volume and length of surface flow in streams, and various aspects of pool numbers and geometry. These changes are expressed in terms of both quartile and 95th percentile analyses of available groundwater drawdown, discharge, and pool data.

The changes in groundwater elevation will result in reduced wetted lengths and volumes in reaches of stream maintained by discharges from the regional aquifer; surface flow effects (including effects to pools) are summarized in Tables A-2 through A-8 in the Effects to Aquatic Ecosystems section, above. WestLand (2012) determined that there could be some reductions in the wetted length of lower Cienega Creek from groundwater drawdowns over the long term. We did not analyze the results from WestLand's study.

We note that the 95th percentile approach included predictions of drawdown from 37 to 38 individual modeling scenarios, including the Myers (2010) best-fit model (one scenario, only available for key reaches EG1, CC2, and CC5, and only for certain time steps), the Tetra Tech (2010) best-fit model (one scenario), the Montgomery best-fit model (one scenario), the Tetra Tech sensitivity analyses (8 scenarios), and the Montgomery (2010) sensitivity analyses (27 scenarios). Please see the Sources of Uncertainty section, above, for additional detail.

As stated in the Sources of Uncertainty Section of this Final BO, we have determined that the 95th percentile approach is appropriate for the evaluation of the effects of mine drawdown and climate change on aquatic and riparian species. We also stated that selecting any one of the best-fit models as the sole description of hydrologic impacts risks picking a wrong interpretation and underestimating impacts to hydrology elsewhere.

There is, however, a practical limitation with respect to using the 95th percentile approach for measuring (and complying with) incidental take. Incidental take occurs in the future, and it is not practicable to implement an ongoing 95th percentile analysis of all three groundwater models (and sensitivity analyses) moving forward. The primary issue is that the 95th percentile approach is intended to encompass reasonable sources of uncertainty in order to incorporate reasonable precaution into our effects analyses. It is not intended to and cannot be a tool for future compliance monitoring.

The use of a single groundwater model is justified for future compliance monitoring, because one model needs to be selected to set clear and enforceable thresholds. We have selected the Tetra Tech (2010) model because it represents the upper end of the range of drawdown that could be observed in the nearest (to the pit) and most critically sensitive (to threatened and endangered riparian and aquatic species) areas, specifically Empire Gulch and Upper Cienega Creek. Of equal importance is the practical matter that only the Tetra Tech (2010) model remains in an active state (in the possession of NEIBRO Hydrogeology). The Montgomery (2010) and Myers (2010) models are no longer active to the best of our knowledge, and the latter lacks the spatial coverage to be useful in the measurement of incidental take.

The exact model scenario that most closely approximates the upper end of the 95th percentile analysis will differ geographically. As discussed in the "Sources of Uncertainty" section, the Tetra Tech model incorporates a hypothesized dike in Davidson Canyon, which impedes drawdown in that direction and instead increases drawdown in the area of Empire Gulch and Upper Cienega Creek. In these critically sensitive areas, the high end of the Tetra Tech sensitivity analyses very closely approximates the upper-end values relied upon for the analyses in the BO. As such, it is reasonable to express incidental take as the drawdowns observed under the high end of the Tetra Tech model sensitivity analyses.

Table GC-4, below, displays the anticipated amount or extent of take (again, in terms of Tetra Tech 2010) in the locations and time frames (0, 20, 50, and 150 years) discussed in the analysis of the effects to the species, above; these locations are: (1) Empire Gulch Springs, representing effects to Empire Gulch; (2) USGS stream gage No. 09484550, representing effects to upper Cienega Creek; (3) the Davidson/Cienega Confluence, representing effects to Davidson Canyon Wash; and (4) USGS stream gage No. 09484560, representing effects to lower Cienega Creek.

Table GC-4: Anticipated amount or extent of take for the Gila chub, based on Tetra Tech (2010, as referenced in SWCA 2012) and Table A-5 in the October 30, 2013, BO's Effects to Aquatic Ecosystems section, for mine only.

Location	**Maximum anticipated post-mining groundwater drawdown (in feet) by year[1]**			
	0	20	50	150

Upper Empire Gulch Springs	0.1	0.5	1.8	5.0
Upper Cienega Creek near stream gage No. 09484550	<0.1	<0.1	0.15	0.35
Davidson/Cienega Confluence	<0.1	0.15	0.2	0.2
Lower Cienega Creek near stream gage No. 09484560	<0.1	<0.1	<0.1	<0.1
[1] Drawdowns described as less than 0.1 foot would be exceeded if they met or exceeded 0.1 foot.				

The sites and time frames, which appear in Table GC-4 (above), are a subset of the values contained in Table A-5 in the Effects to Aquatic Ecosystems section of the October 30, 2013 BO. These data are referred to throughout this BO's effects analyses, and represent groundwater model outputs at locations and times of interest to biological resources. It is recognized, however, that the sites currently lack observation wells; groundwater elevations cannot be monitored at these locations. Moreover, these sites are proximal to streams and will experience confounding influences from recharge by runoff, riparian ET, and drought, rendering the sites relatively unsuited for groundwater monitoring – and unsuited for determining cause and effect relationships for hydrologic changes - even if wells were emplaced. It is also recognized that the time intervals for the reported drawdowns (0, 20, 50, 150 years post-mining) are not meaningful for monitoring take; the intervals are too infrequent and become even less frequent over time. The selected groundwater model, however, can be run such that drawdowns at any location within its domain (such as where groundwater monitoring wells have been or will be placed; see Table GC-5, below) and at any desired time interval can be determined (USGS 1997). Given that the drawdowns at alternative sites displayed in Table GC-5 (appropriate locations for monitoring wells) would be derived from the same model that resulted in the anticipated levels of take at the sites described in Table GC-4, the alternative sites can serve as directly-comparable proxies for the key locations noted in Table GC-4.

We also note that fluctuations in groundwater elevation can vary daily and seasonally from environmental factors. These daily fluctuations have the potential to exceed the smaller magnitude groundwater drawdowns displayed in Table GC-4 (particularly those ≤0.1 foot). During the initial implementation phase (site construction, early pit construction) there is an opportunity to monitor daily and seasonal groundwater fluctuations for 2 to 4 years - under background conditions - before the anticipated effects from the pit dewatering are realized. The results from this initial monitoring will help determine the degree of background (baseline) variation in the observed groundwater elevations before the realization of Rosemont's effects. The data will also assist in discerning the groundwater drawdown attributable to the pit from unrelated environmental factors.

The USFS (2013b) has provided a list of well sites, already subject to monitoring for various environmental compliance purposes (see Monitoring Measure FS-BR-27 in the FEIS) that are likely to be suitable for monitoring the surrogate measure of incidental take (groundwater drawdown). The wells are located east of the crest of the Santa Rita Mountains, between the mine pit and Cienega Creek and Davidson Canyon Wash. Monitoring of some or all of these wells as proxies (for groundwater drawdown at the key locations in Table GC-4) will allow take of Gila Chub to be monitored immediately and during the active life of the mine, rather than waiting for the decades or centuries that it is modeled to take measurable drawdown to reach the

affected streams, Cienega Creek and Empire Gulch. This suite of potential alternative monitoring sites has been reproduced in Table GC-5, below.

Table GC-5: Potential groundwater monitoring wells for compliance with the surrogate measure of incidental take (groundwater drawdown) described in Table GC-4, above. Groundwater drawdowns at a suite of these sites – once modeled and analyzed for their degree of natural variation – will serve as proxies for the drawdowns in Table GC-4.

Well Name	Direction from Mine Pit	Approximate Distance from Mine Pit (miles)
Gardner Canyon monitoring wells that could potentially be a proxy for the Gardner/Cienega Confluence		
HC-6	S	0.5
17bdb	SE	3
RP-5	SSE	1.2
18ddb	SSE	3.2
16cbb	SE	3.4
Rosemont Ranch	SE	3.8
Empire Gulch monitoring wells that could potentially serve as a proxy for Empire Gulch springs		
DH-1541	ESE	2.6
Oaktree Windmill	ESE	4.1
Davidson Canyon Wash monitoring wells that could potentially serve as a proxy for the Davidson/Cienega Confluence		
C-1	NE	0.5
HC-5B	NNE	0.6
P-899	NE	1
HC-4B	NE	1.6
RP-2C	ENE	2.5
RP-6	NE	3.8
RP-7	NE	4.5
Cienega Creek monitoring wells that could potentially serve as proxies for Upper and Lower Cienega Creek		
RP-3B	E	1.5
RP-9	E	3.4
RP-8	ENE	4.5

In summary, and stated differently, the maximum allowable incidental take of Gila chub is represented by the surrogate measure of groundwater drawdowns at the sites and time intervals stated in Table GC-4, above. The to-be-modeled groundwater drawdowns at a suite of potential sites specified in Table GC-5, above, will serve as proxies for the incidental take at the sites in Table GC-4. The manner by which Rosemont and the USFS shall monitor compliance with the amount of incidental take is described further in the Terms and Conditions, below.

Effect of the Take – Gila Chub

In this BO, the FWS determined that the level of take anticipated to result from the action is not

likely to result in jeopardy to the Gila chub, nor lead to destruction or adverse modification of designated critical habitat.

Reasonable and Prudent Measures – Gila Chub

The FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of Gila chub:

1. The USFS and Corps shall ensure that Rosemont monitor groundwater levels (as a surrogate for take of Gila chub) at least annually (see also FEIS mitigation measure FS-BR-27);
2. The USFS and Corps shall ensure that Rosemont creates and funds the Cienega Creek Watershed Conservation Fund according to stipulations contained in FEIS mitigation measure FS-BR-16 and this BO.
3. The USFS and Corps shall ensure that Rosemont manages the Sonoita Creek Ranch as specified, and includes the creation of a Gila chub population in at least one of the ponds.
4. The USFS and Corps shall ensure that the program to manage against nonnative aquatic species is conducted as stated.

Terms and Conditions – Gila Chub

In order to be exempt from the prohibitions of section 9 of the Act, Rosemont, the USFS, and Corps 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.

Terms and Conditions 1.1 through 1.5 implement Reasonable and Prudent Measure 1. Term and Condition 2 pertains to the implementation of Reasonable and Prudent Measures 2, 3, and 4.

1.1 Consistent with FEIS mitigation measure FS-BR-27, Rosemont, the USFS, and the Corps shall select a representative group of the observation wells found in Table GC-5, above (USFS 2013b) at which groundwater levels, a surrogate for take of Gila chub, shall be monitored. Once the wells have been selected, the USFS shall ensure that Rosemont re-run the Tetra Tech (2010) groundwater model to obtain groundwater drawdowns (including sensitivity analyses) at all of the well sites. The wells selected and the modeling results should be reviewed by an independent third party, with the U.S. Geological Survey being the preferred party. The time intervals shall be once a year through closure of the mine, and thereafter, every 5 years. Monitoring will continue postclosure for a duration determined to be necessary by FWS, USFS, and the Corps based on data gathered during implementation and input from the team described in Term and Condition 1.5, below.

1.2 At the time construction of the mine commences (and before pit excavation), the USFS and Corps shall ensure that Rosemont initiate monitoring of the selected groundwater wells and report the results annually to the USFS, Corps, and FWS through closure of the mine (FEIS mitigation measure FS-BR-27, and FS-BR-16). Monitoring will continue postclosure for a duration determined to be necessary by FWS and USFS based on data

gathered during implementation and input from the team described in Term and Condition 1.5, below.

1.3 During the initial implementation phase (site construction and early pit construction), The USFS and Corps shall ensure that Rosemont monitor the wells daily (or via continuous data collection devices) to determine the magnitude of daily and seasonal groundwater fluctuations before the onset of the anticipated effects of pit dewatering (FS-BR-27). The results from initial monitoring will help the USFS to determine if and to what degree observed groundwater elevations vary due to natural fluctuations (present-day baseline conditions). The magnitude of the observed fluctuations shall accompany the model results from Term and Condition 1.1, which will then be reported to the USFS, Corps, and FWS.

1.4 Rosemont, the USFS, and Corps shall compare the results of the monitoring described in Term and Condition 1.2 to the groundwater model results described in Term and Condition 1.1, including the variation noted from implementation of Term and Condition 1.3, and report the finding to FWS annually.

1.5 If it is determined at any time via monitoring that the observed groundwater drawdowns exceed the upper bounds of the sensitivity analyses for the modeled groundwater drawdowns, including consideration of applicable daily and seasonal fluctuations, then it is possible that the take of Gila chub described in Table GC-4 has been exceeded. In this event, the USFS and Corps shall consult with Forest Service staff, FWS, Rosemont Copper, and/or the USGS, the University of Arizona, Bureau of Land Management, and/or other appropriate sources of expertise to seek consensus on whether the specific metrics identified in the take statement have been exceeded and whether the exceedance can be attributable to Rosemont's activities and thus be considered an exceedance of the take authorized by this Incidental Take Statement. The USFS and Corps may convene any of these individuals as a team, in consultation with FWS, which may advise USFS and the Corps. The USFS, Corps, and/or FWS have ultimate responsibility to make the determination of whether reinitiation of consultation is appropriate.

2. The funds identified for the non-HMMP Cienega Creek Watershed Conservation Fund, Sonoita Creek Ranch, and Harmful Nonnative Species Control conservation measures may only be used for projects as described in the Conservation Measures subsection of the Description of the Proposed Action Section, above, unless more appropriate actions are later identified and approved by the USFS, Corps, and FWS. Indirect (overhead) costs must be funded separately.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effects of the 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 and/or Corps must immediately provide an explanation of the causes.

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. The USFS full-time Biologist position (Revised Conservation Measure 1 – Staff Funding Biological Monitor) should coordinate directly with Rosemont and Rosemont's consultants on behalf of the Forest Service, and also coordinate with other land managers as deemed necessary.

2. We recommend that Rosemont and the eventual owner or manager of Pantano Dam consider changing how water is diverted there to reduce fish entrainment. An infiltration gallery would be ideal to reduce entrainment;

3. We recommend that Rosemont and the eventual owner or manager of Sonoita Creek Ranch consider changing how water is diverted at Monkey Spring to reduce fish entrainment. An infiltration gallery would be ideal to reduce entrainment;

4. We recommend that the USFS, while implementing the harmful nonnative species management and removal conservation measure, 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 continue to remove any source populations of nonnative aquatic species from the area;

5. We recommend that the USFS continue to assist us and the AGFD in conserving and recovering the Gila chub;

6. We recommend that the USFS continue to assist us with the completion and implementation of the Gila chub recovery plan;

7. We recommend that the USFS and Rosemont acquire instream flow water rights to ensure perennial flow in streams with Gila chub;

8. We recommend that the USFS continue to work with the FWS and AGFD to remove nonnative species and reestablish Gila chub throughout its historical range in Arizona;

9. We recommend that the USFS conduct fish surveys on National Forest lands to determine the extent that other chub, such as the headwater chub (*G. nigra*), may occupy those streams.

10. We recommend that the USFS continue to work cooperatively with us and AGFD to establish populations of Gila chub wherever possible.

11. We recommend that the USFS and Corps ensure that Rosemont researches techniques for reducing the use and loss of groundwater from the proposed action in the project area, considering any and all current and future techniques that may be technologically and economically feasible.

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.

GILA TOPMINNOW

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 (FWS 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, Brooks 1986, Stefferud and Stefferud 1994, 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.

Environmental Baseline – Gila topminnow

The action area for Gila topminnow encompasses all occupied or likely-to-be occupied reaches of stream and other waters within the Cienega Creek watershed, as these will be subject to the proposed action's effects to groundwater and surface flow hydrology. Sonoita Creek Ranch is also in the action area, because the proposed action includes the likely release of Gila topminnow there. This area is described in detail in the Status of the Species within the Action Area section, below. The narrative 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 and are hereby incorporated from the 2013 Rosemont BO. Although groundwater levels have historically been variable in this area, there is a trend of increasing water use in parts of the action area, which is likely to initiate or contribute to a downward trend in groundwater levels. 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; and more frequent severe climatic events (such as storms, droughts, wildfires, etc.).

Table GT-1. Reestablished wild populations of Gila topminnow that are likely extant, 2013 to 2015. In Arizona unless noted otherwise (Voeltz and Bettaso 2007, Crowder and Robinson 2015, Robinson and Crowder 2015, FWS files).

Site Name	Year stocked (discovered)	Mixed/pure	Lineage(s)	Fish From:
Cottonwood Artesian	1982 - **Failed** 2001	Mixed Pure	Monkey/Bylas/Cocio Bylas Springs	BTA ASU ARC
Lime Creek	Dispersal from Lime Cabin Spring (1996)	Mixed	Monkey/Bylas/Cocio (Lime Cabin Spring stocked in 1982)	BTA
Bass Canyon	2014	Pure	Bylas	Dudleyville pond
Bonita Creek (upper)	2010/2014	Pure	Bylas Spring	Dudleyville pond
Buckhorn Spring	2011	Pure	Sharp Spring	
Burro Cienega, NM	2008	Pure	Bylas Spring	Dudleyville pond
Chalky Spring	2009	Pure	Sharp Spring	
Cherry Spring Canyon (Muleshoe)	2007-2008	Pure	Bylas Spring	Dudleyville pond
Cieneguita Wetland 1 & 3	2013	Pure	Cienega Creek	
Cold Spring (#85)	1985	Pure	Monkey Springs	BTA
Cottonwood Spring (Goldfield Mountains)	2008	Mixed	Monkey Springs	Boyce Thompson Arboretum
Cottonwood Tank	2013	Pure	Cienega	Cienega
Empire Tank	2013	Pure	Cienega Creek	
Fossil Creek (#280)	2007-2010	Pure	Sharp Spring	
Gaucho Tank	2013	Pure	Cienega	Cienega
Headquarters Spring (Muleshoe)	2008	Pure	Bylas Spring	Dudleyville pond
Hot Springs Canyon	2013	Pure	Bylas	Dudleyville
Howard Well	2008	Pure	Bylas Spring	Dudleyville pond
Larry Creek trib	2005	Pure	Coalmine Spring	Coalmine Spring
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	Bubbling Ponds
O'Donnell Creek	1974	Pure	Monkey	Monkey
Pasture 2 Tank	2013	Pure	Sharp Spring	Robbins Butte
Redfield Canyon	2012	Pure	Bylas	Dudleyville Ponds
Redrock Wildlife Area NM	2010	Pure	Bylas Spring	Dudleyville pond
Road Canyon Tank	2012	Pure	Cienega Creek	Robbins Butte
Rock Spring	2013	Pure	Santa Cruz (Peck)	Phoenix Zoo
San Rafael	2013	Pure	Sharp Spring	Robbins Butte
Secret Spring (#331, Muleshoe)	2007	Pure	Bylas Spring	Dudleyville pond
Sheepshead Canyon	2014	Pure	Santa Cruz	Phoenix Zoo
Springwater Wetland	2013	Pure	Cienega Creek	
Swamp Springs Canyon (Muleshoe)	2007-2008	Pure	Bylas Spring	Dudleyville pond
Tule Creek	1981	Mixed	Monkey/Bylas/Cocio	BTA
Unnamed Drainage 68b	Dispersal from Mesquite Tank #2 (1985)	Mixed	Monkey/Bylas/Cocio (Mesquite Tank @ stocked in 1982)	BTA

Usery Park	2011	Pure	Cottonwood Springs	
Walnut Spring (Mesa Ranger District)	1982	Mixed	Monkey/Bylas/Cocio	BTA
Walnut Spring (Tonto Basin Ranger District)	2013	Pure	Redrock Canyon	ASU & Desert Harbor
Wildcat Canyon	2013	Pure	Bylas	Dudleyville pond

Status of the Species within the Action Area

The action area for the Gila topminnow 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 NCAs, Arizona (File numbers 22410-2008-F-0103, 22410-2002-F-0162-R001) and in the 2013 Rosemont BO. The action areas for those earlier 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. Since the 2013 BO, Cottonwood Tank, Gaucho Tank, and Cieneguita Wetlands have had topminnow reestablished there (Crowder and Robinson 2015, Robinson and Crowder 2015).

The natural population of Gila topminnow in Las Cienegas NCA 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 2013). 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).

The lower reaches (CC5 & CC7) of upper Cienega Creek appear to have a stable, although small, Gila topminnow population, but because of how data were collected, even that is uncertain (Bodner *et al.* 2007). The Cienega Creek topminnow population is considered a viable population under recovery plan guidelines (Weedman 1999), and it is still the largest by far in the U.S.

Sampling by AGFD in 2012 and 2015 found Gila topminnow in the Pima County CCNP at two sampling sites (Timmons and Upton 2013; Timmons, AGFD, pers. comm., October 13, 2015). Recent surveys suggest that Gila topminnow continue to be abundant in upper Cienega Creek (Rosen *et al.* 2013, Simms 2014d, Simms and Ehret 2014).

Hatch (2015) analyzed fish counts conducted by the BLM from 2005 through 2012, and based on these counts estimated positive mean growth rates for this species in two populations (upper and lower) in Cienega Creek. By evaluating this probability distribution, Hatch determined that the lower bound of the 95 percent confidence intervals include growth rates that are negative for the population found below Spring Water Canyon. This means that even though overall mean growth rate is positive for this population, there is still the possibility of long-term population decline due to environmental stresses. The probability that the extirpation threshold (which Hatch defines as a catch per unit of 1 fish over a 24-hour period) is reached above Spring Water

Canyon was 0.000006, meaning that there is far less than 0.01 percent chance that this specific population of this species would be functionally extirpated in the future. It should be noted that extirpation is not the same as extinction; extirpation refers only to the local populations analyzed by this study. Below Spring Water Canyon the probability is 0.9609, meaning there is an about 96 percent chance that this species would be functionally extirpated at some point in the future.

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) and BLM (2012) 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. Since the 2013 BO, Cottonwood Tank, Cieneguita Wetland, and Gaucho Tank have had Gila topminnow reestablished. There are six other sites where topminnow may be released on Las Cienegas NCA (BLM 2012).

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 NCAs, 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 reference, as is the Gila topminnow section of the 2013 Rosemont BO. There is no designated critical habitat for Gila topminnow.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following Gila topminnow-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

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. Effects that differ from those described for the Gila chub will be discussed below. Information from the 2013 Rosemont BO that has not changed will not be repeated here. There are no direct effects from the mine. Indirect effects caused by groundwater draw down from the mine will negatively impact stream flow and pool metrics. Impacts from the mine only are small when compared to the effects of climate change. However, the impacts from the mine only do cause negative impacts to aquatic habitats that negatively impact the Gila topminnow.

Climate change may be less problematic for Gila topminnow compared to Gila chub, because Gila topminnow have about a 2° C higher tolerance of water temperature than Gila chub (Carveth *et al.* 2006). Also, Gila topminnow are more tolerant of reduced dissolved oxygen in the water; topminnow can survive with dissolved oxygen at 1ppm, while chub require at least 3ppm (Meffe *et al.* 1982, FWS 2015). 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 and pool surface area will be more deleterious for topminnow than Gila chub, since all life stages of Gila topminnow prefer and use shallow waters much more than chub (Schoenherr 1974). 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 (Pima County CCNP), Cienega Creek on Las Cienegas NCA, Cieneguita Wetlands, and Mattie Canyon. The modeled loss of surface water in the northern reaches of upper Cienega Creek (CC5 & 7) is more of a concern than in the southern reaches, because the most robust topminnow populations on the Las Cienegas NCA occur there (Bodner *et al.* 2007).

Impacts from only the mine reduce pool surface area (mean and total) by less than 10 percent for all reaches of Cienega Creek. Though the loss by percent is small for all Cienega Creek reaches, 1,068 square feet (3%) of surface area is lost from the pools during June, 150 years post closure. Cieneguita Wetlands lose 50 percent of their surface area. Only key reach CC2 has any individual pools that lose more than 24 percent of their surface area. However, all three of these CC2 pools are very small (8, 12, and 31 ft^2, SBA Addendum Table G3).

Effects to pool surface area in June are much greater when the impacts of climate change are added to the impacts of the mine, 150 years post closure. All Cienega Creek key reaches

combined lose approximately 17,000 ft^2 of pool surface area, or 29 percent (dropping from approximately 59,000 to 42,000 ft^2). The key reaches in lower Cienega Creek lose the most surface area, 63 and 35 percent for CC13 and CC15 respectively. The two key reaches in upper Cienega Creek (CC2 & CC4) that have had robust Gila topminnow populations (Bodner *et al.* 2007) each lose 27 percent of their surface area after 150 years due to the effects of climate change and the mine. CC5 loses 3,162 ft^2 surface area after 150 years due to the effects of climate change and the mine (dropping from 11,597 to 8,435ft^3).

In looking at quartile losses for pool area, 63 of 83 pools lose more than 24 percent (retaining 76 percent) after 150 years due to the combined effects of climate change and the mine. The two upper key reaches of Cienega Creek have 13 of 16 and 11 of 19 pools that lose at least 25 percent of their surface area (retaining 75 percent). In addition, 12 of 16 and 6 of 19 pools lose at least 50 percent of their surface area (and retain up to 50 percent) after 150 years due to the effects of climate change and the mine.

Since attempts to establish Gila topminnow in Empire Gulch have failed, the modeled groundwater decline at key reach EG1 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 issues in EG1 with excess aquatic vegetation and shade in the spring run would need to change before Gila topminnow releases were entertained. Gila topminnow could potentially get into EG2 on their own from Cienega Creek.

About 825 AFA of surface water from Cienega Creek will be used for aquifer recharge below Pantano Dam, in support of an In-lieu-fee (ILF) mitigation program. Gila topminnow and longfin dace have been observed right above the dam, on the dam (dead), and in the scour pool below the dam. It is certain that fish have been and will continue to go into the diversion as long as it operates, and suffer death or injury. 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. Other water rights will be transferred to a suitable entity (HMMP 2014). Lastly, the $2,000,000 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 actions anticipated to be 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 1,580 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 project area. Funding for restoration and management of the property will include management against nonnative species, generally in the two existing ponds on the property that are maintained with water from Monkey Spring. An evolutionarily significant unit (ESU) 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, a key task in the draft revised recovery plan (Weedman 1999). Gila

chub and Gila topminnow will likely be established in the ponds after nonnatives are removed from them. Because this parcel is outside of the project area, this action represents recovery in lieu of threat removal and a minimization of the action's effects.

The environmental baseline and recovery status of Gila topminnow should be improved by actions taken at Sonoita Creek Ranch. The proposed action implements tasks in the draft revised Gila Topminnow Recovery Plan (Weedman 1999) by partially protecting the water rights from Monkey Spring. 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, especially Monkey Spring. Also, the groundwater source of Monkey Spring appears to be the regional aquifer, which should be somewhat buffered from local groundwater pumping and climate change. The ponds on Sonoita Creek Ranch would be the best location to replicate the Monkey Springs topminnow ESU. We consider the Sonoita Creek Ranch and Cienega Creek Watershed Fund (see analysis of the latter's beneficial effects in the Gila chub analysis, above) conservation measures to be essential to partially offset expected effects to Gila topminnow and their habitat.

Lastly, the draft revised recovery plan for Gila topminnow (Weedman 1999; see Status of the Species section, above), contains Survival and Reclassification Criteria. The proposed action will affect the habitat for and the population of Gila topminnow in Cienega Creek, the securing of which is described in Survival Criterion I(A), but we anticipate, as previously stated, that the Cienega Creek Watershed Fund should help conserve aquatic habitats and Gila topminnow in this system. Survival Criteria II, III, and IV will not be affected.

Reclassification Criterion I is met when the Survival Criteria have been met. Given that the proposed action supports Survival Criterion I and does not affect Survival Criteria II, III, or IV, we anticipate that the ability to reclassify (downlist) Gila topminnow will not be precluded by the proposed action. Reclassification Criterion II refers to the replication, establishment, and survival of populations within the Gila topminnow's historical range. The acquisition and restoration of the Sonoita Creek Ranch will contribute to the implementation of this criterion, thus supporting reclassification from endangered to threatened, a meaningful increment toward recovery of the species. Reclassification Criterion III refers to monitoring of populations and periodic assessments of genetic integrity. The restoration of and likely reestablishment of Gila topminnow to the Sonoita Creek Ranch will be monitored; genetic assessments are beyond the scope of the proposed action and will most likely be pursued at the species-wide scale by, FWS, other Federal and State agencies, and academia. Reclassification Criterion IV requires a genetic protocol that allows for the exchange of genetic material between populations; this too is beyond the scope of the proposed action and will most likely be pursued by wildlife agencies and researchers.

The harmful nonnative species management and removal conservation measure should benefit existing populations of Gila topminnow in Cienega Creek and in the San Rafael Valley, and any populations that may be established in those watersheds. This conservation measure, while not removing the indirect effects of the mine on groundwater, allows for recovery of listed species in lieu of threat removal. In addition, Forest System lands preferentially receive funding under this conservation measure, though other partners and landowners and managers can take part in management actions against nonnative aquatic species. Because nonnative aquatic species are

one of the greatest threats to native fish conservation (Meffe *et al.* 1983, Meffe 1985, Brooks 1986, Marsh and Minckley 1990, Stefferud and Stefferud 1994, Weedman and Young 1997; FWS 2002, 2008; Minckley and Marsh 2009), removing them from the landscape and potential fish habitat provides a benefit to native fishes. Cienega Creek currently has no nonnative fishes; if certain nonnative fishes were to become established in the creek, it could be catastrophic for the native aquatic vertebrates there (including Gila topminnow). Removing nonnative aquatic fish from the nearby watershed minimizes the chance that nonnative fish could find their way into Cienega Creek, or to occupied habitats in the San Rafael Valley. Removal of nonnative aquatic fish in the San Rafael Valley could open up habitats for the release of Gila topminnow.

Summary of Effects – Gila Topminnow

- Although groundwater levels have historically been variable, the environmental baseline shows trends of increasing water use in some parts of the action area, which is likely to decrease groundwater levels in the near future;
- 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 climatic events (such as storms, droughts, wildfires, etc.);
- Impacts to groundwater from the action, and thus to surface water (stream flow, pool area, pool volume, pool depth), are reasonably certain to effect areas occupied by Gila topminnow, and thus will negatively impact Gila topminnow;
- Within 50 to 150 years post-closure, substantial decreases to wetted stream perimeter and pool area are anticipated to occur.
- Cienega Creek is one of six extant natural populations of Gila topminnow range-wide in the U.S. and is relatively stable, with no nonnative fishes present; there are at least 40 reestablished populations, and numerous refuge populations;
- The effects of the proposed action do not reach a tipping point that would preclude the recovery of the species, as topminnow are expected to persist within the action area, occur in locations outside of the action area, and are subject to ongoing recovery actions; and
- While the proposed conservation measures will not preclude all anticipated effects due to the mine to surface waters and Gila topminnow from occurring, the Cienega Creek water rights transfer, the Cienega Creek Watershed Fund, the Harmful Nonnative Species Management and Removal program, and acquisition of Sonoita Creek Ranch are anticipated to partially minimize the adverse effects of the mine. The acquisition of Sonoita Creek Ranch provides significant benefits to a critically important natural Gila topminnow population, because it is likely to greatly expand the amount of habitat available to the topminnow of Monkey Springs.

Cumulative Effects – Gila Topminnow

The cumulative effects for the action area, and specifically for aquatic species, were discussed in the Gila chub section of this BO. These effects are incorporated here by reference.

Conclusion – Gila Topminnow

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusion of non-jeopardy, below, would remain valid.

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 topminnow. We present this conclusion for the following reasons:

1. No direct effects to Gila topminnow habitat 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 will be evaluated and may require reinitiation of section 7 consultation;
3. The Cienega Creek Watershed Conservation Fund projects will, for the short-term at least, protect and potentially increase habitat for Gila topminnow by funding management actions and restoration actions in the watershed, protecting water rights, and creating habitat;
4. The Cienega Creek Watershed Conservation Fund projects are likely to increase ecosystem resiliency in the face of the expected groundwater drawdown from Rosemont Mine, and impacts from climate change;
5. Cienega Creek is one of six extant natural populations of Gila topminnow range-wide and Cienega Creek is relatively stable, with no nonnative fishes present; there at least 40 reestablished populations, and numerous refuge populations;
6. The effects of the proposed action are not a tipping point that would preclude the recovery of the species because we believe there will be enough water in Cienega Creek to maintain a viable population, as defined in the *Draft Revised Gila Topminnow Recovery Plan*;
7. The Sonoita Creek Ranch ponds should provide new habitat for Gila topminnow from a reliable water source (Monkey Spring) for an Evolutionarily Significant Unit of Gila topminnow;
8. The conservation measures proposed at Sonoita Creek Ranch will also protect most of the water rights to Monkey Spring, and will implement actions in the *Draft Revised Gila Topminnow Recovery Plan*;
9. The Cienega Creek Watershed Fund and Sonoita Creek Ranch conservation measures are considered to be essential to partially offset expected effects to Gila topminnow and its habitat;

10. Indirect effects from groundwater drawdown are difficult to predict at the distances from the drawdown (Rosemont Mine), and are not anticipated to occur until after mine closure;
11. Groundwater drawdown from the mine is not expected to be more than 0.1 foot in any of the modeled locations until 150 years after mine closure;
12. Numerous conservation and recovery actions have been implemen ted over the last 10 years, and will continue to be implemented, with more actions in planning, in particular at Las Cienegas NCA. We believe that these recovery actions are improving the status of the species;
13. The anticipated relatively small magnitude of the proposed action's effects to Gila topminnow and the implementation of conservation measures (as described above) lead us to the conclusion that the recovery potential of Gila topminnow (per the draft revised recovery plan) will not be diminished; and
14. Critical habitat has not been designated for the Gila topminnow; therefore, none will be affected.

The draft revised Recovery Plan (Weedman 1999) has two criteria that are useful for determining jeopardy. Before considering Gila topminnow for down- or de-listing, survival of the species in the U.S. must be ensured by securing remaining Level 1 (natural, including Cienega Creek) populations and the habitat they occupy in the U.S. In addition, the draft revised recovery plan defines a stable (viable) population as one containing at least 500 overwintering adults, possessing an adequate representation of all age-classes and cohorts, and having evidence of reliable annual recruitment. Therefore, the complete loss of Gila topminnow in Cienega Creek, or even the reduction of the population to less than 500 overwintering adults, would be a serious blow to the recovery of Gila topminnow.

Since the impacts of the proposed action affect only one natural Gila topminnow population and the action area is small compared to the range of the species, it is highly unlikely that the proposed action would cause large-scale physical alteration to the species' habitat, thus making it unlikely that a tipping point away from recovery would be reached. While the action area does include an important population of the species, the effects of the action are not anticipated to be large enough to cause the loss of the population, and it is similarly unlikely that a tipping point away from recovery would be reached. We believe that Gila topminnow will still be present in Cienega Creek 150 years after closure of the mine since adequate water is anticipated to be present to support at least 500 overwintering Gila topminnow. We believe this despite the higher temperatures and lower dissolved oxygen levels that will be present then.

The adverse effects that do occur in the action area do not reach the scale where recovery of the species would be delayed or precluded.

INCIDENTAL TAKE STATEMENT – GILA TOPMINNOW

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 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). 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. 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 – Gila Topminnow

We anticipate that the proposed action will result in incidental take of Gila topminnow, as enumerated by the surrogate measure described in Table GC-4. Any reduction in stream discharge and pool surface area resulting from groundwater drawdowns attributable to the proposed action will reduce the extent and quality of aquatic habitat required by Gila topminnow, thus harming the species. We are therefore reasonably certain that take will occur.

Incidental take of Gila topminnow in Cienega Creek will be difficult to detect for the reasons below. Thus we will use a surrogate measure of take. 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.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (e.g., long-lived, territorial species such as the desert tortoise). However, it is impossible to quantify the number of individual Gila topminnow taken because: (1) dead or impaired individuals are almost impossible to find (and are readily consumed by scavengers and predators) and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species will change over time through disease, natural population variation, natural habitat loss, or the active creation of habitat through management; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity.

Gila topminnow are subject to an existing monitoring program in the Cienega Creek watershed on the Las Cienegas NCA. The currently used sampling techniques result in an index of fish abundance per sampling site, as catch-per-unit-effort per pool. The sampling techniques used on Las Cienegas NCA are only sensitive enough to be statistically significant if the population

doubles or is halved (Bodner *et al.* 2007). Monitoring in reaches downstream from the Las Cienegas NCA (Marsh and Kesner 2011, Timmons and Upton 2012) is even less suited to determining population trends. Gila topminnow population estimates can theoretically be acquired, but are difficult, time consuming, stressful to the fish (to the point of harm), and expensive. In addition, the number of Gila topminnow in any population is normally extremely variable during a year due to an r-selected (high fecundity, short generation time, wide dispersal of offspring) reproductive strategy, common in highly variable environments such as desert streams.

It is reasonable to assume that the abundance of Gila topminnow is correlated with the extent of suitable aquatic habitat provided by surface flows and pool surface area in the affected streams (see Status of the Species within the Action Area section). Baseflows maintain stream discharge when surface runoff is low or nonexistent, and these baseflows result from groundwater discharge. The discharge of groundwater to springs and streams is related to the elevation and gradient that regional groundwater exhibits relative to those surface waters. Decreases in groundwater elevation affect this gradient and thus, reduce the discharge of groundwater to streams (see Effects to Aquatic Ecosystems section). Groundwater elevations, which can be readily measured, are therefore effective surrogate measures for the incidental take of Gila topminnow.

The Effects to Aquatic Ecosystems section of this BO as well as the analysis of effects for the Gila chub, above, discuss the relationship between the proposed action, changes in groundwater elevation, the volume and length of surface flow in streams, and various aspects of pool numbers and geometry. These changes are expressed in terms of both quartile and 95th percentile analyses of available groundwater drawdown, discharge, and pool data.

The changes in groundwater elevation will result in reduced wetted lengths and volumes in reaches of stream maintained by discharges from the regional aquifer; surface flow effects (including effects to pools) are summarized in Tables A-2 through A-8 in the Effects to Aquatic Ecosystems section, above. WestLand (2012) determined that there could be some reductions in the wetted length of lower Cienega Creek from groundwater drawdowns over the long term. We did not analyze the results from WestLand's study. We also anticipate that reduced flow volumes could result in increased summer water temperatures (Barlow and Leake 2012) and thus reductions in dissolved oxygen content (oxygen solubility is inversely related to water temperature), thus further adversely affecting (Bodner *et al.* 2007) the already-reduced numbers of Gila topminnow that would remain. The number of days with extremely low flows per year (see Table A-3, above) are a useful proxy for water quality effects.

Therefore, the take of Gila topminnow is expressed in terms of drawdown, in the magnitudes specified in the Gila chub section (including Table GC-4); this table is incorporated here by reference.

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 for the reasons stated in the Conclusion section.

Reasonable and Prudent Measures – Gila Topminnow

The FWS believes the reasonable and prudent measures and terms and conditions in the Gila chub section of this BO are also necessary and appropriate to minimize impacts of incidental take of Gila topminnow; the prior measures are hereby incorporated by reference.

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. We recommend that the USFS and the Corps coordinate with the Cienega Watershed Partnership, the F.R.O.G. Project, other wildlife agencies, and our office in efforts to work with private landowners to remove populations of nonnative aquatic species from lands in the area;
2. We recommend that the USFS and the Corps continue to assist us and other wildlife agencies in conserving and recovering the Gila topminnow;
3. We recommend that the USFS continue to assist us with the completion and implementation of the Gila topminnow revised recovery plan;
4. We recommend that Rosemont consider releasing Gila topminnow into water features on the mine site, when the site is suitable, and when the release of topminnow would not conflict with other conservation actions;
5. We recommend that Rosemont and the eventual owner or manager of Sonoita Creek Ranch consider changing how water is diverted at Monkey Spring to reduce fish entrainment. An infiltration gallery would be ideal to reduce entrainment;
6. We recommend that Rosemont consider acquiring the remaining water rights for Monkey Spring and the fee title property with Monkey Spring;
7. We recommend that Rosemont consider acquiring the water rights for Cottonwood Spring;
8. We recommend that the USFS acquire instream flow water rights to ensure perennial flow in streams with Gila topminnow;
9. We recommend that the USFS continue to work cooperatively with the FWS and other wildlife agencies to remove nonnative species and reestablish Gila topminnow whenever possible throughout its historical range in Arizona; and
10. We recommend that the USFS conduct fish surveys on NFS lands to determine the extent that Gila topminnow occupy those streams.

In order 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.

DESERT PUPFISH

Status of the Species

The desert pupfish was listed as an endangered species with critical habitat in 1986 (51 FR 10842). Historical collections occurred in Baja California and Sonora, Mexico and in the United States in California and Arizona. Historical distribution of desert pupfish in Arizona included the Gila, San Pedro, Salt, and Santa Cruz rivers, and likely the Hassayampa, Verde, and Agua Fria rivers, although collections are lacking for the latter three. The desert pupfish was also found in the Lower Colorado River, Rio Sonoyta basin, Salton Sink basin, and Laguna Salada basin (Eigenmann and Eigenmann 1888, Garman 1895, Gilbert and Scofield 1898, Evermann 1916, Miller 1943, Minckley 1980, Black 1980, Turner 1983, Miller and Fuiman 1987). Additional life history information can be found in the recovery plan (FWS 1993) and five-year review (FWS 2010 and other references cited there).

In Arizona, the desert pupfish genus *Cyprinodon* was historically comprised of two recognized subspecies, (*C. m. macularius)* and (*C. m. eremus*), and an undescribed taxon, the Monkey Spring pupfish (FWS 2010). They are still recognized as subspecies under the Act. The desert pupfish subspecies are now recognized as separate species, the desert pupfish (*Cyprinodon macularius*) and the Rio Sonoyta (Quitobaquito) pupfish (*C. eremus*)(Echelle *et al.* 2000), and the undescribed Monkey Spring form has since been described and renamed the Santa Cruz pupfish (*C. arcuatus*)(Minckley *et al.* 2002). The desert pupfish and Rio Sonoyta pupfish were listed as endangered (sub)species with critical habitat in 1986 (FWS 1986a). Critical habitat was designated in Arizona at Quitobaquito Springs on Organ Pipe Cactus National Monument in Pima County and in California along parts of San Felipe Creek, Carrizo Wash, and Fish Creek Wash. The Mexican government has also listed the species as endangered.

Work on the genetics and taxonomy of *C. macularius* has led to the division of the taxon into three species. This has effectively reduced the historical range of *C. macularius.* However, because *C. arcuatus* is likely extinct and is also considered ecologically similar to *C. macularius*, the range of *C. arcuatus* in the Santa Cruz River basin will be stocked with *C. macularius*.

More recent work (Echelle *et al.* 2007, Koike *et al.* 2008) provided further evidence that *C. macularius* and *C. eremus* are separate species. Results from microsatellites assays attribute 23 percent of microsatellite diversity to differences between the two species (Echelle *et al.* 2007). There was a small, but statistically significant part of the microsatellite diversity attributed to variation among the Salton Sea populations and the Colorado River delta populations. For *C. eremus*, there were differences in microsatellites between the two populations, but they were not significant (Echelle *et al.* 2007). They found no genetic evidence of separate evolutionarily significant units for either species. However, they recommended the recognition of two management units for *C. eremus* (Quitobaquito and Rio Sonoyta) and five for *C. macularius*, three in the Colorado River delta (Laguna Salada, Cerro Prieto, and Cienega de Santa Clara/El Doctor) and two in the Salton Sea (San Felipe Creek/San Sebastian Marsh and Salton Sea). They state that the loss of any one of the management units would be a significant step toward extinction of the species (Echelle *et al.* 2007).

The desert pupfish is a small fish, less than three inches long, and a member of the Cyprinodontidae family (Minckley 1973). The body is thickened and laterally compressed; coloration is a silvery background with narrow dark vertical bars on the sides. The protruding mouth is equipped with tricuspid teeth and the desert pupfish has an opportunistic, omnivorous diet, consisting of invertebrates, plants, algae, and detritus (Cox 1966 and 1972; Naiman 1979). Males are larger than females and become bright blue with orange-tipped fins during the breeding season and exhibit aggressive, territorial behavior (FWS 1993). Spawning occurs from spring through autumn, but reproduction may occur year-round depending on conditions (Constanz 1981). The desert pupfish appears to go through cycles of expansion and contraction in response to natural weather patterns (FWS 1986, 1993; Weedman and Young 1997). In very wet years, populations can rapidly expand into new habitats (Hendrickson and Varela-Romero 1989). Historically, this scenario would have led to panmixia among populations over a very large geographic area (FWS 1993).

The desert pupfish has a tolerance for high temperatures, high salinities, and low dissolved oxygen concentrations that exceed the levels known for many other freshwater fishes (Lowe *et al.* 1967, FWS 1993). Habitats have included clear, shallow waters with soft substrates associated with cienegas, springs, streams, margins of larger lakes and rivers, shoreline pools, and irrigation drains and ditches below 1,585 meters (5,200 feet) in elevation (Minckley 1973, Hendrickson and Varela-Romero 1989). Historical collections occurred in Baja California and Sonora, Mexico, and in the United States in California and Arizona.

Naturally occurring populations of desert pupfish (*C. m. macularius* or *C. macularius*) are now restricted in the United States to two streams tributary to, in shoreline pools and irrigation drains of the Salton Sea, and in the Sea itself, in California (Lau and Boehm 1991, Keeney 2013). This species is found in Mexico at scattered localities along the Colorado River Delta and in the Laguna Salada basin (Hendrickson and Varela-Romero 1989, Minckley 2000). The Quitobaquito pupfish (*C. m. eremus* or *C. eremus*), considered to be a separate species, persists in only two natural populations: one near the United States – Mexico border at Quitobaquito Springs in Organ Pipe Cactus National Monument in Arizona, in the U.S., and the other at Rio Sonoyta in Sonora, Mexico. Collectively, there are 11 extant populations of desert pupfish known in the wild in the United States and Mexico (California = 5, Arizona = 1, and Mexico = 5; Tier 1 populations in the Recovery Plan) (Table DP-1). Although many reestablishments have been attempted, approximately 25 transplanted populations of the desert pupfish exist in the wild at present, though this number fluctuates due to the establishment (and failure) of populations (Moyle 2002)(Tier 2 populations in the Recovery Plan)(FWS 1993, Voeltz and Bettaso 2003, FWS files)(Table DP-2). There is a total of 47 captive or refuge desert pupfish populations (that do not qualify as Tier 3), comprised of 34 in Arizona, 8 in California, and 5 in Sonora, Mexico. The range-wide status of desert pupfish is poor but stable, although increasing in Arizona due to an active recovery program (Duncan and Clarkson 2013, Crowder and Robinson 2015, Robinson and Crowder 2015). The fate of the species depends heavily upon future developments in water management of the Salton Sea and Santa de Clara Cienega in Mexico.

Table DP-1. Extant natural populations of desert pupfish in the United States and Mexico, by state, by subspecies.

Arizona	Baja California	California	Sonora

Cyprinodon m. macularius			
-	Cerro Prieto	San Felipe Creek	Cienega de Santa Clara
	Laguna Salada	Salt Creek	El Doctor
		Salton Sea	
		Hot Mineral Spa Wash	
		Salton Sea irrigation drains	
Cyprinodon m. eremus			
Quitobaquito pond and springs			Rio Sonoyta

]

Table DP-2. Reestablished wild populations of desert pupfish that are likely extant. In Arizona unless noted otherwise (AGFD, CDFW, Service files). The wild source for all releases is Cienega de Santa Clara/El Doctor.

Site Name	Years stocked	Last survey date pupfish found	Last survey date (if no pupfish found)
Antelope Hill – Las Cienegas NCA	2013	2016	
Bald Wildlife Pond – Las Cienegas NCA	2013	2016	
Bonita Creek	2008, 2010, 2011	2015	2011
Cherry Spring Canyon	2007, 2008	2010	2014
Cieneguita Wetland Ponds	2013 2005	2015	
Cinco Canyon Wildlife Pond	2013	2014	
Cold Springs	1983	2014	
Cottonwood Wildlife Pond – Las Cienegas NCA	2013	2015	
Empire Wildlife Pond - Las Cienegas NCA	2013	2015	
Gaucho Wildlife Pond – Las Cienegas NCA	2013	2015	
Headquarters Spring	2008-2010	2015	
Howard Well	2008,2009	2015	

Kei Sundt Pond	2010	2015	
Little Joe Spring – San Pedro Riparian National Conservation Area	2013	2015	
Larry/Charlie Tank	1976	2013	
Morgan/KT Ranch Pond	2012	2015	
Morgan City Wash	2009, 2010	2015	
Mud Springs	2007-2009, 2011	2015	
Murray Spring	2011, 2013	2014	
Nabhan-Monti Pond	2012	2015	
Road Canyon Wildlife Pond	2012	2014	
Secret Springs	2007, 2008, 2010	2012	2013
Swamp Springs Canyon (Muleshoe)	2007-2009	2008	2014
Tule Creek	2007, 2009	2009	2011
Walnut Spring	2008		2015

Arizona

No natural populations of *C. m. macularius* remain in Arizona, although numerous captive and wild, reestablished populations currently exist (Table DP-2; AGFD & FWS, unpublished data). These populations have been established on private, municipal, county, state, and Federal lands. Desert pupfish have been established at Mud Springs on the Tonto National Forest, and there are plans to stock them at several additional sites on that Forest. Desert pupfish have also been successfully established at several wild sites on the Muleshoe Cooperative Management Area, at Las Cienegas NCA, and at the San Pedro Riparian National Conservation Area. Additional sites in both NCA areas will also receive desert pupfish. Additional captive sites persist in southern Arizona, with a number of refuge and wild ponds having recently been created under a Safe Harbor Agreement (Table DP-3; AGFD 2015).

Table DP-3. Known extant refuge or captive populations of desert pupfish (*Cyprinodon m. macularius*) and Rio Sonoyta pupfish (*C. m. eremus*) (the latter indicated in **bold text**) in the U.S. and Mexico.

Arizona	California	Mexico
Apache Elementary School	Anza Borrego State Park	CEDES, Hermosillo
Aquatic Research & Conservation Center	Borrego Springs High School – 2 ponds	**Reserva Pinacate, Schuk Toak**

Arizona Historical Society	Oasis Springs Ecological Reserve – 2 ponds/streams	**Reserva Pinacate, HQ**
Arizona-Sonora Desert Museum	Dos Palmas Reserve – 4 ponds	**COBACH, Sonoyta**
Arizona-Sonora Desert Museum	Living Desert Museum – 4 ponds	**CEDO, Puerto Penasco**
ASU Desert Arboretum	Salton Sea State Recreation Area	
Audubon Society Appleton-Whittell Research Ranch	Coachella Valley Preserve – McCallum Pond	
Bill Williams NWR	University-California Riverside, Palm Desert Campus	
Black Canyon City		
Boyce-Thompson Arboretum		
Cabeza Prieta NWR		
Cibola NWR		
Deer Valley High School		
Desert Botanical Garden		
Flowing Wells Jr. HS		
Hermosa Montessori		
Hernbrode Pond		
Imperial NWR		
International Wildlife Museum		
Keiser Pond[3]		
Libby Elementary School		
Lulu Walker Elementary School		
McDowell Mountain Regional Park – 2 ponds		
MCC Red Mountain Campus		
Onofryton Pond		
Organ Pipe Cactus National Monument – La Cienega		
Palo Verde HS		
Phoenix Zoo – 2 ponds		
Rio Salado Audubon		
Robbins Butte Wildlife Management Area – 2 ponds		
Scottsdale Community College		
Southwestern Native Aquatic Resources & Recovery Center		
Spur Cross Solar Oasis		
TNC Lower San Pedro Preserve		

California

Five natural populations persist in California and no reestablished wild populations exist in California or Mexico. There are a total of 15 refuge populations in California (Table DP-3) (Keeney 2010, 2013, 2015). A total of six of the ponds have problems with nonnative species,

mainly mosquitofish. In addition, desert pupfish are likely extirpated at two more ponds, one of which is being restored (McCallum Pond, Coachella Valley Preserve) (Keeney 2010a).

Desert pupfish numbers in the Salton Sea are relatively low, but they are patchily distributed throughout (Parmenter *et al.* 2002; Keeney 2010b, 2013, 2015). While populations in irrigation drains entering the Sea can be abundant (Keeney 2010a, 2013, 2015), fish populations there are still dominated by nonnative fish (Martin and Saiki 2005; Keeney 2010a, 2013, 2015). The desert pupfish population in Salt Creek is stable to increasing, and currently has few nonnative species. San Felipe Creek also has a stable to increasing population, and no nonnative fish have been found in recent surveys (Keeney 2010a, 2013, 2015).

Desert pupfish do occur in other areas of the Salton Sink when conditions are suitable, and currently do occur in a wash near Hot Mineral Spa. This population is basically a fifth natural population (Tier 1) of *C. m. macularius* in California. As part of the research surrounding Salton Sea restoration, a shallow water habitat was constructed near the Alamo River (USBR 2005). The project was designed to exclude fish (USBR 2005); however, desert pupfish got into the ponds and flourished (Roberts 2010). The pilot project is over, the site was decommissioned, and pupfish were salvaged. Over 1,000,000 desert pupfish were moved to existing and new refuges, and to irrigation drains and other habitats around the Salton Sea (Keeney 2010b).

Mexico

In Mexico, five natural populations persist; no reestablished populations persist there. One natural population of *C. m. eremus* persists in Sonora, Mexico, in the Rio Sonoyta. Four refuge populations have been established in the last few years (Table DP-3; Duncan and Tibbitts 2008).

Additionally, *C. m. eremus* was stocked into the Quitovac Spring and ponds at Ejido Quitovac in 2007. Quitovac is within the Rio Guadelupe drainage, rather than the Rio Sonoyta drainage, and thus is outside of known historical range. The Rio Guadelupe is the next drainage to the east of the Rio Sonoyta, and very rarely, if ever, flows to the Sea of Cortez. The springs at Quitovac are faunistically similar to the Rio Sonoyta, in that they contain the Rio Sonoyta mud turtle (*Kinosternon sonoriensis sonoytae*), which only occurs in the Rio Sonoyta and Rio Guadelupe drainages (Rosen 2003). The northern divide in the headwaters between the two watersheds is very subtle.

Many natural and reestablished desert pupfish populations are imperiled by one or more threats. Threats to the species relating to destruction or curtailment of habitat include loss and degradation of suitable habitat through ground water pumping or water diversion; contamination from agricultural return flows, as well as other contaminants, and physical changes to water properties involving suitable water quality (71 FR 20714, FWS 1986, 2010; Moyle 2002, Martin and Saiki 2005, Echelle *et al.* 2007, Minckley and Marsh 2009). On Federal lands, Endangered Species Act Section 7 consultations have addressed effects of grazing, roads and bridges, agency planning, fire, flooding, recreation, pest control programs, irrigation drain maintenance, water transfers, and water development as potential threats to desert pupfish habitat. Although effects from these threats continue to be moderated for the desert pupfish, biologically, impacts from these threats individually and collectively can create fragmented populations in poorer quality habitat that are small and restricted in range, which can further endanger the desert pupfish.

The threats identified at the time of listing and in the recovery plan continue unabated. New nonnative aquatic species continue to establish within the desert pupfish's range, and previously existing nonnative species increase in numbers and distribution (Minckley and Marsh 2009). Human demands for water are unending, with the Salton Sea, Cienega de Santa Clara, and the Rio Sonoyta suffering water level declines and the associated threats to the desert pupfish from water depletion, such as habitat loss, fragmentation, and degradation of habitat quality still ongoing. Water availability for the desert pupfish will continue to suffer with predicted trends for warmer, drier, and more extreme hydrological conditions associated with climate change.

Groundwater extraction was considered a threat in the listing (51 FR 10842), recovery plan (FWS 1993), and in the five-year review (FWS 2010). It is still considered a threat; especially at Quitobaquito, Rio Sonoyta (Brown 1991), and El Doctor (P. Reinthal, University of Arizona, pers. comm.). Water extraction removes and degrades habitat, leaving higher concentrations of salts, toxic contaminants, and sediment in the remaining volumes of water and lower amounts of dissolved oxygen, and thus interacts with other compounding threats. Water reductions could lead to less shallow-water habitat preferred by the desert pupfish. Slight increases in salinity could benefit desert pupfish, by reducing populations of problematic nonnative fishes. However, if salinity keeps increasing, wetland areas may become unsuitable even for pupfish. The proposed changes to the configuration of the Salton Sea will reduce pupfish habitat, but there will still be habitat for numerous populations to persist. Any change to the water budget at Cienega de Santa Clara could be detrimental to the desert pupfish there. Groundwater withdrawal in the Rio Sonoyta drainage has exceeded recharge for decades. In addition, the pumping capacity is about twice of what is withdrawn in an average year (Brown 1991, Pearson and Conner 2000).

Watershed condition has been and continues to be a concern over most of the Southwest. Recreational pursuits that have the potential to increase soil erosion (i.e. off-highway vehicles (OHVs)) are a concern for desert pupfish because of their impacts to watershed health, rather than any direct effects. Overgrazing and historically extensive logging combined with climatic events (drought followed by rain events), have led to increased erosion and deeper channelization (Miller 1961, Bahre 1991), which do not provide the more shallow, clear, and vegetatively complex wetlands preferred by the desert pupfish (Hanes 1996).

Extensive logging is no longer a threat to desert pupfish or their habitats. Improper grazing at a watershed level probably does not impact desert pupfish populations anymore, except at the Rio Sonoyta. Grazing of occupied sites still occurs in Mexico and the United States. However, grazing in the United States is better managed and much less of a concern for its impacts to desert pupfish habitat. Urbanization and other human activities can and continue to impact watershed health and functioning.

Environmental contaminants, such as heavy metals, accumulating in water sources were given as threats at the time of listing, particularly in the form of mercury. At this time, selenium seems to be the element of most concern for fishes in the Salton Sea (Saiki 1990, California Regional Water Quality Control Board 1991, McClurg 1994, Saiki *et al.* 2008). In addition to conditions of elevated salinity, contaminants are still present in irrigation drains entering the Salton Sea.

These include problematic levels of heavy metals and organochlorines entering the Salton Sea, and effects to dissolved oxygen in the Salton Sea (Saiki 1990, Matsui *et al.* 1992). Salinity in the Salton Sea is expected to continue increasing (Saiki 1990, Matsui *et al.* 1992) to the point the Sea will be inhospitable for all fish (California Regional Water Quality Control Board 1991, McClurg 1994), unless planned restoration actions occur.

Livestock grazing was not mentioned as a threat in the final rule (51 FR 10842), although habitat modification from grazing was mentioned in the recovery plan (FWS 1993). The small size and high physical tolerance of the desert pupfish allow it to exist in small amounts of water spanning a wide variety of extreme habitat and water quality conditions (FWS 1993). Due to the scarcity of water in the desert pupfish's desert habitat and the tendency for cattle to congregate in watered areas, cattle are attracted to desert pupfish habitats that can lead to local impacts quickly. Low water conditions combined with congregations of cattle activity (grazing, watering, hoof action) can lead to additional reductions in water, physiological effects of reduced water quality, bank trampling, fragmentation of contiguous water, isolation/stranding and trampling of fish and eggs (Roberts and White 1992), and loss of habitat through de-watering. Long-term or seasonal drought can also exacerbate these conditions. Round-up of trespass cattle within these small enclosed areas could cause cattle congregations to increase their hoof action and cause movement into fish habitat. Cattle can cause disturbance, a decline in water quality, and mortality of fish and desert pupfish eggs, particularly at the perimeter of ponds, springs, wells, and shallow wetland areas, by reducing the distribution and abundance of water and isolating fish and eggs into inhospitable areas (Kauffman and Krueger 1984, Fleischner 1994, and Belsky *et al.* 1999). Carefully controlled grazing around some of the small pond habitats as a tool to manage problematic aquatic vegetation could actually be beneficial to the desert pupfish (Kodric-Brown and Brown 2008). Although impacts from livestock grazing have been problematic in some areas, as a result of consultations many of the impacts have been alleviated through fencing and grazing rotations.

Desert pupfish are susceptible to parasites and predation and competition from nonnative fish and other species. Desert pupfish are known to suffer infestations of anchor worm (*Lernea* spp.) (51 FR 10842) (Robinson 2009). Miller and Fuiman (1987) noted a nematode parasite present in desert pupfish collected from Quitobaquito Springs in Organ Pipe Cactus National Monument and hypothesized, after Cox (1966) that the parasites resembled a nematode known from birds and that waterfowl or shorebirds were a possible vector for introduction to the desert pupfish. It is therefore conceivable that many desert pupfish populations are at risk of infestation by this parasite. However, the specific effects to individual desert pupfish or populations are unknown. *Lernea* can kill its host, although largely through secondary infections.

Predation and competition from nonnative fish have been identified as main causes of the decline of the species (51 FR 10842; FWS 1993, 2010). Nonnative fish are still a major threat to the desert pupfish at this time. Martin and Saiki (2009) found the remains of *C. m. macularius* in the gastrointestinal contents of one longjaw mudsucker. In addition they found unidentifiable fish remains in the gastrointestinal contents of sailfin molly, porthole livebearer, longjaw mudsucker, redbelly tilapia, Mozambique tilapia, and western mosquitofish. In an earlier study (2005) they found the abundance of *C. m. macularius* to be inversely related to the abundance of nonnative fish.

It has long been assumed that western mosquitofish have a negative impact on desert pupfish (Deacon and Minckley 1974, FWS 1993), through similar mechanisms by which they affect other small fishes, such as competition for food and the predacious habits of mosquito fish upon young fish, as well as fin damage under crowded conditions (Meffe *et al.* 1983, Meffe 1985). Martin and Saiki (2009) found unidentifiable fish remains in western mosquitofish. They also believed there was significant dietary overlap between desert pupfish and western mosquitofish. To the contrary however, Martin and Saiki (2005) also found the abundance of desert pupfish was positively correlated with the presence of western mosquitofish. We surmise that this result stems from the high tolerance of both species to poor water quality and from competition with the many other nonnative fish individuals present in shared habitats. Because nonnative aquatic species are present in many occupied or potential desert pupfish habitats and nonnative aquatic species are exceedingly difficult to get rid of once established, nonnative aquatic species continue to be a major threat to the conservation of the desert pupfish.

Since the 19th century, desert pupfish habitat has been impacted by streambank erosion, the construction of water impoundments that dewatered downstream habitat, excessive groundwater pumping, the application of pesticides to nearby agricultural areas, and the introduction of nonnative aquatic species as both predators and potential competitors (Matsui 1981, Hendrickson and Minckley 1984, Minckley 1985, Schoenherr 1988). The bullfrog is an opportunistic omnivore with a diet that includes fish (Frost 1935, Cohen and Howard 1958, Brooks 1964, McCoy 1967, Clarkson and deVos 1986). Introduced salt cedar (*Tamarisk* spp.) growing adjacent to desert pupfish habitat might cause a lack of water at critical times (Bolster 1990, R. Bransfield, FWS, pers. comm. 1999); however, recent scientific information contradicts the long-held belief that tamarisk consumes more water than native trees (Glenn and Nagler 2005). These threats still occur today and continue to be impacted by increasing human development and demand for water, as well as interactions with predicted trends for warmer, drier, and more extreme hydrological conditions associated with climate change.

The recovery plan treats the two subspecies recognized then differently. Insoluble threats and limited habitat are stated as rendering delisting infeasible for either subspecies in the foreseeable future. There are downlisting criteria, but no delisting criteria for the subspecies desert pupfish (*C. m. macularius*). Downlisting or delisting of the single population of Quitobaquito pupfish (*C. m. eremus*), located in southern Arizona on the border, is not expected according to the recovery plan; therefore *C. m. eremus* is not discussed further in this section. A Desert Fishes Team report (2006) analyzes and rates recovery plan implementation for *C. m. macularius* in the Gila River basin.

Recovery criterion 1 has not been met. Currently, naturally-occurring populations are relatively secure only at San Felipe Creek, California. Table DP-1 shows the currently known natural populations of desert pupfish. Recovery criterion 1 addresses threat factor A, the present or threatened destruction, modification, or curtailment of the desert pupfish's range, and seeks to minimize the impact of disease and predation (factor C) and other natural or manmade factors (factor E) on the population as a whole.

The number of natural and reestablished populations contained in the Task 2 specifications (FWS 1993: Tables DP-1 and DP-2) has not been met in Arizona, California, Baja California, or Sonora (Varela-Romero *et al.* 2002, Voeltz and Bettaso 2003, Duncan and Tibbits 2008, FWS files). Most of the reestablished populations are in human constructed environments (Table DP-2). The United States refuge populations of Quitobaquito pupfish are all outside of the Rio Sonoyta drainage, and ostensibly outside of historical range. The Desert Fishes Team report (2006) rated the implementation of this task as "low," though multiple reestablishments have occurred since the report (Table DP-2).

Based on their work on the natural populations and contrary to the recovery plan, Loftis (2007) and Echelle *et al.* (2007) recommended several management units. For *C. m. eremus* they recommended that the Rio Sonoyta and Quitobaquito populations be managed separately (Echelle at al. 2000). They recommended five management units for *C. m. macularius*: Laguna Salada, Cerro Prieto, Cienega de Santa Clara/El Doctor, San Felipe Creek, and the rest of the Salton Sea system (Echelle *et al.* 2007, Loftis *et al.* 2009). The recovery plan has three management units for California: San Felipe Creek, Salt Creek, and the Salton Sea (including the irrigation drains).

As stated in Section 1.3.4, above, the AGFD has conducted periodic and comprehensive status reviews of the desert pupfish in Arizona (Simons 1987, Bagley *et al.* 1991, Brown and Abarca 1992, Weedman and Young 1997, Voeltz and Bettaso 2003). The methodology used to assess the status of the desert pupfish in Arizona has been refined by these authors and currently exists as a *de facto* population monitoring protocol in Arizona. Quitobaquito is monitored regularly by Organ Pipe Cactus National Monument staff, following an established protocol (Douglas *et al.* 2001, Tibbitts 2009). The Rio Sonoyta is sampled annually; the Cienega de Santa Clara and El Doctor in Mexico are regularly surveyed by CEDES (State of Sonora resource agency) and CONANP (Mexican national parks agency). The California Department of Fish and Wildlife monitors all populations in California monthly or bi-monthly, following an established protocol (Black 1980). These monitoring protocols only partially meet the requirements of recovery criterion 4 and task 5 from the recovery plan. Genetic monitoring and population monitoring and maintenance were ranked as "moderate" implementation by the Desert Fishes Team (2006).

Environmental Baseline – Desert Pupfish

The portion of the action area associated with desert pupfish encompasses all occupied or likely-to-be occupied waters within the Cienega Creek watershed, as these will be subject to the proposed action's effects to groundwater and surface flow hydrology. Sonoita Creek Ranch may also be included if desert pupfish are released there. This area is described in detail in the Status of the Species and Critical Habitat within the Action Area section, below. The narrative that follows includes accounts of rangewide effects to desert pupfish 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 desert pupfish will be discussed here and are also in the 2013 Rosemont BO.

Status of the Species within the Action Area

The action area for the desert pupfish encompasses the occupied waters in the Cienega Creek watershed. The action-area status of the desert pupfish was described in our 2008 and 2012 BOs that addressed effects of Aquatic Species Conservation at the San Pedro Riparian and Las Cienegas NCAs, 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. The only designated critical habitat for desert pupfish in Arizona is at Quitobaquito Springs and Pond. Since the 2013 BO, Cottonwood Wildlife Pond, Gaucho Wildlife Pond, and Cieneguita Wetland Ponds have had pupfish reestablished (Crowder and Robinson 2015, Robinson and Crowder 2015).

Factors affecting species environment within the action area

The factors affecting the Gila chub are the same ones affecting the desert pupfish at Cieneguita Wetlands; so that section of this BO is incorporated here by reference. There is no designated critical habitat for desert pupfish.

On Las Cienegas NCA, pupfish have been released to eight sites: Cieneguita Wetland Ponds, Gaucho Wildlife Pond, Bald Hill Wildlife Pond, Cottonwood Wildlife Pond, Road Canyon Wildlife Pond, Antelope Wildlife Pond, Cinco Canyon Wildlife Pond, and Empire Wildlife Pond. Also, desert pupfish may be released to five more sites: Clyne Pond, Maternity Wildlife Pond, Oil Well Wildlife Pond, Bill's Wildlife Pond, and Apache Spring Wildlife Pond. Of these 13 sites, only Cieneguita, Cottonwood, Maternity, and Empire are in the Cienega Creek watershed within the action area. All sites but Cieneguita are supported by pumped well water. Thus, Cieneguita Wetland is the only site that may be affected by the proposed action.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following desert pupfish-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile

approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

Effects of the Action - Desert Pupfish

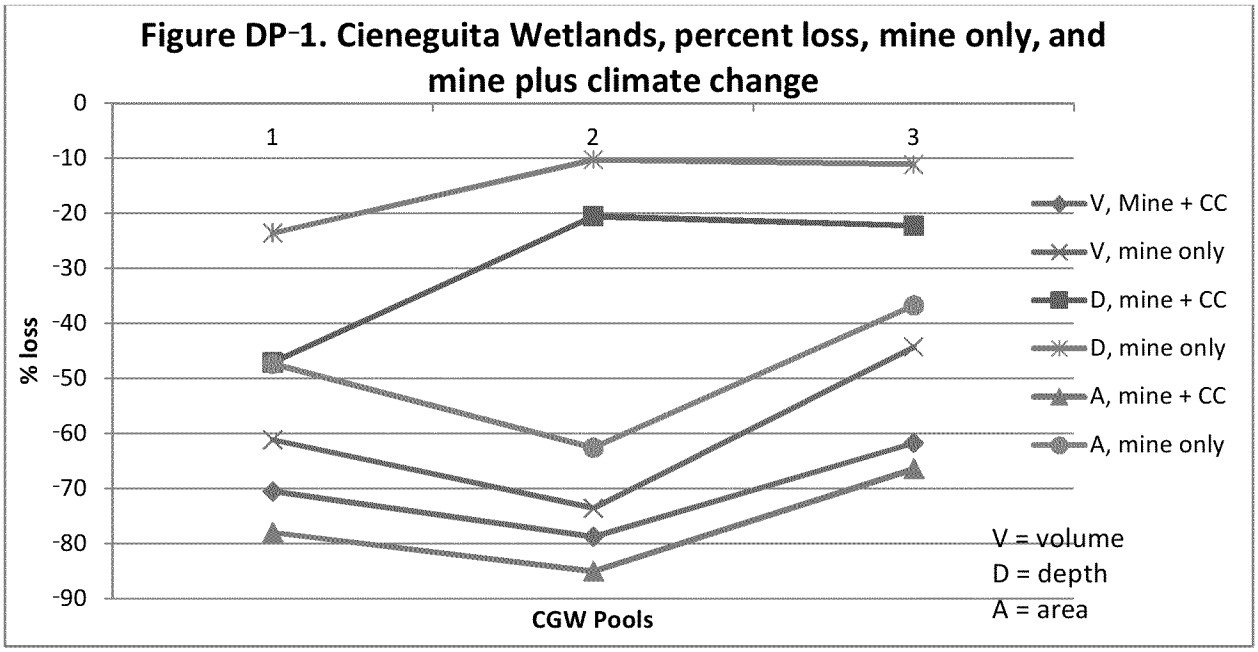
The effects of the action to desert pupfish will be very similar to those described for Gila chub for Cieneguita Wetland. Therefore, that discussion in this BO is incorporated here by reference. Effects that may affect the desert pupfish differently than Gila chub will be discussed below. Information from the 2013 Rosemont BO that has not changed will not be repeated here. There are no direct effects from the mine. Indirect effects caused by groundwater drawdown from the mine will negatively impact stream flow and pool metrics. Impacts from the mine only are small when compared to the effects of climate change. However, the impacts from the mine only do cause negative impacts to aquatic habitats; this results in negative impacts to the desert pupfish.

Climate change may be less problematic for desert pupfish compared to Gila chub, because desert pupfish have about a 3° C higher tolerance of water temperature than Gila chub (Carveth *et al.* 2006). Also, desert pupfish are also more tolerant of reduced dissolved oxygen in the water; pupfish can survive with dissolved oxygen at <1ppm, while chub require at least 3ppm (Lowe *et al.* 1967, FWS 2015). Amount of stream flow is a factor in dissolved oxygen; generally the less the flow, the less dissolved oxygen there is. But since desert pupfish only occur in wetlands and constructed ponds, water flow is not a factor.

As for how the modeled groundwater drawdowns will impact desert pupfish, Cieneguita Wetland Wildlife Ponds are the only concern. Cieneguita Wetlands only has three ponds; looking at those ponds separately is an adequate analysis of effects. The 95th percentile range of results for the Cieneguita Wetlands encompasses a wide range of results for mine only. The number of pools does not change, but pool depth does change; by 150 years after mine closure, median pool depth decreases from 3.6 to 3.2 feet. Pool volumes change significantly, with the three Cieneguita pools losing 67 percent of their volume due to impacts from the mine after 150 years. Cieneguita Wetland pools lose 50 percent of their surface area during this time (Figure DP-1).

Climate change in combination with mine drawdown 150 years post-closure reduces pool volume to 19 percent of original volume. Pool depth loses 26 percent, and pool surface area declines by 76 percent due to mine plus climate change by 150 years post-mine (Figure DP-1). The loss of depth, surface area, and volume at the three pools at the Cieneguita Wetlands will significantly reduce the amount of habitat for desert pupfish. In particular, the loss of 67 percent

of pool volume at Cieneguita from impacts from the mine only is of great concern, because even if fish can still survive in the wetlands, population size and viability will be greatly decreased.



The Cienega Creek Watershed Conservation Fund and acquisition of water rights for Cienega Creek may be beneficial for desert pupfish conservation, but that will depend on the specifics of how the funds and water rights are used. Control of invasive aquatic species could be beneficial, depending on the species, their location, and where pupfish are. Restoration activities could benefit pupfish. It is unknown if these actions would mitigate for impacts to desert pupfish without greater detail. The purchase of conservation land and conservation activities along Sonoita Creek could benefit desert pupfish if they are included in the conservation planning.

Lastly, there is a recovery plan for desert pupfish (FWS 1993), which contains Survival and Reclassification Criteria. Because the desert pupfish populations in the action area are reestablished populations, the survival criteria in the plan will not be affected. The proposed action will affect the habitats for and the populations of desert pupfish at Las Cienegas NCA.

Given that the proposed action does not affect Survival Criteria I, II, III, or IV in the desert pupfish recovery plan, we anticipate that the ability to reclassify (downlist) desert pupfish will not be precluded by the proposed action. Reclassification Criterion II refers to the replication, establishment, and survival of populations within the desert pupfish's historical range. The existing and planned reestablishment of desert pupfish to Las Cienegas NCA will further the conservation and recovery of the species, and will not be precluded by the proposed action.

Lastly, the conservation measure directing the management and removal of harmful nonnative species may also benefit desert pupfish, as sites currently occupied by predatory and/or competitive nonnative aquatic species may be made suitable to reestablishment (or establishment) of desert pupfish.

Summary of Effects – Desert Pupfish

- Although groundwater levels have historically been variable in this area, the environmental baseline (see the Effects to Aquatic Ecosystems section, above, and Powell *et al.* 2013) shows a trend of increasing water use in parts of the action area, which is likely to initiate or contribute to a downward trend in groundwater levels in the near future;
- The effects from the mine lead to the loss of 67 percent of the total pool volume at Cieneguita Wetlands, and will lead to incidental take;
- The current extended drought and climate change are highly likely to negatively impact many system components from the upper parts of the watershed through:
    - Higher ambient and water temperatures;
    - Changes in upland vegetation and fire regime;
    - Increased variability in stream hydrographs;
    - More frequent severe climatic events (such as storms, droughts, wildfires, etc.);
- The proposed conservation measures will minimize the action's adverse effects, but will not preclude the occurrence of (or mitigate for) all anticipated effects to surface waters and desert pupfish;
- Las Cienegas NCA has eight reestablished populations of desert pupfish; there are at least 25 reestablished populations, and numerous refuge populations in Arizona;
- The effects of the proposed action do not reach a tipping point that would preclude the recovery of the species, as it may persist within the action area, occurs in locations outside of the action area, and is subject to ongoing recovery actions; and
- Impacts to groundwater, and thus surface water, are reasonably certain to affect areas occupied by desert pupfish, and thus will negatively impact desert pupfish.

Cumulative Effects – Desert Pupfish

The cumulative effects for the action area, and specifically for aquatic species, were thoroughly discussed in the Gila chub section of this BO. That section is incorporated here by reference.

Conclusion – Desert Pupfish

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusion of non-jeopardy (destruction and adverse modification of critical habitat does not apply), below, would remain valid.

After reviewing the current status of the desert pupfish, 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 desert

pupfish. 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 may, for the short-term at least, protect and potentially increase habitat for desert pupfish by funding management and restoration actions in the watershed, protecting water rights, and creating habitat;
4. Groundwater drawdown is not expected to be more than 0.1 ft in any of the modeled locations until 150 years after mine closure;
5. Las Cienegas NCA has eight reestablished populations of desert pupfish of which only one population may be impacted by the mine (Cieneguita Wetlands); there at least 25 reestablished populations, and numerous refuge populations in Arizona, in addition to sites in California and Mexico;
6. The effects of the proposed action do not reach a tipping point that would preclude the recovery of the species, as it may persist within the action area, occurs in locations outside of the action area, and is subject to ongoing recovery actions;
7. Numerous conservation and recovery actions have occurred during the last 10 years, and continue to occur, with more actions in planning, in particular at Las Cienegas NCA. Therefore, we believe the status of the species is static or improving within the action area and rangewide;
8. The limited extent of the proposed action's effects on this species' habitat and the implementation of conservation measures, mean that the recovery potential of desert pupfish (per the recovery plan) will not be diminished;
9. Indirect effects are only experienced by desert pupfish and pupfish habitat at the three Cieneguita Wetlands pools;
10. Incidental take of desert pupfish will only occur at the three Cieneguita Wetlands pools, representing a small portion of the species' total occupied range; and
11. Critical habitat for the desert pupfish does not occur in the action area; therefore, none will be affected.

The Recovery Plan (FWS 1993) has two criteria that are useful for determining jeopardy. Before considering desert pupfish for down- or de-listing, survival of the species in the U.S. must be ensured by securing remaining Level 1 (natural) populations and the habitat they occupy in the U.S. In addition, the recovery plan defines a stable (viable) population as one containing at least 500 overwintering adults, possessing an adequate representation of all age-classes and cohorts, and having evidence of reliable annual recruitment.

Since the impacts of the proposed action do not affect any natural desert pupfish populations and the action area is small (one site) compared to the range of the species, it is unlikely that the proposed action would cause large-scale physical alteration to the species' habitat, thus making it

unlikely that a tipping point away from recovery would be reached. We believe that desert pupfish will still be present on Las Cienegas NCA 150 years after closure of the mine since adequate waters will be present at multiple sites to support at least 500 overwintering desert pupfish in the metapopulation. We believe this even with the higher temperatures and lower dissolved oxygen levels that are likely to be present then. Dissolved oxygen should only be an issue at Cieneguita Wetlands, and not the other sites where pupfish have been, or may be, released.

The adverse effects that do occur in the action area do not reach the scale where recovery of the species would be delayed or precluded. The effects of the proposed action are not anticipated to reach any tipping point that would preclude the conservation and recovery of the desert pupfish.

Lastly, we note that the Cienega Creek Watershed Conservation Fund is designed to increase ecosystem resiliency in the face of both the expected groundwater drawdown from Rosemont Mine and impacts from climate change, although the fund's benefit to desert pupfish cannot yet be determined. Similarly, the Sonoita Creek Ranch conservation measure is intended to create new habitat for desert pupfish, habitat that would be sourced by a reliable water source (Monkey Spring), but we cannot definitively credit this conservation measure unless and until desert pupfish are successfully established at the site.

INCIDENTAL TAKE STATEMENT – DESERT PUPFISH

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 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). 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 – Desert Pupfish

We anticipate that the proposed action will result in incidental take of desert pupfish. Any reduction in pool size at Cieneguita Wetlands resulting from groundwater drawdowns attributable to the proposed action will reduce the extent and quality of aquatic habitat required by desert pupfish, thus harming the species. We are therefore reasonably certain that take will occur.

Incidental take of desert pupfish at Cieneguita Wetlands 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.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (e.g., long-lived, territorial species such as the desert tortoise). However, it is impossible to quantify the number of individual desert pupfish taken because: (1) dead or impaired individuals are almost impossible to find (and are readily consumed by scavengers and predators) and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species will change over time through disease, natural population variation, natural habitat loss, or the active creation of habitat through management; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity with differing amounts of aquatic vegetation and algae. Therefore, the take of desert pupfish is expressed in terms of groundwater drawdown, in the magnitudes specified in the Gila chub section (including Table GC-4); this table is incorporated here by reference.

Desert pupfish are subject to an existing monitoring program in the Cienega Creek watershed on the Las Cienegas NCA. The currently used sampling techniques result in an index of fish abundance per sampling site, as catch-per-unit-effort (Crowder and Robinson 2015, Love-Chezem *et al.* 2015, Robinson and Crowder 2015). Desert pupfish population estimates can theoretically be acquired, but are difficult, time consuming, stressful to the fish (to the point of harm), and expensive. In addition, the number of desert pupfish in any population is normally extremely variable during the year due to an r-selected (high fecundity, short generation time, wide dispersal of offspring) reproductive strategy, common in highly variable environments such as desert aquatic ecosystems.

It is reasonable to assume that the abundance of desert pupfish is correlated with the extent of suitable aquatic habitat provided the Cieneguita Wetland pools. The discharge of groundwater to wetlands is related to the elevation and gradient that regional groundwater exhibits relative to those surface waters. Decreases in groundwater elevation affect this gradient and thus, reduce the discharge of groundwater to wetlands (see Effects to Aquatic Ecosystems section). Groundwater

elevations, which can be readily measured, are therefore effective surrogate measures for the incidental take of desert pupfish.

The Effects to Aquatic Ecosystems section of this BO as well as the analysis of effects for the Gila chub, above, discuss the relationship between the proposed action, changes in groundwater elevation, the volume and length of surface flow in streams, and various aspects of pool numbers and geometry. These changes are expressed in terms of both quartile and 95th percentile analyses of available groundwater drawdown, discharge, and pool data.

The changes in groundwater elevation will result in reduced wetted lengths and volumes in reaches of stream maintained by discharges from the regional aquifer; surface flow effects (including effects to pools) are summarized in Tables A-2 through A-8 in the Effects to Aquatic Ecosystems section, above. WestLand (2012) determined that there could be some reductions in the wetted length of lower Cienega Creek from groundwater drawdowns over the long term. We did not analyze the results from WestLand's study. We also anticipate that reduced flow volumes could result in increased summer water temperatures (Barlow and Leake 2012) and thus reductions in dissolved oxygen content (oxygen solubility is inversely related to water temperature), thus further adversely affecting (Bodner *et al.* 2007) the already-reduced numbers of desert pupfish that would remain. The number of days with extremely low flows per year (see Table A-3, above) are a useful proxy for water quality effects.

Effect of the Take – Desert Pupfish

In this BO, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the desert pupfish, based on the conclusions presented above.

Reasonable and Prudent Measures – Desert Pupfish

The FWS believes the reasonable and prudent measures and terms and conditions in the Gila chub section of this BO are also necessary and appropriate to minimize impacts of incidental take of desert pupfish, and these are hereby incorporated by reference.

Conservation Recommendations – Desert Pupfish

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. We recommend that the USFS, the Corps, and Rosemont coordinate with the Cienega Watershed Partnership, the F.R.O.G. Project, other wildlife agencies, and our office in efforts to work with private landowners to remove populations of nonnative aquatic species from lands in the area;

2. We recommend that the USFS continue to assist us and other wildlife agencies in conserving and recovering the desert pupfish;
3. We recommend that the USFS and Corps assist us with the implementation of the desert pupfish recovery plan;
4. We recommend that Rosemont consider releasing desert pupfish into water features on the mine site, when the site is suitable (i.e. exhibits no deleterious levels of contaminants), and when the release of pupfish would not conflict with other conservation actions;
5. Waters at Sonoita Creek Ranch should be considered for the release of desert pupfish;
6. We recommend that Rosemont consider acquiring the remaining water rights for Monkey Spring and the fee title property with Monkey Spring;
7. We recommend that the USFS continue to work cooperatively with the FWS and other wildlife agencies to remove nonnative species and reestablish desert pupfish wherever possible throughout its historical range in Arizona; and
8. We recommend that the USFS survey streams on NFS lands to determine which may support desert pupfish.

In order 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.

CHIRICAHUA LEOPARD FROG

Status of the Species – Chiricahua Leopard Frog

The status of the species information contained in the October 30, 2013 BO remains current and is incorporated herein via reference, except for new, preliminary data on dispersal distance and behavior (Hall 2016) and additional information regarding overall population status and recovery planning for the species presented below.

Evidence indicates that since the time of listing, the Chiricahua leopard frog has probably made at least modest population gains in Arizona, but is apparently declining in New Mexico. Overall in the U.S., the status of the Chiricahua leopard frog is either static or, more likely, improving, with much of the increase attributable to an aggressive recovery program that is showing considerable results on the ground through the reestablishment of populations (mainly in Arizona), captive rearing programs, non-native species eradication programs, and enhancement and development of habitat (FWS 2011). Population status and trends in Mexico are unknown.

The Recovery Plan for the Chiricahua leopard frog identifies eight recovery units (RUs) in Arizona, New Mexico, and Mexico (FWS 2007). An RU is a population unit that has been documented as necessary to both the survival and recovery of the species. The RUs are natural units in which frog metapopulation dynamics function or could function as the species recovers. A metapopulation is a set of local populations that interact via individuals moving among local populations. Within RUs, it is important to implement recovery actions over large landscapes with the greatest potential for successful recovery. These areas are referred to as management areas (MAs), and are identified within each RU. Hydrologic units and mountain ranges are used as MA boundaries. MAs have been delineated to include all habitats of known extant Chiricahua leopard frog populations as well as other sites with the highest potential for recovery, including sites where habitat restoration or creation, and establishment or re-establishment of Chiricahua leopard frog populations will likely occur or has already occurred. We included all known extant populations within MA boundaries because of the high value of those populations for recovery. Metapopulations consisting of at least four local populations that exhibit local recruitment, three of which are continually in existence, as well as isolated robust populations will be established within MAs (FWS 2007, USWFS 2012). Metapopulations and isolated robust populations are referred to as "recovery sites" in the Recovery Plan (FWS 2007).

For the Chiricahua leopard frog to be recovered, conservation must occur in each RU (FWS 2007). Successful conservation is not necessary in every MA and recovery does not depend upon an even distribution of recovery efforts across an RU. Rather, we anticipate that recovery efforts will be focused in those MAs and portions of RUs in which opportunities are best. Recovery criteria, as identified in the Recovery Plan (FWS 2007), to delist the Chiricahua leopard frog includes 1) at least two metapopulations located in different drainages, plus at least one isolated and robust population in each RU; 2) protection of these populations and metapopulations; 3) connectivity and dispersal habitat protection; and, 4) reduction or elimination of threats and long-term protection (FWS 2007). As noted in the FWS's 1998 Consultation Handbook, RUs are population units that have been documented as necessary to both the survival and recovery of the species. Avoiding loss of populations or other serious adverse effects in a RU will ensure

continued contribution of that RU to the recovery of the species. To date, recovery criterion 1 has been accomplished only in RU1 although we are close to achieving it in RU2. No other recovery criteria have been achieved in any recovery unit. However, ongoing recovery actions have helped stabilize or improve the status of the species in other recovery units in Arizona and New Mexico.

Existing populations and suitable habitat in MAs will be protected through management (FWS 2007). As identified in the Recovery Plan, management will include maintaining or improving watershed conditions both upstream and downstream of Chiricahua leopard frog habitats to reduce physical threats to aquatic sites and allow for Chiricahua leopard frog dispersal, reducing or eliminating nonnative species, preventing and managing disease, and other actions. Suitable or potentially suitable unoccupied habitat with high potential for supporting Chiricahua leopard frog populations or metapopulations will be protected, and restored or created as needed, within MAs (FWS 2007). These habitats should include aquatic breeding habitats and uplands or ephemeral aquatic sites needed for movement among local populations in a metapopulation. Activities to achieve this include habitat management, removal of nonnative species (e.g. American bullfrogs, nonnative fishes, and crayfish), enhancing water quality conditions, and reducing sedimentation. Populations of Chiricahua leopard frogs will be established or reestablished in these MAs. Landscape level removal of nonnative species in conjunction with captive propagation-headstarting-release of Chiricahua leopard frogs has achieved recovery criterion 1 in RU1 and has made tremendous headway in reaching recovery criterion 1 in RU2 as well as recovery criterion 4 in RU1 and RU2.

Critical Habitat

The status of critical habitat information contained in the October 30, 2013 BO remains current and is incorporated herein via reference.

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 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.

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 Chiricahua leopard frog are discussed here and in the 2013 BO.

Description of the Action Area

The action area remains as described in the October 30, 2013 BO except as described in the Description of the Proposed Action section (see Table 1) and in the following text:

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. In addition to the areas described in the October 30, 2013 BO, the action area for the Chiricahua leopard frog also encompasses all occupied or likely-to-be occupied aquatic sites including streams and wetlands within the Cienega Creek watershed, as these will be subject to the proposed action's effects to groundwater and surface flow hydrology. In addition, the action area includes a mitigation property identified in the HMMP known as Sonoita Creek Ranch, because the proposed action includes release of Chiricahua leopard frogs there as well as the to-be-determined sites in which the vertebrate species-focused Harmful Nonnative Species Management and Removal program will be implemented.

The proposed project falls within the three management areas (MAs) within the Santa Rita-Huachuca-Ajos/Bavispe Recovery Unit (RU2) for Chiricahua leopard frog. RU 2 was designed to encompass metapopulation(s) of frogs centered around the headwaters of the San Pedro and Santa Cruz rivers and adjacent mountain ranges in Arizona and Sonora. The RU was also designed so that land management and recovery efforts could be coordinated via relatively few land managers. In Arizona, management of frogs and their habitats is focused on the Sierra Vista and Nogales Ranger Districts of the Coronado National Forest and adjacent private and BLM lands including Las Cienegas NCA. The three MAs in RU2 that fall within the action area are described in detail in the Status of the Species and Critical Habitat within the Action Area sections, below.

Status of the Species within the Action Area

The status of the species and critical habitat within the action area information contained in the October 30, 2013 BO is updated here. The status of Chiricahua leopard frog in the action area has declined since the October 30, 2013 BO was completed. Updated information on metapopulations of the species is summarized below by each MA in the action area.

Santa Rita MA
The Santa Rita MA supports one functioning metapopulation in the Greaterville area within the action area and another potential developing metapopulation in and around Gardner Canyon just south of the action area. The Greaterville area metapopulation includes 5 sites where breeding has been documented between 2010 and 2015: Greaterville Tank and Granite Mountain Tank in Ophir Gulch, drinkers and another site in Louisiana Gulch, and West Tank in California Gulch. However, frogs have been extirpated from West tank since 2013. Frogs have also been detected at several other dispersal sites in this area including the following: Granite Tank and an unmarked well west of Greaterville Tank in Ophir Gulch, East Tank in California Gulch, Upper Enzenberg and Redtail Tank in Enzenberg Canyon, Box Canyon, and Bowman Tank in upper Empire Gulch. None of these aforementioned sites are within the perimeter fence of the proposed action. Of the 14 stock ponds and springs found in the mine within the perimeter fence, two have had detections of Chiricahua leopard frogs: Lower Stock Tank and Barrel Tank. Chiricahua leopard frogs were found in Lower Stock Tank in 2008 but have not been found since then although this tank and at least three other adjacent tanks appear to be perennial. Since completion of the 2013 BO, Chiricahua leopard frogs were found at two new sites in the action area: one

juvenile frog was detected in Barrel Tank east of Oak Tree Canyon within the area of the mine footprint, and two sub-adult to adult sized frogs were found in Deering Spring just outside the mine footprint but within the perimeter fence. These frogs were found during the monsoon season and were likely recent dispersers from nearby breeding sites. It is unknown if these two sites hold water long enough to support breeding.

The major threat in this MA continues to be scarcity of water, although disease now rivals water scarcity as a leading threat to the species in this MA since completion of the 2013 BO. The first detection of chytridiomycosis (Bd) in Chiricahua leopard frogs in this MA was confirmed in frogs from West Tank and Greaterville Tank in the winter of 2014. Much of the population at Greaterville Tank died during the winter of 2014 and all specimens sampled tested positive for Bd (please refer to status of species in 2013 BO for explanation of this disease). November 2015 surveys detected 11 adult frogs in Greaterville Tank (C. Akins, pers. comm. 2015). At the same time, West Tank experienced a large die-off that was initially detected in February 2014 (E. Wallace, Pers. Comm. 2014). A few tadpoles and a number of juveniles were seen post die-off, but no adult frog life stages were detected there in most recent November 2015 surveys conducted by AGFD (C. Akins, pers. comm. 2015). Cave Creek confluence with Gardner Canyon in this MA also experienced a die-off with frogs testing positive for Bd, although this site is just south of the action area. Negative trends associated with Bd continue, based on recent surveys (April 5-6, 2016) of eight sites within the Santa Rita MA, several of which had been reliable source populations with large numbers of frogs (Akins 2016). Specifically, a total of two Chiricahua leopard frog tadpoles (at a single site) were observed and no metamorphosed frogs were detected (Akins 2016).

We would like to note that Bd has been confirmed in another species of ranid frog, the Tarahumara frog (*Lithobates tarahumarae*), in Big Casa Blanca Canyon prior to the current die-offs we are seeing in Chiricahua leopard frogs. Although Big Casa Blanca Canyon is in this MA, Chiricahua leopard frogs have not been verified here, although Hale and Jarchow (1988) documented leopard frogs (either Chiricahua leopard frogs or lowland leopard frogs, but species not confirmed) in lower Big Casa Blanca Canyon in the late 1970s and possibly the early 1980s. In addition, the habitat that Tarahumara frogs primarily occupy is in an extremely rugged portion of the canyon with deep plunge pools and tinajas, and is likely to have little if any overlap with Chiricahua leopard frog habitat.

Empire Cienega MA

Due in large part to a ten-year effort intended to create, enhance, and protect habitat for at-risk species and remove the threat of harmful nonnative species from within the Las Cienegas NCA, the Empire Cienega MA is now capable of supporting a functioning metapopulation of frogs within the action area, but for the effect of Bd (see below). The Las Cienegas NCA metapopulation has included 10 sites where breeding has occurred since at least 2012: Empire Spring in Empire Cienega, Headwaters Reach of Cienega Creek, Cold Spring Reach of Cienega Creek just upstream of the confluence with Mattie Canyon, and 7 wildlife ponds including Cinco Well, Cottonwood, Empire Well, Gaucho, Maternity Well, Spring Water Wetlands, and Road Canyon Tank.

Empire Spring, located about 4 miles upstream of Cienega Creek in Empire Gulch, is the most

consistent source population for Chiricahua leopard frogs in this metapopulation. The Empire Spring population has persisted since at least the 1990s when records began in the area, and has increased in recent years from about 7 observed individuals to 100s of frogs detected in 2015 (Hall *et al.* 2015). Frogs were also documented at Cieneguita Wetlands throughout 2015, although breeding was not observed at this site.

Frogs have been known to disperse to numerous sites during the monsoon season, including 12 sites in 2015, three of which were new detection sites for the species (Rattlesnake Tank, Karen's Tank, and Clyne Pond; Hall *et al.* 2015). As of April 2016, approximately 20 surveys have occurred in the Las Cienegas NCA (Hall 2016b). Hall (2016b) found that metamorphosed frogs at all surveyed lentic sites experienced 100 percent mortality over the 2015-2016 winter; tadpoles remain extant at these sites, but two lentic sites where Bd is absent, Hilton Tank and Cline Pond, still maintain metamorphosed frogs. There are three lotic sites where metamorphosed Chiricahua leopard frogs survived the 2015-2016 winter: Empire Spring, and both the Headwaters and Cold Spring reaches of Cienega Creek; these sites all tested positive for the presence of Bd (Hall 2016b). Currently unoccupied sites where releases may occur include Cinco Ponds, Frog Tank and eight other stock tanks within the action area; these are considered included as part of the baseline in this consultation.

As part of the larger conservation effort on Las Cienegas NCA, nonnative aquatic species removal followed by captive propagation-headstarting-release of Chiricahua leopard frogs took place from 2010-2012, resulting in recent recovery successes. Partners continue to monitor Chiricahua leopard frog populations, disease (Bd), and bullfrog presence (Rosen *et al.* 2013, Hall *et al.* 2015). The most significant threat in this area is Bd. Nearly all harmful nonnative species have been removed from the Las Cienegas NCA, but bullfrogs and crayfish are still present regionally and represent a potential, on-going threat on the larger landscape scale that includes other surrounding Chiricahua leopard frog MAs.

Chiricahua leopard frogs experience periodic die-offs from Bd in this MA. The most recent die-off was initially detected in the winter of 2014 and appears to continue presently since temperatures have dropped in 2015 (Hall *et al* 2015). The current die-off was documented at 7 of 10 sites sampled on Las Cienegas NCA in 2014 (Hall *et al.* 2015). These 7 sites are all wildlife ponds including Cinco Well, Cottonwood, Empire Well, Gaucho, Maternity Well, Spring Water Wetlands, and Road Canyon. Notably, die-offs were not detected at Empire Spring in Empire Gulch, nor in the Headwaters and Cold Spring reaches of Cienega Creek, although frogs sampled at Empire Spring carried zoospore loads of Bd considered to be below disease-level (Hall *et al.* 2015). In spring 2015, surveys revealed that only tadpoles survived the winter in Cottonwood, Gaucho, and Road Canyon sites; Spring Water Wetlands and Maternity Well had no life stages present; and only a small number of adult frogs survived at Cinco Well and Empire Well sites, but adult survival appeared to be high at Empire Spring, Headwaters Reach, and Cold Spring Reach. In October and November 2015, dead and moribund frogs showing signs of Bd were again collected at all 5 remaining wildlife pond sites that experienced a die-off during the winter of 2014. The three lotic sites were also surveyed in November 2015 and no dead or moribund frogs were detected, but samples were collected to test for Bd (D. Hall, pers. comm. 2015). Both Cienega Creek and Empire Gulch are fed by springs which may provide a more thermally stable environment; this stable temperature environment is thought to prevent die-offs from the disease,

although the mechanism is not clearly understood (Forrest and Schlaepfer 2011, Rowley and Alford 2013).

Potential, Bd-influenced population trends from 2015-2016 in both the Santa Rita and Empire MAs suggest a particular dynamic may be occurring. In simplified terms, sites that have supported Chiricahua leopard frogs in all age classes over successive years now may be behaving as "annual" sites where metamorphosed frogs succumb to Bd during their first winter, leaving only tadpoles present the following spring. These tadpoles may, in turn, metamorphose and even disperse to other sites where they might reproduce themselves, only to die from Bd in their first winter – again, leaving only tadpoles behind. We are uncertain what this trend, should it continue, may mean for these sites or these MAs as a whole, but are concerned that reproduction, and therefore recruitment, at affected sites may be significantly hampered at the least, or at worst, cease altogether. If this population dynamic persists, it would require active management through annual captive propagation-headstarting-release programs to keep metapopulations viable in these MAs.

Red Rock-Sonoita Creek MA
Red Rock-Sonoita Creek MA is discussed here because Sonoita Creek Ranch, identified as a mitigation property in the HMMP, is part of the proposed action and falls within this MA. Sonoita Creek Ranch is adjacent to an ephemeral section of Sonoita Creek. Red-Rock Sonoita Creek MA does not support a functioning metapopulation of Chiricahua leopard frogs. In October 2014, Chiricahua leopard frogs were discovered in a wildlife drinker and within an associated underground storage tank in Alamo Canyon within this MA. In 2015, Chiricahua leopard frogs were detected at a stock tank 0.9 stream-miles southeast of this wildlife drinker (D. Hall, pers. comm. 2015). Prior to these recent detections, Chiricahua leopard frogs were detected in Monkey Spring as late as 2000; this spring is located 5.5 stream-miles upstream in an ephemeral channel from the recent detections in the wildlife drinker in Alamo Canyon. Sonoita Creek is the only stream within the MA that has perennial water. However, the perennial portion of Sonoita Creek does not support Chiricahua leopard frogs because bullfrogs, crayfish, and nonnative, spiny-rayed fish are present along the creek. Bullfrogs and nonnative, soft-rayed fish species are also known to occur within other perennial spring sites and stock tanks within the MA, including the ponds on the Sonoita Creek Ranch mitigation property (FWS 2007). The Chiricahua leopard frog Recovery Plan identifies this MA as having potential for a metapopulation or isolated robust population, although we are not actively recovering the species in this MA to date due to the prevalence of nonnative predators occupying the majority of the sites that hold water perennially (FWS 2007, FWS 2011).

Huachuca Mountains MA
Huachuca Mountains MA is included in the action area because the northwest corner of the MA is part of Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal; this conservation measure is new and was not analyzed in the October 30, 2013 BO. We are limiting the discussion of the status to the portion of the MA that falls within the action area, which includes perennial waters at Peterson Ranch Pond in Scotia Canyon and Parker Canyon, and fewer than ten stock tanks. Chiricahua leopard frogs are currently only extant at Peterson Ranch Pond within Scotia Canyon in this portion of the MA. Frogs were first translocated from a Safe Harbor site in Miller Canyon to Peterson Ranch Pond in 2009. The

population grew quickly and peaked at over 200 individuals in 2013. However, by March 2014, the only adult frog observed at the pond was found dead. Although the frog was too decomposed to analyze, the most likely explanation for this rapid population decline is a large outbreak of chytridiomycosis caused by Bd. Since then, CLFs have persisted in relatively low numbers, despite the probable presence of Bd and the occasional presence of bullfrogs. Three augmentations to the Peterson Ranch Pond population took place in 2015 (H. McCall, personal communication, 2016).

Patagonia Mountains-San Rafael Valley MA
Patagonia Mountains-San Rafael Valley MA is included in the action area because it is part of a conservation measure that has been added to the proposed action since completion of the October 30, 2013 BO. Patagonia Mountains-San Rafael Valley MA currently does not support a functioning metapopulation or isolated robust population of Chiricahua leopard frogs. This MA includes perennial lotic waters in the upper Santa Cruz River, Sheehy Spring, and Sharp Spring, as well as roughly 80 springs and stock tanks spread across the landscape. The Santa Cruz River and many of the stock tanks support bullfrog and nonnative fish populations. Chiricahua leopard frogs were last seen in the upper Santa Cruz River portion of the MA in 1980. In 2008, Chiricahua leopard frogs were translocated from the Huachuca Mountains MA to a Safe Harbor site in the Patagonia Mountains-San Rafael Valley MA. The Safe Harbor site consists of a well-fed pond that has a hardware cloth fence around it designed to keep bullfrogs from entering the pond. In addition to Chiricahua leopard frogs, northern Mexican gartersnakes and Sonoran tiger salamanders have been detected in this pond. The fence has since been breached by bullfrogs, and the last observation of Chiricahua leopard frogs in this pond was in October 2012, when over 200 adults were detected. By April 2013, no Chiricahua leopard frogs were detected, and from September 2013 to April 2015, only bullfrogs have been detected (H. McCall, pers. comm. 2016).

Status of Critical Habitat within the Action Area

Information regarding the primary constituent elements (PCEs) for Chiricahua leopard frog designated critical habitat and the status of critical habitat within the action area contained in the October 30, 2013 BO remains current and is incorporated herein via reference. Key information is also summarized here along with updated information on the current condition and conservation role of individual critical habitat units in the action area, as well as special management required.

The action area includes two of 39 designated critical habitat units for Chiricahua leopard frog as described in the Final Rule (77 FR 16324), the Las Cienegas NCA Unit, the Eastern Slope of the Santa Rita Mountains Unit, and the Scotia Canyon Unit. These critical habitat units fall entirely within the action area and all occur within Recovery Unit 2 for the Chiricahua leopard frog.

The Las Cienegas NCA Unit consists of 1,554 acres (627 ha) that includes 4.3 mile (7 km) reach of Empire Gulch and 1.9 mile (3 km) reach of Cienega Creek. Lateral extent of critical habitat in this unit also includes approximately 25 acres (11 ha) wetlands known as Cinco Ponds, Empire,

Springwater, Cieneguita, Rattlesnake, and Oak Tree. Special management is required in this unit to control disease, remove nonnative species, and improve habitat.

The Eastern Slope of the Santa Rita Mountains Unit consists of 186 acres (76 ha) that includes two steel tanks in Louisiana Gulch, Greaterville Tank, Los Posos Gulch Tank, Granite Mountain Tank complex, and dispersal habitat in intervening ephemeral drainages between these four lentic sites. Special management is required in this unit to address limited surface water and control disease.

The Scotia Canyon Unit includes 70 ac (29 ha) in Scotia Canyon, Huachuca Mountain, Cochise County, Arizona, and is entirely on Federal lands in the Coronado National Forest. Special management is required in this unit to remove nonnative predators and disease, protect from catastrophic wildlife impacts, and improve aquatic habitat.

The Las Cienegas NCA Unit is the largest of six critical habitat units in RU2 and the third largest critical habitat unit of all 39 units designated for the species. Even though the Las Cienegas NCA Unit is large compared to other units, we give it no more value than other critical habitat units in the designation beyond its size, and therefore its capacity to support larger populations of frogs. The critical habitat designation was based on functionality, or whether or not each unit has the PCEs to support a metapopulation in and of itself (must have PCE1 and PCE2 and at least four spatially disjunct breeding sites), contribute to a future metapopulation (must have PCE1 and PCE2, but fewer than 4 spatially disjunct breeding sites) or isolated robust population of frogs (PCE1 only) that would then contribute to recovery of the species as described above in the Status of the Species section. In the critical habitat designation, Las Cienegas NCA CH Unit is identified as an isolated population that could contribute to a metapopulation and has both PCE1 and PCE2, and the Eastern Slope of the Santa Ritas Unit is identified as a metapopulation and also has PCE1 and PCE2. There are 4 other critical habitat units in RU2: Florida Canyon Unit and Carr Barn Pond Unit with PCE1 to support an isolated population, Scotia Canyon Unit with PCE1 and PCE2 to support an isolated population with potential for connectivity to a nearby metapopulation, and Ramsey and Brown Canyons Unit with PCE1 and PCE2 to support a metapopulation.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following Chiricahua leopard frog-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present-day, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

Effects of the 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 or interdependent with that action (50 CFR §402.02). Indirect effects are caused by the action, occur later in time, and 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).

Direct and indirect adverse effects to Chiricahua leopard frogs from the proposed action are anticipated during construction and operation of the mine as well as after mine operations cease, and are anticipated to continue far into the future. The proposed action may result in injury, death, or disturbance to Chiricahua leopard frogs as well as permanent removal and degradation of their habitats. Conservation measures included in the project description may help offset adverse effects to Chiricahua leopard frogs to some extent.

<u>Effects of Mine Construction and Operation</u>

Effects of Mine Construction and Operation unrelated to groundwater drawdown discussed in the October 30, 2013 BO remain current and are incorporated herein via reference, except for updated information on potential loss of habitat within the security fence as described below.

Complete loss of current and potential habitat for Chiricahua leopard frog will occur within the security fence of the mine. This includes at least four perennial sites centered around Lower Stock Tank (occupied in 2008) and Rosemont Springs, as well as at least three ephemeral tanks including Barrel Tank, North Basin Tank, unnamed tank and ephemeral drainages connecting these sites and other sites outside of the security fence.

<u>Effects of Groundwater Drawdown associated with the Mine</u>

Effects of Groundwater Drawdown associated with the Mine discussed in the October 30, 2013 BO are replaced with the following narrative:

Three different indirect effects from the mine to the Chiricahua leopard frog are associated with groundwater drawdown within the Cienega Creek HUC10 basin: reductions in stream flow, reductions in pool metrics, and reduced water quality. Climate change will further increase these effects relative to the present day baseline conditionThe "Effects to Aquatic Ecosystems" section of this BO describes the hydrologic basis for effects to streams and associated pools in which Chiricahua leopard frogs occur in the Santa Rita MA and Empire Cienega MA, as well as the species critical habitat in the East Slope of the Santa Rita Mountains Unit and Las Cienegas NCA Unit. In addition, the "Effects of the Action – Gila Chub" and "Effects of the Action – Gila Topminnow" sections further detail impacts of groundwater drawdown in key reaches in Cienega Creek and Empire Gulch, and are incorporated by reference. Impacts from the effects of climate change, mine drawdown, and both effects combined, are included as part of our jeopardy and adverse modification analyses.

Chiricahua leopard frogs have been documented in stream and wetland reaches defined in the May 2015 SBA including Empire Gulch reaches 1 and 2, Cieneguita Wetland, and Cienega Creek reaches 1 to 7 (see Figure A-1 in the Effects to Aquatic Ecosystems section and Environmental Baseline for species). Although our analysis will focus on Key Reaches identified in the May 2015 SBA (EG1, EG2, CC2, CC4, CC5, and CC7), we will interpolate to occupied habitats outsides of Key Reaches to the extent possible, including CC1, CC3, CC6, and all habitats that make up the entire Greaterville metapopulation in the Santa Rita MA that also fall within the Cienega Creek HUC10 basin. Although we are not aware of any methodology to correlate Chiricahua leopard frog abundance with stream flow, indirect effects to Chiricahua leopard frog from modeled groundwater drawdown related to stream flow and pool metrics, as well as changes in riparian community composition occur within the action area in all occupied reaches. Impacts from the mine only are small when compared to the effects of climate change. However, the impacts from the mine only do cause negative effects to aquatic habitats; this habitat degradation negatively impacts the Chiricahua leopard frog. Some of these impacts are similar to those described for Gila chub and Gila topminnow, which are incorporated herein with specific applicability to the frog discussed below.

Upper Empire Gulch – Key Reach EG1

Although the 95th percentile stream flow analysis of reach EG1 varies greatly, based on the modeling analyses, we assume that streamflow in EG1 ceases at 100 years post mine closure and pools begin to disappear 50 years after mine closure with all pools eventually lost from groundwater drawdown solely due to operation of the mine. Climate change has very little effect on streamflow and the number of pools, even in combination with mine drawdown. The robust breeding site for Chiricahua leopard frogs at Empire Spring within EG1 will become much more important throughout the life of this project prior to its ultimate disappearance, as climate change is anticipated to reduce availability of water to lentic sites that are part of the Las Cienegas NCA metapopulation. As flow decreases and habitat shrinks, fewer and fewer frogs will be able to use EG1, a reach that appears to be protected from die-offs during outbreaks of Bd. As pools begin to decrease in size, reduction in the wetted perimeter and pool surface area will result in take

because all life stages of the frog use the wetted perimeter extensively and tadpoles metamorphose faster in warmer water in the shallows. In addition, smaller pool area and lower volume within pools will affect water chemistry by increasing water temperatures which lower dissolved oxygen levels; both will also adversely affect tadpoles. As flow and pools decrease, effects include 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. These effects will reduce the success of eggs, alter growth rates of tadpoles, reduce food for tadpoles and adults, and increase the exposure of tadpoles and adults to vertebrate predation and desiccation (Southwest Endangered Species Act Team 2008).

Degradation and ultimate disappearance of surface water as modeled in the upper portion of Empire Gulch, would permanently remove the longest standing and most prolific site occupied by the Chiricahua leopard frog in the Las Cienegas NCA metapopulation and likely within RU2 for the frog.

Lower Empire Gulch – Key Reach EG2
The percent of June flow remaining at 150 years is predicted to be 82 percent from mine drawdown alone and 54 percent of baseline June flow (12 gpm) from mine and climate change combined (Figure GC-3). An 18 percent decrease in flow from mine drawdown only will decrease habitat available to all life stages of frogs. Loss of pool surface area due to mine drawdown alone predicts that as much as 11 percent loss of surface area at 150 years, with all other time steps at a less than 10 percent loss. Climate change is the predominate factor in surface area losses in EG2 pools, leaving 51 percent of the area at all modeled intervals. Together, climate change and the mine will leave 51 percent of pool surface area intact at end of mining and continue to decrease until only 29 percent of pool surface area remains at 150 years. Therefore frog habitat in pools in lower Empire Gulch will decrease significantly, and experience other effects similar to those described for upper Empire Gulch, although somewhat lower in magnitude. Mine-only data indicate that drawdown may have no contribution (0 days) or up to 19 days of extremely low flows, which would also contribute to adverse effects to tadpoles due to low concentrations of dissolved oxygen.

There are no days of zero flow in lower Empire Gulch under any of the 95th percentile analyses. This equates with no change from the baseline, and flow status would remain perennial. Climate change will result in an additional 26 days of extremely low flows in lower Empire Gulch; mining plus climate change will not increase this number under the 95th percentile analysis. However, mine-only analysis indicates that drawdown may contribute zero or up to 19 of the 26 days of extremely low flow. An additional 26 days of extremely low flow in lower Empire Gulch contributes to the overall adverse effects to the frog.

Upper Cienega Creek – Key Reaches CC2,CC4, CC5 & CC7
Modeled loss of June streamflow from mine-only drawdown is 11 or 12 percent in each of these four key reaches of upper Cienega Creek. The combined impacts of the mine and climate change 150 years after mine closure are much worse with streamflow loss from current June flow at 19 percent decrease in CC2, 24 percent in CC4, 68 percent in CC5, and 100 percent in CC7. This will result in a significant decrease of habitat available to all stages of frogs and reduce connectivity between breeding populations in upper Cienega Creek. However, habitat within

pools will remain within these four reaches in all scenarios. Mine drawdown, with or without climate change, does not change the number of pools present in these reaches, and mine drawdown alone also does not substantially change the pool depth, pool volume, or surface area (1-5%). Climate change plus the mine exacerbates decreases in pool metrics with a reduction in pool depth of 13 to15 percent, reduction of pool area of 12 to 27 percent, and reduction of pool volume by 29 to 45 percent across these four reaches.

There are no zero flow days in CC2 or CC4 under any scenario. Reaches CC5 and CC7 currently exhibit an average of two days with zero stream flow per year. Under the 95th percentile analyses, mine drawdown would change this to two or three days per year in both reaches, and climate change absent the mine's impacts would result in five additional days with zero stream flow per year in CC5, and 23 additional days with zero stream flow per year in CC7. In combination, mine drawdown plus climate change would result in 5 to 9 days with zero stream flow per year in CC5, and from 23 to 31 days with zero stream flow per year in CC7. A review of the 95th percentile mine-only data indicates that climate change drives the frequency of extremely low-flow days 10 to 50 years post mine closure, and the mine's relative contribution to the effects increases at 100 to 150 years. Low flow days increase significantly from current conditions (< 5 days) to the climate change scenario in 150 years (5 to 60 days), with the addition of mine impacts adding 5 to 10 more days of low flow.

As stated before, groundwater drawdown was not specifically modeled in non-key reaches in Cienega Creek that are currently occupied by Chiricahua leopard frogs, including CC1, CC3, and CC6. However, we anticipate effects from drawdown in these reaches to be similar to those described in key reaches.

Overall, streamflow loss, pool reduction, and decreased water quality in these four key reaches of upper Cienega Creek from mine-only drawdown are especially of concern, as these reaches include several stable breeding sites for the species, provide connectivity between these breeding populations, and along with EG1, appear to afford some protection from die-offs of Chiricahua leopard frogs related to Bd. Remaining habitat in Cienega Creek will be more important to the species 150 years post mine closure not only because EG1 will be lost, but also because at this point in time mine drawdown and climate change may have already significantly decreased three wetland habitats within the floodplain of Empire Gulch or Cienega Creek that support breeding populations of frogs and were not modeled in the key reach analysis but are within the 5-foot drawdown perimeter discussed in SWCA (2012) (Spring Water Wetlands in EG2, Cinco Ponds in CC2, and Rattlesnake north of CWG). Climate change may have also reduced or removed breeding sites in wildlife ponds within the action area that are solely supported by surface water, also increasing the importance of remaining populations and habitat within Cienega Creek.

Cieneguita Wetland – Key Reach CGW

Similar to EG1, the 95th percentile range of groundwater drawdown results from mine only encompasses a wide range for the three Cieneguita Wetlands. The number of pools does not change, although pool volumes change significantly, losing 67 percent of their volume and 50 percent of surface area due to impacts from the mine after 150 years. In addition median pool depth of Cieneguita wetlands is reduced from 3.6 to 3.2 feet (11 percent) 150 years after mine closure. Climate change in combination with mine drawdown reduces pool volume by 81

percent, pool surface area by 76 percent, and pool depth by 26 percent.

Other areas
The groundwater modeling results do not discuss the potential for groundwater drawdowns in the Greaterville metapopulation within the Santa Rita MA, although it is inside the 5-foot drawdown perimeter discussed in SWCA (2012). There are no perennial drainages in the portion of the Santa Rita MA that falls within this drawdown perimeter. However, three of the six current breeding sites for Chiricahua leopard frogs in the Greaterville metapopulation are perennial due to wells that could be affected by groundwater drawdown. These sites include the two steel tanks in Louisiana Gulch, Ophir Well, and West Tank. If depth to groundwater drops below the well depth in any of these wells, existing well would no longer be available to supply a perennial source of water to 50% of current breeding sites in this metapopulation.

The May 2015 SBA states that groundwater modeling indicates that in the first 150 years after mine closure, drawdown greater than 10 feet is unlikely to occur at the Empire Wildlife Pond and Maternity Wildlife Ponds (FEIS, pp. 341–345) (Montgomery and Associates Inc. 2010; Tetra Tech 2010). The exact depth of the well at those sites is not known; however, drawdown less than 10 feet was not considered in the FEIS to impact nearby wells (FEIS, p. 294). There also are not expected to be any changes in surface runoff (which also maintains water in the the sites) due to the mine in this watershed (FEIS, p. 398). We do not have groundwater drawdown data to determine if the tanks in Louisiana Gulch, Ophir Well, and West Tank would be similarly unaffected, if a 10-foot threshold is appropriate, nor can we determine if a deepening of the wells maintaining these sites would be effective in sustaining water supplies; no funding for such work has been proposed.

Lastly, we reiterate the analysis that appeared in our October 30, 2013 BO, regarding the potential effects of the pit lake to Chiricahua leopard frogs. 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 (which do not actually apply to the water) for three contaminants that are known to bioaccumulate (i.e., cadmium, mercury, and selenium). 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. Chiricahua leopard frogs could thus be directly exposed to contaminants should individuals disperse to and occupy the pit lake. We hypothesize that effects to this species could also occur from eating winged aquatic invertebrates originating in and, via flight, being exported from the mine pit lake to sites where they may be preyed upon by Chiricahua leopard frogs.

Effects of the Action on Critical Habitat

Adverse effects as a result of the mine are anticipated in two of 39 designated CH units for Chiricahua leopard frog. All effects of the action to critical habitat are associated with groundwater drawdown associated with the mine or the mine plus climate change. Reaches EG1, EG2, CGW, CC1, and CC2 make up the majority (71 percent) of the Las Cienegas NCA CH Unit. In addition, the Eastern Slope of the Santa Ritas CH Unit is entirely within the groundwater drawdown area associated with the mine, although it includes no stream reaches modeled in the May 2015 SBA or SIR.

Within the Las Cienegas NCA CH Unit, potential adverse effects to aquatic breeding habitat and immediately adjacent uplands (PCE1) include complete loss and of standing water in Empire Spring in reach EG1 with pools beginning to disappear 20 years after the beginning of mine operations, and partial loss of standing water in slow-moving water and reduction of pools in Empire Gulch at its confluence with Cienega Creek (EG2), Cieneguita Wetlands (CGW), and reaches modeled in Cienega Creek (CC1 and CC2). As discussed above in the Status of the Species in the Action Area section, Empire Spring in EG1 and the Headwaters Reach in CC2 may afford some protection from Bd (PCE1d), since frogs in this area carry low levels of chytrid zoospores but have not been found to succumb to the disease here to date (Hall *et al* 2015). Groundwater withdrawal may also cause a reduction in emergent and submergent vegetation and foraging and basking habitat immediately adjacent to surrounding breeding aquatic habitat (PCE1b). Within the Eastern Slope of the Santa Rita Mountains CH Unit, there is a potential reduction in standing water in aquatic breeding habitat (PCE1) in the steel tanks in Louisiana Gulch and Granite Mountain Well in Ophir Gulch because they are supplied by groundwater wells, which represent 50% of the breeding sites included in this critical habitat unit.

Mine-only groundwater withdrawal and the combined impacts of the mine and climate change may adversely affect all dispersal and nonbreeding habitat (PCE2) critical habitat within the Las Cienegas NCA and Eastern Slope of the Santa Rita Mountains CH Units. Dispersal and nonbreeding habitat is found within the portion of Empire Gulch between EG1 and CGW, lower Empire Gulch (EG2), and upper Cienega Creek reaches CC1 and CC2. This includes complete loss of value of dispersal habitat in Empire Gulch that connected breeding habitat at Empire Spring to breeding habitats in Cieneguita Wetlands, lower Empire Gulch, and upper Cienega Creek. In other words, there is no longer a need for connectivity because the breeding population at Empire Spring in EG1 is lost. In remaining critical habitat areas reduced by groundwater withdrawal (CGW, EG2, CC1, and CC2), there will be a reduction in low and mid-story vegetation cover for shelter, forage, and protection from predators. Intermittent and perennial aquatic habitat may be reduced in wetted corridors as well. In the Eastern Slope of the Santa Rita Mountains CH Unit, if PCE1 is lost due to groundwater withdrawal, this effectively reduces the need for connectivity to these sites, making PCE2 in Louisiana Gulch and Ophir Gulch obsolete.

Overall, mine-only groundwater withdrawal alone may permanently remove 49 percent of the Las Cienegas NCA CH Unit beginning 20 years after mine closure and mine impact combined with impacts of climate change may reduce the functionality of both PCE1 and PCE2 in the remaining 51 percent of this CH Unit within 150 years of mine closure. Mine-only groundwater withdrawal may also remove 50 percent of the Eastern Slope of the Santa Rita Mountains CH

Unit (climate change effects were not modeled here). In terms of RU2 for Chiricahua leopard frog, mine-only groundwater withdrawal may permanently remove 40-45 percent (759.5 to 852.5 acres) and reduce functionality of 41 percent (792 acres) of the 1,912.6 acres of critical habitat designated within RU2. Remaining critical habitat in RU2 unaffected by the proposed action includes 249 acres (13 percent) among five critical habitat units in this RU. A portion of the Eastern slope of the Santa Rita Mountains CH Unit as well as four other small critical habitat units will not be affected by the proposed action, but may be affected by climate change. In terms of all RUs for the frog, mine-only groundwater withdrawal permanently removes 6.8-7.7 percent of the total CH designation for the species, and mine-only plus climate change groundwater withdrawal reduces functionality of another 7.7 percent of the total CH designation for the species.

Effect of the Proposed Conservation Measures

Effects of the proposed conservation measures to Chiricahua leopard frogs contained in the October 30, 2013 BO remain applicable and are incorporated herein via reference, with the exception of updated information on Sonoita Creek Ranch and the addition of the Harmful Nonnative Species Management and Removal Conservation Measure. The latter conservation measure was identified in the February 11, 2016 letter from the Rosemont Copper Company to the Coronado National Forest, and has been described in detail in the Description of the Proposed Action section, above. The revised and new conservation measures are as follows:

Sonoita Creek Ranch – As described in the 2013 BO and HMMP, Rosemont will acquire Sonoita Creek Ranch. In the 2013 BO, we concurred 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. However, regional bullfrog populations are likely to continuously infiltrate these ponds and render them useless for Chiricahua leopard frog conservation unless bullfrogs are removed from the Sonoita Creek watershed. While construction of barrier fencing to restrict movement of bullfrogs might allow these water features to act as an isolated source population of Chiricahua leopard frogs, fencing would have to be constantly managed; this has not been shown to be a long-term solution that contributes to recovery of the frog. Bullfrogs would likely breech the facility at some point due to the lack of any bullfrog eradication program in this area. In addition, as stated in the update of the environmental baseline, since the 2013 BO was completed we have discovered isolated populations of Chiricahua leopard frogs on the eastern edge of the Sonoita Creek MA that are serving as source populations for other sites within the MA. Adding an isolated population that is surrounded by bullfrogs does not contribute to recovery of the Chiricahua leopard frog. Therefore, we do not support introducing Chiricahua leopard frogs into Sonoita Creek Ranch waters for conservation purposes. Please note that Chiricahua leopard frog Term and Condition 4 from the October 30, 2013, Final BO is no longer binding.

Cienega Creek Watershed Conservation Fund-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. For our analysis of effects to the Chiricahua leopard

frog and based on recent history, continued commitments from recovery partners, and near- to mid-term planning efforts from the local recovery group, we assume that in most years, the Las Cienegas NCA will be maintained free of harmful nonnatives through a combination of BLM funding and supplementary funding through grant awards, other public and private partnerships, and as necessary, through the Cienega Creek Watershed Conservation Fund. Maintaining Las Cienegas NCA free from nonnative species will help minimize the effect of take from the proposed action; the proposed action is anticipated to result in the loss of occupied habitat that supports the Empire Cienega metapopulation of Chiricahua leopard frogs and its critical habitat within the Las Cienegas NCA CH Unit.

Harmful Nonnative Species Management and Removal- The addition of a conservation measure to fund nonnative species management removal in the San Rafael Valley-Santa Cruz River Hydrologic Unit 10 subbasin may also help minimize the effect of take from the proposed action. If implemented fully and successfully, this conservation measure would benefit the Chiricahua leopard frog in the Patagonia Mountains-San Rafael Valley MA and a small portion of the Huachuca Mountains MA. The USFS owns 68 percent of the San Rafael Valley-Santa Cruz River Hydrologic Unit 10 subbasin, with remaining lands owned by the State of Arizona (3 percent), and private land owners (29 percent). While addressing nonnatives on USFS lands is important, it will be critical to work with the two remaining landowners since the Santa Cruz River headwaters are located on their lands, acting as a major source population of harmful nonnative species throughout the remainder of the San Rafael Valley. Because there is currently only one site within this subbasin that is occupied by the Chiricahua leopard frog, successful implementation of this conservation measure would provide an opportunity to establish a metapopulation similar to the scope and function of the large Empire Gulch metapopulation on Las Cienegas NCA.

Summary of Effects – Chiricahua leopard frog

- Mine construction and operation are anticipated to directly kill and harm Chiricahua leopard frogs, to remove at least two lentic sites currently occupied by the frog within the fenced area, and to render the mine pit potentially both a source of contaminated prey and a sink for the species within its dispersal distance;
- Impacts from the mine to groundwater, and thus to surface water (streamflow, pool area, pool volume, pool depth), are expected in designated critical habitat and areas occupied by Chiricahua leopard frogs, and thus would negatively affect the frog;
- The proposed conservation measures will not preclude all anticipated effects to surface water from occurring nor entirely mitigate those effects;
- Within 50 to 150 years post-closure of the mine, substantial decreases to wetted stream perimeter and water depth are anticipated to occur;
- Mine-only groundwater drawdown in upper Empire Gulch may result in total loss of the most robust breeding population of Chiricahua leopard frogs in the MA at Empire Spring. This spring serves as a major source of frogs for dispersal to other sites within the Empire Cienega metapopulation, as well as potential connectivity to the Santa Rita metapopulation;
- Mine-only groundwater drawdown is anticipated to potentially result in complete loss of streamflow and pools in upper Empire Gulch, 18 percent loss in lower Empire Gulch, and 11 percent average loss in Cienega Creek reaches occupied by Chiricahua leopard frog. In

addition, pool metrics in Cieneguita Wetlands change significantly, losing 67 percent of their volume and 50 percent of surface area;

- There is more impact from the mine resulting in loss of present-day baseline streamflows than impact from climate change in areas of upper Cienega Creek occupied by the frog (CC2 and CC4). Together, the effects of both the mine and climate change to present-day conditions are relatively large. Downstream in CC7, climate change represents the greatest adverse effect to surface flow, with the effects of the mine being relatively less. Partial loss of breeding and dispersal habitat may occur in Empire Gulch reach EG2 located at the confluence of Empire Gulch and Cienega Creek, and Cienega Creek reaches CC2, CC4, CC5 and CC7 that currently support all life stages of frogs;
- Habitat in Cienega Creek will likely be more important to frogs by the time of 150 years post mine-closure because climate change will likely have already significantly decreased wetland habitats outside of the creek that are currently supporting breeding populations of Chiricahua leopard frogs;
- Loss of habitat in the Headwaters, Coldwater Spring and immediately downstream of Coldwater Spring reaches of upper Cienega Creek (CC2, CC4, CC5) may also decrease the ability of the frog to deal with Bd die-offs since these sites may not be able to support as many frogs due to further loss of habitat after the effects of climate change are considered;
- As a conservation measure (see the Description of the Proposed Action section in our October 30, 2013, BO and Item 5, page 48, of the second supplemental BA dated February 2013 for additional detail), the project proponent will secure water sources (via tank improvements, liner installations, and/or installation of solar wells) for up to 30 sites in the Santa Ritas MA, including all six current breeding sites that make up PCE1 of the Eastern Santa Rita CH Unit. This measure mitigates effects from drought (a serious threat in this MA) over time and therefore, may improve the baseline for this species in the area and its resiliency against extirpation. However, this conservation measure does not reduce or minimize the effect of groundwater withdrawal because groundwater withdrawal is not anticipated to influence water levels in stock tanks;
- Almost half of the Las Cienegas NCA CH Unit may be completely lost due to mine-driven drawdowns and the effects of climate change relative to the present-day baseline, and the remaining half diminished, although remaining portions in upper Cienega Creek, lower Empire Gulch, and Cieneguita Wetlands will still contain PCE1 and PCE2 and are likely to continue to contribute to the larger functioning Las Cienegas NCA metapopulation;
- A proposed conservation measure will create the "Cienega Creek Watershed Conservation Fund" which will supplement funding for nonnative species control on Las Cienegas NCA as well as other management and restoration actions in the watershed for a period of ten years; and,
- A proposed Harmful Nonnative Species Management and Removal conservation measure will decrease the threat of nonnative species in a majority of the currently unoccupied Patagonia Mountains-San Rafael Valley MA and a small portion of the currently occupied Huachuca Mountains MA.

Cumulative Effects - Chiricahua Leopard Frog

Cumulative effects described in the October 30, 2013BO remain current; this section is incorporated herein via reference.

Conclusion - Chiricahua Leopard Frog

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusions of non-jeopardy and no destruction or adverse modification, below, would remain valid.

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 FWS's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Chiricahua leopard frog nor destroy or adversely modify its designated critical habitat. Definitions of jeopardy and adverse modification are provided in the Gila chub section of this document. We present this conclusion for the following reasons:

1. The majority of the project activity likely associated with direct adverse effects from mine construction and operation is located on the northern-most edge of the recovery focus for the Santa Rita MA. The metapopulations that have been the focus of recent recovery actions in the Santa Rita MA are spatially distant from the active mining area, which decreases the likelihood for dispersing frogs to be present in the active mining area.
2. Conservation measures, in particular those which help secure metapopulation resiliency from the effects of drought (securing perennial water at numerous stock tanks in the Santa Rita MA) and from the effects of harmful nonnatives (Cienega Creek Conservation Fund), are expected to continue to provide meaningful conservation and recovery benefit into the long term. The Harmful Nonnative Species Management and Removal Program in the San Rafael Valley is expected to restore a Chiricahua leopard frog metapopulation at a subbasin level if its goals and objectives are met. We believe this measure may provide the same level of conservation and recovery benefit to the species as a whole as the Las Cienegas NCA does currently for the period of time the program remains funded, or approximately 13 years. The species-specific measures as identified and analyzed in the October 30, 2013, BO, which are intended to minimize the effect or likelihood of take associated with mine construction, provide additional benefit in varying degrees.
3. Although complete loss of Empire Spring 20 years after mine closure and significant loss of habitat in key reaches in Cienega Creek within 150 years after mine closure has been modeled, remaining habitat within Cienega Creek, although reduced, will likely continue to support a smaller and less-resilient Las Cienegas NCA metapopulation that will continue to contribute to recovery in RU2 and to the species as a whole.
4. Rosemont will monitor groundwater drawdown and the USFS will compare observed drawdown to modeled drawdown. Groundwater drawdown greater than modeled will be evaluated and may require reinitiation of section 7 consultation;
5. While three of the six current lentic breeding sites currently supported by groundwater wells

in the Greaterville metapopulation may be lost to groundwater withdrawal from the mine, a proposed conservation measure to secure water sources for up to 30 sites in the Santa Ritas MA (see Item 5, page 48, of the second supplemental BA dated February 2013) will ensure that all six breeding sites have a perennial water source supplied by new or improved groundwater wells at each site as needed. This includes the six sites that make up PCE1 of the Eastern Santa Rita CH Unit in the Eastern Santa Rita MA of RU2; these sites will allow conservation of Chiricahua leopard frog habitat in the Santa Ritas MA within RU2 as well as partial threat removal in the Eastern Santa Rita CH Unit. The Cienega Creek Watershed Conservation Fund will protect habitat for Chiricahua leopard frog by funding nonnative species control on Las Cienegas NCA as well as other management and restoration actions in the watershed for a period of 10 years (please note that this nonnative species control action is separate from and in addition to the Harmful Nonnative Species Management and Removal Program);

6. While the proposed Harmful Nonnative Species Management and Removal conservation measure will not preclude anticipated effects to Chiricahua leopard frog from groundwater withdrawal caused by the mine from occurring in the Empire and Santa Rita MAs and their corresponding critical habitat units in RU2, it will set the stage for establishing a new metapopulation of Chiricahua leopard frogs in another MA within this RU.
7. Successful conservation and recovery actions have taken place since species listing and subsequent designation of critical habitat, and continue to occur, with more actions in planning. Therefore, we believe the overall status of the species is improving.
8. Even though functionality of the Las Cienegas NCA CH Unit with respect to PCE 1d (which requires that "…. environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs" [in the presence of Bd]) may be greatly reduced, other attributes of PCEs will only be partially affected or completely unaffected by the proposed action. Quantitatively speaking, the Las Cienegas NCA CH Unit represents 40 percent of designated critical habitat from RU2, and 6.8 percent of total CH designation for the species. While some aquatic habitat will be lost in this Unit, aquatic habitat will be gained in the adjacent Santa Rita MA through securing perennial water in lentic sites. The Las Cienegas NCA CH Unit will maintain much of its functionality and contribute to a smaller, less robust Las Cienegas NCA metapopulation which can contribute to recovery in RU2 and to the species as a whole.

The de-listing criteria in the Chiricahua leopard frog recovery plan (USFS 2007) are useful for determining jeopardy. Before considering Chiricahua leopard frog for de-listing, at least two metapopulations located in different drainages (defined here as USGS 10-digit Hydrologic Units) plus at least one isolated and robust population in each recovery unit must exhibit long-term persistence and stability for a period of 25 years (even though local populations may go extinct in metapopulations) as demonstrated by a scientifically acceptable population monitoring program. In addition, protection of these populations and metapopulations, connectivity and dispersal habitat protection, and reduction or elimination of threats and long-term protection must be achieved in each recovery unit.

Although the impacts of the proposed action may affect the long-term functionality of only one of the two current functioning Chiricahua leopard frog metapopulations in RU2 by indirectly increasing the effect of Bd on the metapopulation, the action area is small compared to the entire

range of the species, and therefore large-scale physical alteration to the species' habitat is not occurring, thus not appreciably diminishing the likelihood of recovery nor the value of critical habitat in serving that role. While the action area does include a unique and important metapopulation of the species, one of the reasons the metapopulation is unique is because it occurs in a subbasin that has been managed in a manner that has functionally removed a primary threat to the species: harmful nonnative species. However, the conservation measure "Harmful Nonnative Species Management and Removal Program in the San Rafael Valley" is expected to create another unique metapopulation. This opportunity is poised to be important in moving the species toward recovery, especially if funding can be secured to keep the program going for the long-term. We believe that Chiricahua leopard frogs will still be present in the Las Cienegas NCA metapopulation 150 years after closure of the mine since adequate water should be present to support breeding populations within upper Cienegas Creek even though Empire Gulch is expected to be effectively lost. The adverse effects to critical habitat are anticipated to be of a similar small scale, and are unlikely to destroy or adversely modify the critical habitat in the action area to the extent that recovery would be delayed or precluded for many of the reasons found in the conclusions and discussion above.

Based on the above analyses and summary, it is the FWS's biological opinion that the proposed action will not alter the ability of this critical habitat to retain its PCEs and to function properly. As such, Chiricahua leopard frog designated critical habitat is anticipated to 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 designated critical habitat nor significantly delay or preclude its role in recovery of the species.

INCIDENTAL TAKE STATEMENT - CHIRICAHUA LEOPARD FROG

The following Incidental Take Statement replaces the Incidental Take Statement for Chiricahua leopard frog in the October 30, 2013, BO.

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 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). "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 take of Chiricahua leopard frogs in the following forms: (1) complete loss of current and potential habitat for Chiricahua leopard frog within the security fence of the mine and outside of the security fence of the mine but within the action area (thus harming the species); (2) harm or harassment to frogs in four perennial sites centered around Lower Stock Tank and Rosemont Springs, as well as three ephemeral tanks including Barrel Tank, North Basin Tank, unnamed tank and ephemeral drainages connecting these sites and other sites outside of the security fence. We also anticipate take of 200 Chiricahua leopard frogs and 8 egg masses 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, including impacts to occurrence of frogs in aquatic sites and stormwater detention ponds (see the Chiricahua leopard frog-specific Conservation Measures in the Oct 2013 BO). 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 – including stormwater ponds - over the life of the mine. Currently there are two stock tanks within the security fence that have had dispersing Chiricahua leopard frogs detected in them. Rosemont will survey for Chiricahua leopard frogs prior to construction, and if frogs are found within the mine footprint they will be moved outside of the mine footprint, which will reduce the potential for take (see the Chiricahua leopard frog-specific Conservation Measures in the Oct 2013 BO).

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 (see Oct 2013 BO). 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.

We also anticipate take of Chiricahua leopard frogs in the form of harm from adverse effects associated with groundwater drawdown from the proposed action, throughout the modeled analysis period and potentially beyond. Reduction in stream discharge and or pool surface area ranging from 11 percent to 100 percent of baseli ne measurements in Key Reaches in Empire Gulch and upper Cienega Creek, as well as a reduction in well discharge in wells in Louisiana Gulch and Ophir Gulch, as a result of groundwater drawdowns attributable to the proposed action will reduce the extent and quality of aquatic habitat required by Chiricahua leopard frog; we are

thus reasonably certain that this take will occur.

Incidental take of Chiricahua leopard frogs in Empire Gulch, Cienega Creek, Cieneguita Wetlands, and breeding sites supplied by well water in Louisiana Gulch and Empire Gulch, is difficult to determine 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. This incidental take is expected to be in the form of harm through the loss of habitat from groundwater drawdown.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible. However, it is impossible to quantify the number of individual Chiricahua leopard frogs taken because: (1) dead or impaired individuals are almost impossible to find (and are readily consumed by scavengers and predators) and losses may be masked by seasonal fluctuations in environmental conditions; (2) the status of the species will change over time through disease, natural population variation, natural habitat loss, or the active creation of habitat through management; and (3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity.

Therefore, the incidental take of Chiricahua leopard frogs due to indirect effects is expressed in terms of the groundwater drawdowns noted in the locations and time frames (0, 20, 50, 150 years) discussed in analysis of the effects to the Gila chub and used to support analyses for the other aquatic vertebrate species under consultation for this project. We believe this surrogate measure is appropriate for the Chiricahua leopard frog under this consultation because the most significant effects to this species (and other aquatic vertebrates under consultation) pertain to diminishment or loss of surface water as a result of groundwater withdrawal. We have based our analysis on how these effects were modeled over time. Groundwater monitoring is the appropriate means to evaluate, over time, what the actual effect on riparian and aquatic habitat will be, prior to it actually occurring.

These Incidental Take Statements are incorporated herein via reference.

Effect of the Take - Chiricahua Leopard Frog

In this biological opinion, we determine that these levels of anticipated take are not likely to result in jeopardy to the species nor result in destruction or adverse modification of its designated critical habitat for the reasons stated in the Conclusions section.

Reasonable and Prudent Measures - Chiricahua Leopard Frog

The FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of Chiricahua leopard frog:

1. The USFS and Corps shall ensure that Rosemont monitors the incidental take within the fenced area of the mine resulting from construction and operation of the mine.

2. The USFS and Corps shall ensure that Rosemont ensures that necessary precautions are taken to minimize the potential for Chiricahua leopard frogs to become attracted to water features near the active mining area (FEIS mitigation measure FS-BR-11).

3. A designated third party shall ensure that Rosemont applies the funds identified for the Cienega Creek Watershed Conservation Fund conservation measure solely to the identified conservation projects, including as a supplement, to maintain Las Cienegas NCA free of harmful nonnative aquatic species, unless more appropriate actions are later identified and approved by the USFS, Corps, and FWS (FEIS, Appendix B, p. B-43). If a third party is not so designated, the USFS and Corps shall ensure the funds are applied as stated. This is equivalent to Reasonable and Prudent Measure 2 for the Gila Chub.

4. The USFS and Corps shall ensure that Rosemont improves the resiliency of lentic aquatic habitat to secure breeding populations of Chiricahua leopard frogs at sites within the affected MAs (see also FS-BR-05 in the FEIS).

5. The USFS shall ensure that the proponent adheres to any Reasonable or Prudent Measures and Terms and Conditions, outlined for the northern Mexican gartersnake, which pertain to the harmful nonnative species removal program.

6. The FS shall ensure that Rosemont monitors groundwater levels (as a surrogate for take of Chiricahua leopard frog from effects of groundwater withdrawal) at least annually (FEIS mitigation measure FS-BR-27). This is equivalent to Reasonable and Prudent Measure 1 for the Gila Chub.

The USFS and Corps shall ensure that the proponent adheres to any Reasonable or Prudent Measures, outlined for the northern Mexican gartersnake, which pertain to the Harmful Nonnative Species Removal and Management Program (which provides equal benefit to the Chiricahua leopard frog, Gila topminnow, Gila chub, desert pupfish, and to a lesser extent, Huachuca Water Umbel).

Terms and Conditions - Chiricahua Leopard Frog

In order to be exempt from the prohibitions of section 9 of the Act, the USFS and Corps shall ensure that Rosemont complies 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 USFS and Corps shall ensure that Rosemont monitors potential Chiricahua leopard frog breeding habitat on National Forest System and Rosemont-owned land within one mile of the active operations area, including (but not limited to) on-site stormwater ponds, twice monthly from July 1 through September 30, while the mine is in operation. The one-mile monitoring criterion is based on the species' overland dispersal distance (see Status of the Species, above). If Chiricahua leopard frogs are detected on site or within a mile of the active operations area, they will be relocated to suitable habitat within the Chiricahua leopard frog

recovery MA under close coordination with the FWS. This Term and Condition augments Conservation Measures 2 and G-3 (3.1-3.6) with respect to Chiricahua leopard frogs. See also FEIS Mitigation Measure BR-11. This Term and Condition implements Reasonable and Prudent Measure 1.

2. Consistent with FEIS mitigation measure FS-BR-11, the USFS and Corps shall ensure that Rosemont explores alternatives to traditional stormwater pond construction, operation, etc. in order to minimize water holding duration to the maximum extent practicable without compromising the primary function of the ponds; this is to reduce the creation and maintenance of habitat in the active operations area that could become an attractive nuisance for frogs. This Term and Condition replaces Conservation Measure G-7 for Chiricahua leopard frogs. See also FEIS Mitigation Measures BR-03 and BR-11. This Term and Condition implements Reasonable and Prudent Measure 2.

3. Refer to Term and Condition 2 for Gila chub for the implementation of Reasonable and Prudent Measure 3 for the Chiricahua leopard frog. In addition, the USFS and Corps shall ensure that Rosemont records a restrictive covenant for Sonoita Creek Ranch stating that it will not be managed as a recovery site for Chiricahua leopard frogs unless bullfrogs are eradicated within a 7-mile radius of the created wetlands. This Term and Condition augments the Conservation Measure pertaining to the acquisition and subsequent management of the Sonoita Creek Ranch. This Term and Condition supersedes Chiricahua leopard frog Term and Condition 4 from the October 30, 2013, Final BO.

4. The USFS and Corps shall ensure that Rosemont coordinates with the FWS in the identification and location of the seven lentic sites to be improved for Chiricahua leopard frog conservation (see the Water Source Enhancement and Mitigation subsection of the Description of the Proposed Action and Chiricahua Leopard Frog Term and Condition 5 in the October 30, 2013, Final BO). These sites may or may not include particular sites referenced in the conservation measures of the Biological Assessment, may or may not be located on grazing allotments managed by Rosemont, but will be located on Coronado National Forest lands within the Santa Rita Management Area. We encourage that sites within the Empire Management Unit also be considered to the extent acceptable to those responsible for compliance with these terms and conditions (see Conservation Recommendation 4 below). 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 coordination with the local recovery group (consisting of private, state, and Federal partners) to facilitate avoiding incidental adverse effects or to create conservation opportunities. This Term and Condition augments or replaces several Conservation Measures proposed, including Conservation Measures 4 and 5 (pages 47-48) from the February 2013, second supplemental BA. This Term and Condition implements Reasonable and Prudent Measure 4.

5. Reasonable and Prudent Measure 5 does not require an implementing Term and Condition.

6. Refer to the Terms and Conditions 1.1 through 1.5 for the Gila chub for the implementation of Reasonable and Prudent Measure 6 for the Chiricahua leopard frog. This Term and Condition implements Reasonable and Prudent Measure 6.

These Reasonable and Prudent Measures, with their implementing Terms and Conditions, are designed to minimize the effects of incidental take that might 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 and/or Corps 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 and/or reinitiation of consultation.

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 recovery actions as described within the Chiricahua Leopard Frog Recovery Plan (FWS 2007).

2. We recommend the Coronado National Forest work with FWS (in coordination with other wildlife agencies) 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 4. 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.

4. We recommend the Coronado National Forest also consider implementation of Term and Condition 4 above in the Empire Management Unit where indirect effects of the action are the most significant although not under the management jurisdiction of the Forest Service itself.

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.

NORTHERN MEXICAN GARTERSNAKE

Status of the Species

The Federal Register notice listing the northern Mexican gartersnake as threatened under the Act was published on July 8, 2014 (79 FR 38678). Please refer to this rule for more in-depth information on the ecology and threats to the species, including references. Critical habitat was proposed on July 10, 2013 (78 FR 41500) and has not yet been designated. We expect to publish a modified re-proposal for critical habitat and an accompanying Notice of Availability announcing the draft Environmental Assessment and draft Economic Analysis in 2016. Details on critical habitat are provided below. The final listing and proposed critical habitat rules are incorporated herein by reference.

The northern Mexican gartersnake, which reaches up to 44 inches total length, ranges in color from olive to olive-brown or olive-gray with three lighter-colored stripes that run the length of the body, the middle of which darkens towards the tail. It may occur with other native gartersnake species and can be difficult for people without specific expertise to identify because of its similarity of appearance to other native gartersnake species.

Throughout its rangewide distribution, the northern Mexican gartersnake occurs at elevations from 130 to 8,497 ft (Rossman *et al.* 1996) and is considered a "terrestrial-aquatic generalist" by Drummond and Marcías-García (1983). The northern Mexican gartersnake is often found in riparian habitat, but has also been found hiding under cover in grassland habitat up to a mile away from any surface water (Cogan 2015). The subspecies has historically been associated with three general habitat types: 1) source-area wetlands (e.g., Cienegas or stock tanks); 2) large-river riparian woodlands and forests; and 3) streamside gallery forests (Hendrickson and Minckley 1984, Rosen and Schwalbe 1988). Emmons and Nowak (2013) found this subspecies most commonly in protected backwaters, braided side channels and beaver ponds, isolated pools near the river mainstem, and edges of dense emergent vegetation that offered cover and foraging opportunities. In the northern-most part of its range, the northern Mexican gartersnake appears to be most active during July and August, followed by June and September.

The northern Mexican gartersnake is an active predator and is thought to heavily depend upon a native prey base (Rosen and Schwalbe 1988). Northern Mexican gartersnakes forage along vegetated stream banks, searching for prey in water and on land, using different strategies (Alfaro 2002). Primarily, its diet consists of amphibians and fishes, such as adult and larval (tadpoles) native leopard frogs, as well as juvenile and adult native fish (Rosen and Schwalbe 1988), but earthworms, leeches, lizards, and small mammals are also taken. In situations where native prey species are rare or absent, this snake's diet may include nonnative species, including larval and juvenile bullfrogs, western mosquitofish (Holycross *et al.* 2006, Emmons and Nowak 2013), or other nonnative fishes. In northern Mexican gartersnake populations where the prey base is skewed heavily towards harmful nonnative species, recruitment of gartersnakes is often diminished or nearly absent.

Natural predators of the northern Mexican gartersnake include birds of prey, other snakes, wading birds, mergansers, belted kingfishers, raccoons, skunks, and coyotes (Rosen and

Schwalbe 1988, Brennan *et al.* 2009). Historically, large, highly predatory native fish species such as Colorado pikeminnow may have preyed upon northern Mexican gartersnakes where they co-occurred. Native chubs in their largest size class may also prey on neonatal gartersnakes, but this has not been confirmed in the literature or through field observation.

Sexual maturity in northern Mexican gartersnakes occurs at two years of age in males and at two to three years of age in females (Rosen and Schwalbe 1988). Northern Mexican gartersnakes are viviparous (bringing forth living young rather than eggs). Mating has been documented in April and May followed by the live birth of between 7 and 38 newborns in July and August (Rosen and Schwalbe 1988, Nowak and Boyarski 2012).

The northern Mexican gartersnake historically occurred in every county and nearly every subbasin within Arizona, from several perennial or intermittent creeks, streams, and rivers as well as lentic wetlands such as Cienegas, ponds, or stock tanks (Rosen and Schwalbe 1988, Rosen *et al.* 2001; Holycross *et al.* 2006; see Figure NMGA-1). In New Mexico, the gartersnake had a limited distribution that consisted of scattered locations throughout the Upper Gila River watershed in Grant and western Hidalgo Counties (Price 1980, Fitzgerald 1986, Degenhardt *et al.* 1996, Holycross *et al.* 2006). Within Mexico, northern Mexican gartersnakes historically occurred within the Sierra Madre Occidental and the Mexican Plateau, comprising approximately 85 percent of the total rangewide distribution of the subspecies (Rossman *et al.* 1996).

The only viable northern Mexican gartersnake populations in the United States where the subspecies remains reliably detected are all in Arizona: 1) The Page Springs and Bubbling Ponds State Fish Hatcheries along Oak Creek; 2) lower Tonto Creek; 3) the upper Santa Cruz River in the San Rafael Valley; 4) the Bill Williams River; and, 5) the middle/upper Verde River. In New Mexico and elsewhere in Arizona, the northern Mexican gartersnake may occur in extremely low population densities within its historical distribution; limited survey effort is inconclusive to determine extirpation of this highly secretive species. The status of the northern Mexican gartersnake on tribal lands, such as those owned by the White Mountain or San Carlos Apache Tribes, is poorly understood. Less is known about the current distribution of the northern Mexican gartersnake in Mexico due to limited surveys and limited access to information on survey efforts and field data from Mexico.

We have concluded that in as many as 23 of 33 known localities in the United States (70 percent), the northern Mexican gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated. Only five populations of northern Mexican gartersnakes in the United States are considered likely viable where the species remains reliably detected. Harmful nonnative species are a significant concern in almost every northern Mexican gartersnake locality in the United States and the most significant reason for their decline. Harmful nonnative species can contribute to starvation of gartersnake populations through competitive mechanisms, and may reduce or eliminate recruitment of young gartersnakes through predation. Other threats include alteration of rivers and streams from dams, diversions, flood-control projects, and groundwater pumping that change flow regimes, reduce or eliminate habitat, and favor harmful nonnative species; and effects from climate change and drought (79 FR 38678).

Table NMGS-1: Current population status of the northern Mexican gartersnake in the United States

Row	Location	Last Record	Suitable Physical Habitat Present	Native Prey Species Present	Harmful Nonnative Species Present	Predicted Population Status
1	Gila River (NM, AZ)	2013	Yes	Yes	Yes	Likely low density
2	Spring Canyon (NM)	1937	Yes	Possible	Likely	Likely extirpated
3	Mule Creek (NM)	1983	Yes	Yes	Yes	Likely low density
4	Mimbres River (NM)	Likely early 1900s	Yes	Yes	Yes	Likely extirpated
5	Lower Colorado River (AZ)	2015	Yes	Yes	Yes	Likely low density
6	Bill Williams River (AZ)	2012	Yes	Yes	Yes	Likely viable
7	Big Sandy River (AZ)	2015	Yes	Yes	Likely	Likely low density
8	Santa Maria River (AZ)	2015	Yes	Yes	Likely	Likely low density
9	Agua Fria River (AZ)	1986	Yes	Yes	Yes	Likely low density
10	Little Ash Creek (AZ)	1992	Yes	Yes	Yes	Likely low density
11	Lower Salt River (AZ)	1964	Yes	Yes	Yes	Likely extirpated
12	Black River (AZ)	1982	Yes	Yes	Yes	Likely low density
13	Big Bonito Creek (AZ)	1986	Yes	Yes	Yes	Likely low density
14	Tonto Creek (AZ)	2005	Yes	Yes	Yes	Likely viable
15	Upper /Middle Verde River (AZ)	2012	Yes	Yes	Yes	Likely viable
16	Oak Creek (AZ) (Page Springs and Bubbling Ponds State Fish Hatcheries)	2015	Yes	Yes	Yes	Likely viable
17	Spring Creek (AZ)	2014	Yes	Yes	Yes	Likely low density
18	Sycamore Creek (Yavapai/Coconino Co., AZ)	1954	Yes	Possible	Yes	Likely extirpated
19	Upper Santa Cruz River/San Rafael Valley (AZ)	2015	Yes	Yes	Yes	Likely viable
20	Redrock Canyon/Cott Drainage (AZ)	2008	Yes	Yes	Yes	Likely low density
21	Sonoita Creek (AZ)	2013	Yes	Possible	Yes	Likely low density
22	Scotia Canyon (AZ)	2009	Yes	Yes	No	Likely low density
23	Parker Canyon (AZ)	1986	Yes	Possible	Yes	Likely low density
24	Las Cienegas NCA and Cienega Creek Natural Preserve (AZ)	2015	Yes	Yes	No	Likely low density
25	Lower Santa Cruz River (AZ)	1956	Yes	Yes	Yes	Likely extirpated
26	Buenos Aires National Wildlife Refuge (AZ)	2000	Yes	Yes	Yes	Likely low density
27	Brown Canyon (AZ)	2014	Yes	Yes	No	Likely low density
28	Fort Huachuca (AZ)	1994	Yes	Yes	Yes	Likely low density
29	Bear Creek (AZ)	1987	Yes	Yes	Yes	Likely low density
30	San Pedro River (AZ)	1996	Yes	Yes	Yes	Likely low density
31	Babocomari River and Cienega (AZ)	1986	Yes	Possible	Yes	Likely low density
32	Canelo Hills-Sonoita Grasslands Area (AZ)	2015	Yes	Yes	Yes	Likely low density
33	San Bernardino National Wildlife Refuge (AZ)	1997	Yes	Yes	Yes	Likely low density

Notes: "Possible" means there were no conclusive data found. "Likely extirpated" means the last record for an area pre-dated 1980, and existing threats suggest the species is likely extirpated. "Likely low density" means there is a post-1980 record for the species, it is not reliably found with minimal to moderate survey effort, and threats exist which suggest the population may be low density or could be extirpated, but there is insufficient evidence to support extirpation. "Likely viable" means that the species is reliably found with minimal to moderate survey effort, and that the population is generally considered to be somewhat resilient.

Critical Habitat

Critical habitat for the northern Mexican gartersnake has been proposed in 14 units in portions of Arizona and New Mexico totaling 421,423 acres. Within these areas, the primary constituent elements (PCEs) of the physical and biological features essential to northern Mexican gartersnake conservation are:

1. Aquatic or riparian habitat that includes:
    a. Perennial or spatially intermittent streams of low to moderate gradient that possess appropriate amounts of in-channel pools, off-channel pools, or backwater habitat, and that possess a natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of processing sediment loads; or
    b. Lentic wetlands such as livestock tanks, springs, and Cienegas; and
    c. Shoreline habitat with adequate organic and inorganic structural complexity to allow for thermoregulation, gestation, shelter, protection from predators, and foraging opportunities (e.g., boulders, rocks, organic debris such as downed trees or logs, debris jams, small mammal burrows, or leaf litter); and
    d. Aquatic habitat with characteristics that support a native amphibian prey base, such as salinities less than 5 parts per thousand, pH greater than or equal to 5.6, and pollutants absent or minimally present at levels that do not affect survival of any age class of the gartersnake or the maintenance of prey populations.
2. Adequate terrestrial space (600 ft lateral extent to either side of bankfull stage) adjacent to designated stream systems with sufficient structural characteristics to support life-history functions such as gestation, immigration, emigration, and brumation.

3. A prey base consisting of viable populations of native amphibian and native fish species.

4. An absence of nonnative fish species of the families Centrarchidae and Ictaluridae, bullfrogs, and/or crayfish (*O. virilis, P. clarki*, etc.), or occurrence of these nonnative species at low enough levels such that recruitment of northern Mexican gartersnakes and maintenance of viable native fish or soft-rayed, nonnative fish populations (prey) is still occurring.

The action area for this project overlaps two proposed critical habitat units, the Cienega Creek Subbasin Unit and the Upper Santa Cruz River Subbasin Unit.

The Cienega Creek Subbasin Unit, which contains a combined 50,393 acres of proposed critical habitat within three subunits, the Cienega Creek Subunit, the Las Cienegas NCA Subunit, and the Cienega Creek Natural Preserve Subunit. This proposed unit is uniquely important for the northern Mexican gartersnake because it is the only unit in southern Arizona that provides an intact native prey base and is currently free of harmful nonnative species. Only one other area proposed for designation as critical habitat in Arizona or New Mexico boasts similar attributes, the Spring Creek Subunit, within the Verde River Subbasin Unit in central Arizona which is

isolated from northern Mexican gartersnake populations in southern Arizona.

In the Las Cienegas NCA Subunit, we have also proposed to designate critical habitat for a total of 45,020 acres of springs, seeps, streams, stock tanks, and terrestrial space in between these features within the Las Cienegas NCA, including portions of Cienega Creek and upper Empire Gulch that occur within the boundary of the Las Cienegas NCA. Native fish and both Chiricahua and lowland leopard frog populations provide prey for northern Mexican gartersnakes, and ongoing bullfrog eradication has eliminated bullfrogs in the area, and reduces the threat of bullfrogs returning to this subunit. This subunit currently contains sufficient physical or biological features, including all PCEs, but will require special management to maintain or develop the physical or biological features, including preventing the invasion or reinvasion of bullfrogs from adjacent watersheds.

The Cienega Creek Natural Preserve Subunit includes the proposal to designate critical habitat for a total of 4,260 acres of springs, seeps, streams, stock tanks, and terrestrial space in between these features within the Cienega Creek Natural Preserve in Pima County, Arizona, including the reach of Cienega Creek that occurs within the Cienega Creek Natural Preserve. The Cienega Creek Natural Preserve is owned and managed by Pima County. Native fish and lowland leopard frog populations provide prey for northern Mexican gartersnakes, and ongoing bullfrog eradication in the area has eliminated them within this subunit. This subunit contains sufficient physical or biological features, including all PCEs but special management will be required to maintain or develop the physical or biological features, including preventing the invasion or reinvasion of bullfrogs. This subunit is being considered for exclusion from the final rule for critical habitat under section 4(b)(2) of the Act due to its conservation and management plan for native species.

Within the Cienega Creek Subunit, and between the Las Cienegas NCA and Cienega Creek Natural Preserve subunits, we have also proposed to designate 1,113 acres of critical habitat along 7.1 stream miles of Cienega Creek, from the northern boundary of the Las Cienegas NCA to the southern boundary of Cienega Creek Natural Preserve in Pima County, Arizona. The Cienega Creek Subunit occurs on lands managed by the Arizona State Land Department in addition to a small amount of private land. Native fish and both Chiricahua and lowland leopard frog populations provide prey for northern Mexican gartersnakes, and recent, ongoing bullfrog eradication in the area reduces the threat of bullfrogs within this subunit. This subunit contains sufficient physical or biological features, including all PCEs. However, special management may be required to maintain or develop the physical or biological features, including preventing the invasion or reinvasion of bullfrogs.

The Cienega Creek Subbasin Unit was proposed as critical habitat for the northern Mexican gartersnake because it was occupied at the time of listing and contained sufficient physical or biological features to support life-history functions essential for the conservation of the species. We expect the physical or biological features in this unit will require special management consideration due to ongoing and regional threat of bullfrogs from adjacent watersheds.

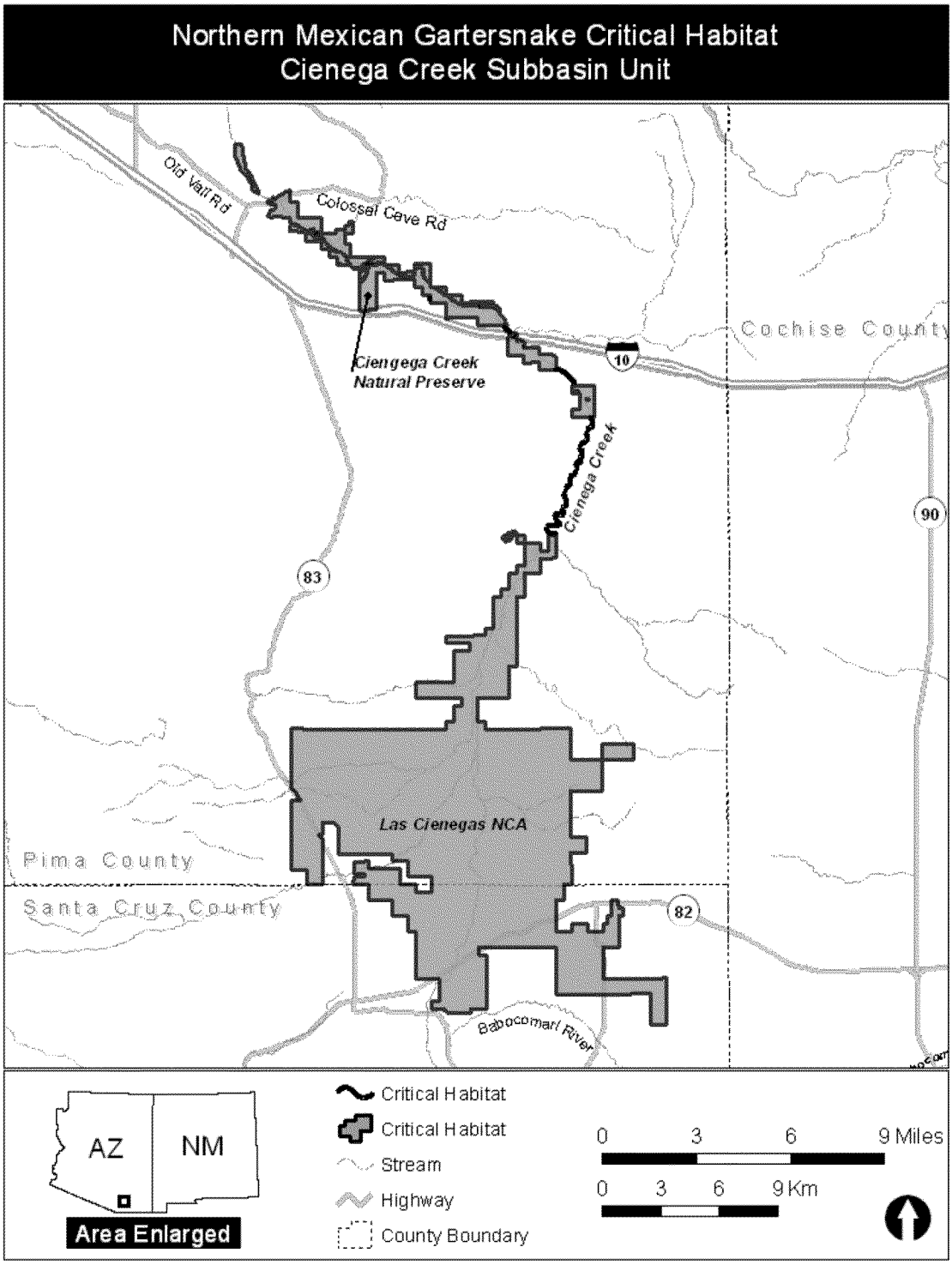


Figure NMGS-1: Map of Cienega Creek Subbasin Unit proposed for designation as critical habitat.

Upper Santa Cruz River Subbasin Unit

The Upper Santa Cruz River Subbasin Unit is generally located in southeastern Arizona, east of Nogales, southeast of Patagonia, and southwest of Sierra Vista, in the San Rafael Valley, in Santa Cruz and Cochise Counties, Arizona. This unit consists of springs, seeps, streams, stock tanks, and terrestrial space (overland areas) in between these features within a total of 113,895 acres (46,092 ha) of proposed critical habitat in the San Rafael Valley, including portions of Parker and Scotia canyons of the Huachuca Mountains, Arizona. For the streams within this unit, we are proposing the reach of Parker Canyon that includes 5.8 stream mi (9.3 km) from Duquesne Road south of Loop Road, upstream to and including Parker Canyon Lake. The reach of Scotia Canyon we are proposing as critical habitat includes 3.7 stream mi (5.9 km) from its confluence with an unnamed drainage at the junction with Bodie Canyon, upstream to its origin west of the Coronado National Forest-Fort Huachuca Boundary. The upper Santa Cruz River occurs within the San Rafael Valley, flowing south into Mexico. We are proposing 13.8 stream mi (22.2 km) of the upper Santa Cruz River, from the International Border, upstream to its headwaters at the top of Sheep Ridge Canyon. The Upper Santa Cruz River Subbasin Unit occurs on lands primarily managed by the Coronado National Forest, with remaining land management under the Arizona State Parks Department. This unit also contains private lands. All identified areas described in this unit have records for northern Mexican gartersnakes, and all identified areas are considered as being currently within the geographical area occupied by the species. Therefore, we are proposing this unit under section 3(5)(A)(i) of the Act because it is occupied by the species and because it contains sufficient amounts of the essential physical or biological features that may require special management considerations or protection.

This unit contains adequate populations of Chiricahua and lowland leopard frogs, as well as native fish species in various locations and densities, with the former being actively recovered in Scotia Canyon. Bullfrogs and nonnative, spiny-rayed fish are also known to occur at various densities within this unit, and Parker Canyon Lake is managed as a warm-water sport fishery. Crayfish are also likely to occur in various locations and densities within this unit. Within this unit, PCEs 1 (aquatic habitat characteristics), 2 (terrestrial habitat characteristics) and 3 (prey base) are generally met, but PCE 4 (absence or low level of harmful nonnative species) is deficient. Special management may be required to maintain or develop the physical or biological features, including continuing to promote the recovery or expansion of native leopard frogs and fish, and eliminating or reducing harmful nonnative species. The San Rafael Ranch is being considered for exclusion from the final rule for critical habitat under section 4(b)(2) of the Act (see *Application of Section 4(b)(2) of the Act* section below).

The Upper Santa Cruz River Subbasin Unit is proposed as critical habitat for the northern Mexican gartersnake because it was occupied at the time of listing and contains sufficient physical or biological features to support life-history functions essential for the conservation of the species. The physical or biological features in this unit may require special management consideration due to competition with, and predation by, harmful nonnative species that are present in this unit and potential effects from future high-intensity wildfires.

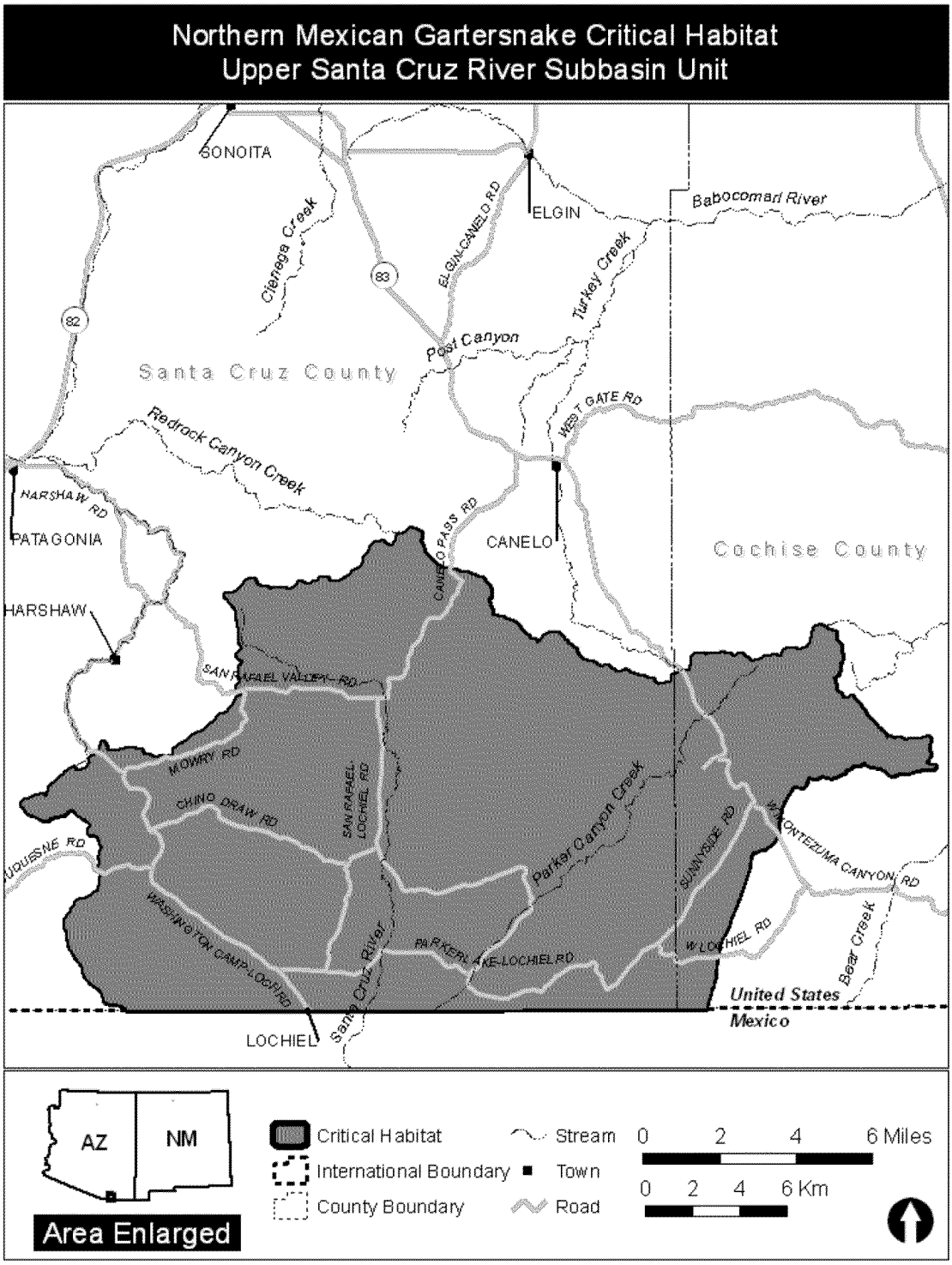


Figure NMGS-2: Map of Upper Santa Cruz River Subbasin Unit proposed for designation as critical habitat.

Status of the Species within the Action Area

Las Cienegas National Conservation Area and Cienega Creek Natural Preserve—Several records for the northern Mexican gartersnake in the Las Cienegas NCA and Cienega Creek Natural Preserve have been documented in the literature, predominantly from Cienega Creek, the first dating to 1986 (Rosen and Schwalbe 1988, Appendix I). Cienega Creek maintains perennial surface flow in two reaches; from its headwaters to just downstream of "the Narrows;" and from the confluence with Mescal Wash to just downstream of the Colossal Cave Road crossing in Vail, Arizona. The upper portion of the creek has historically been occupied by bullfrogs, but continues to support a native fish community, as well as both Chiricahua and lowland leopard frogs (Rosen *et al.* 2001, Appendix I). The lower perennial portion of Cienega Creek runs through Pima County's 3,979 acre Cienega Creek Natural Preserve for approximately 12 river miles. This reach supports a native fish community (Timmons *et al.* 2013, Table 1), including Gila chub and longfin dace as well as lowland leopard frogs (Caldwell 2014, entire), although there is a persistent threat of bullfrog invasion from a nearby house pond that continues to contribute immigrant bullfrogs to Cienega Creek. Despite this source, bullfrog numbers have remained somewhat low in recent years (Caldwell 2012, pers. comm.). In addition to Cienega Creek, the Las Cienegas NCA supports several tanks, springs, and wetlands that provide physically suitable northern Mexican gartersnake habitat and that may be used by northern Mexican gartersnakes sporadically as they emigrate from Cienega Creek and explore new foraging opportunities in the area. According to GIS analysis, Mattie Canyon, a tributary of Cienega Creek also supports suitable northern Mexican gartersnake habitat as a well as a native prey base.

In 2007 and 2008, more than 2,300 trap-hours were required per snake captured in this area (Caldwell 2008a, pers. comm.; 2008b, pers. comm.; Servoss *et al.* 2007, p. 1–12), compared with Rosen and Caldwell (2004, p. 21, Table 2) capture rates of 561 trap-hours per snake in this same area in 2002 and 2003; more than a four-fold increase in the effort needed to capture northern Mexican gartersnakes. In 2011, the capture rate was 3,167 trap-hours per capture (Hall 2012). These capture rate data point to increasing rarity over time which historically mirrored area declines in leopard frogs and may be exacerbated to some degree by continued bullfrog eradication efforts which may reduce the prey base for adult gartersnakes. As a recovery cooperator, the Arizona –Sonora Desert Museum (ASDM) has been successfully propagating northern Mexican gartersnakes in captivity since 2011 and releases of captive-bred snakes occurred in 2012, 2014, and 2015. Although no follow-up surveys have been conducted in areas where the releases occurred, one individual from the 2015 release was observed and captured several months later slightly downstream of its release point in Cienega Creek. Regardless, conservation and recovery efforts for native aquatic species in this area have reduced the influence of harmful nonnative species and provide a net-positive effect on the areas aquatic communities. Bullfrog surveys in 2015 confirm their absence from the Las Cienegas NCA (Hall *et al.* 2015); crayfish persist in Cline Pond/Spring in the extreme southeastern portion of the Las Cienegas NCA. Mosquitofish, while not present in Cienega Creek, are frequently used as mosquito control on private property and are known to currently occur in the adjacent Santa Rita Mountains and Elgin/Sonoita regions and pose a consistent threat to Cienega Creek. Recent records and recovery efforts confirm the northern Mexican gartersnake still exists in within Cienega Creek and surrounding lands, but existing information based on incidental observations

without current surveys suggests the population exists as a low density population that appears to remain unstable.

Table NMGS-2 (Section 1 of 5): Santa Cruz River Subbasin: Las Cienegas NCA and Cienega Creek Natural Preserve (Arizona)			
Record Year	**Locality Descriptor**	**Reference**	**Notes**
1986	At Cienega Ranch; 35 mi SE Tucson	Rosen and Schwalbe 1988, Appendix I	Two adults
1994	R17E, T19S	Holycross *et al.* 2006; Appendix A	
1996	Cienega Creek at main perennial headwater	Rosen *et al.* 2001; Appendix I	Juvenile; dead
1997	Cienega Creek County Preserve; Nad 83 535113/354197	Caldwell 2012	
1999	UTM 536600, 3541200, S 1/2 Sec 28, T16S, R17E	Holycross *et al.* 2006; Appendix A	
2000	Cienega Creek at main perennial headwater	Rosen *et al.* 2001; Appendix I	Adult
2001	Cienega Creek County Preserve; Nad 83 535825/354952	Caldwell 2012	
2011	Las Cienegas NCA	Hall 2012	Five adults; two subadults
2012		FWS Files	40 captive-bred juveniles from ASDM released; cautery-marked
2014			36 captive-bred animals from ASDM released; Empire Wildlife Pond (5 subadults/ 6 juveniles), the Maternity Wildlife Pond (2 subadults/ 6 juveniles), and upper Cienega Creek (2 subadults/ 15 juveniles)
2014	Cienega Creek County Preserve	Caldwell 2014, pp. 1-2	One adult; one juvenile
2015	Las Cienegas NCA	Crawford 2015	19 captive-bred individuals from ASDM released; 12 near Cold Spring at the confluence with Mattie Canyon and 7 in the Cienega Creek headwaters area
Predicted Population Status: Likely low density			

Status of Prey Communities in the Las Cienegas NCA: Ranid Frogs

Numerous sites historically and currently support Chiricahua leopard frogs on the Las Cienegas NCA, including Cinco Well Wildlife Pond, Cottonwood Wildlife Pond, Empire Well Wildlife

Pond, Gaucho Wildlife Pond, Maternity Well Wildlife Pond, Road Canyon Wildlife Pond, Spring Water Wetlands, and Cienega Creek at Cold Spring, which produced a large cohort of young leopard frogs in 2015 (Hall *et al.* 2015). These sites represent areas where frogs were introduced, re-established by dispersal, or in a single locale, naturally persisted. Chiricahua leopard frogs were also confirmed in 2015 within two reaches of Cienega Creek (headwaters reach and Mattie Canyon reach) where they naturally dispersed into from other sites (Hall *et al.* 2015). Downstream of these reaches is the Narrows reach. Within this reach, a lowland leopard frog population persists and appears to be growing (Hall *et al.* 2015; Akins 2016b). Survey information as of April 2016, show lowland leopard frogs continue to advance upstream in Cienega Creek, having move approximately two stream miles from the Narrows reach into the Cold Spring reach and occur in slightly less than equal numbers as Chiricahua leopard frogs (Hall 2016b).

Historically, the stable source population for the Chiricahua leopard frog metapopulation in the Las Cienegas NCA is at Empire Spring within upper Empire Gulch, about 4 miles upstream of Cienega Creek. This is a historic population that has persisted since at least the 1990's, and has increased in recent years, numbering from below 10 individuals to over 100 currently (Hall *et al.* 2015). Water temperatures at this site are remarkably stable throughout the year, which is thought to be the key variable in this population's ability to persist in the presence of the *Bd* disease pathogen (Hall *et al.* 2015).

Chiricahua leopard frog reproduction was confirmed in 2015 at many of the aforementioned sites in the Las Cienegas NCA. This led to significant dispersal activity to and within Cienega Creek, and several other sites within or adjacent to the Las Cienegas NCA (Hall *et al.* 2015). Outside of Cienega Creek, sites that received dispersed frogs include Rattlesnake Tank, Karen's Tank, Clyne Pond, Cieneguita Wetlands (all 3 ponds), Bill's Tank, HQ Corral Pond, Cinco Well Wildlife Drinker, Lane Tank, Road Grate above Empire Spring, Bills Turnoff Small Tank, Oil Well Tank, and Borrow Pit (Gaucho) (Hall *et al.* 2015).

Frog populations in the Las Cienegas NCA are vulnerable to disease-related die-offs. The latest mass mortality event related to Bd occurred during the 2014-2015 winter (Hall *et al.* 2015); winter months are often when Bd outbreaks are most significant in native ranid frogs (Hyman and Collins 2015). Specifically, severe Chiricahua frog die-offs were observed in November and December of 2014 in all populations except for those at Empire Spring, Cold Spring, and Headwaters Reach, where temperatures are stabilized by spring flow (Hall *et al.* 2015). Of these three sites, only frogs Empire Spring experienced zero winter-disease mortality (Hall *et al.* 2015). Therefore, from a metapopulation persistence perspective, Empire Spring is critically important for Chiricahua leopard frogs in the Las Cienegas NCA as it is the only site that has been resistant to Bd die-offs in this area.

Status of Prey Communities in the Las Cienegas NCA: Native Fish

Four species of native fish are known from Cienega Creek: Gila chub, Gila topminnow, desert pupfish, and longfin dace (*Agosia chrysogaster*). Longfin dace will not be specifically addressed in this biological opinion although they are considered an important component to the northern Mexican gartersnake prey base within the action area, have similar ecology to the other native

fish discussed, and will therefore be affected similarly by indirect effects of groundwater drawdown from the proposed action.

Of the five extant populations of Gila chub within the Santa Cruz watershed, only the Cienega Creek population is considered stable-secure. The other four populations are considered unstable-threatened. Within the Las Cienegas NCA, Gila chub are distributed and continue to be abundant throughout upper Cienega Creek (Rosen *et al.* 2013; Simms 2014d, Simms and Ehret 2014) and have made a steady comeback in lower Mattie Canyon after a failure of a grade-control structure resulted in heavy sedimentation and erosion. Where Gila chub occupy pool and backwater habitat, they provide an important source of prey for resident northern Mexican gartersnakes. Gila chub do not occur in upper Empire Gulch, nor in any stock tank or wildlife pond on the Las Cienegas NCA (Ehret and Simms n.d., Simms 2013).

The population of Gila topminnow in the Las Cienegas NCA demonstrably represents the largest natural population in the United States and the only extant one on Federal land (Simms and Simms 1992, Bodner *et al.* 2007) where the species continues to remain abundant within upper Cienega Creek (Rosen *et al.* 2013; Simms 2014d, Simms and Ehret 2014) and to a lesser extent, lower Cienega Creek (Bodner *et al.* 2007). Gila topminnow populations above and below the Spring Canyon confluence with Cienega Creek may face drastically different futures. Hatch (2015) found that above the Spring Canyon confluence, Gila topminnow have a 0.01 percent chance of extirpation at some point in the future, whereas downstream of the Spring Canyon confluence, Gila topminnow have a 96 percent chance of extirpation. Since 2013, several lentic sites have received Gila topminnow as part of an effort intended to create, enhance, and protect habitat for at-risk species within the Las Cienegas NCA, including Cottonwood Tank, Cieneguita Wetland, and Gaucho Tank. We have records documenting northern Mexican gartersnakes using these specific tanks, but there have not been any targeted surveys either.

Desert pupfish are extant in the Las Cienegas NCA, but only in lentic habitat; they are not extant in Cienega Creek. Several releases of desert pupfish have occurred on the Las Cienegas NCA in recent years, the first occurring at Road Canyon Wildlife Pond in 2012, with the release of 656 individuals. Subsequent to that event there were seven releases in 2013, including at Cinco Canyon Wildlife Pond (n=250), Cottonwood Wildlife Pond (n=269), Empire Wildlife Pond (n=299), Cieneguita Wetland Pond #3 (n=290) and #4 (n=240), Antelope Wildlife Pond (n=257), and Bald Hill Wildlife Pond (n=263). Future releases at Gaucho Wildlife Pond, Maternity Wildlife Pond, Oil Well Wildlife Pond, Bill's Wildlife Pond, Clyne Pond, and Apache Spring Wildlife Pond are pending. To date, none of these populations have become extirpated and some are thriving. Only the populations in Cieneguita Wetland Ponds #3 and #4 are anticipated to be affected by the proposed action.

Several factors have affected, or could affect, native fish habitat within the action area including water use, the risk of illegal releases of harmful nonnative species, livestock grazing, fire, and effects related to regional climate change. These factors are discussed in detail elsewhere in this biological opinion where addressed for native fish. For more detail on the status of native fish species within the action area and predicted effects to native fish populations as a result of the proposed action, we encourage further review of discussion under the species sub-headers, Gila Chub, Gila Topminnow, and Desert Pupfish.

Sonoita Creek—Three records of northern Mexican gartersnakes from 1954 to 2013 document the northern Mexican gartersnake in Sonoita Creek (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A; Bookwalter 2014, pers. comm.). Turner (2007, pp. 1–5) found no northern Mexican gartersnakes in a 204 person-search-hour, 5,472 trap-hour survey effort in the Sonoita Creek State Natural Area. Crayfish, bullfrogs, and nonnative fish were observed by Turner (2007, p. 41) which likely emigrate from Patagonia Lake from which Sonoita Creek feeds. The length of time since the last records for northern Mexican gartersnakes as well as the persistent influence of harmful nonnative species supported by Patagonia Lake suggest the subspecies likely occurs at a very low density in Sonoita Creek.

Table NMGS-2 (Section 2 of 5) Santa Cruz River Subbasin: Sonoita Creek (Arizona)			
Record Year	**Locality Descriptor**	**Reference**	**Notes**
1954	Patagonia vicinity	Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A	
1974	3 mi SW of Patagonia on AZ Route 82		
2013	On trail where it's closest to creek; TNC's Patagonia-Sonoita Creek Preserve	Bookwalter 2014, pers. comm.	Sub-adult
Predicted Population Status: Likely low density			

Upper Santa Cruz River/San Rafael Valley Subbasin—Several recent and historical records document the northern Mexican gartersnake (neonates and adults) from tanks and springs within the San Rafael Valley, as well as the upper Santa Cruz River, confirming that the northern Mexican gartersnake is using various wetland habitats in the San Rafael Valley, and that reproduction is occurring. Recruitment rates within the population appear to be low and more study is required to confirm. In 2012, the capture rate was one snake every 378.75 trap hours (Lashway 2012, p. 5). Additionally, low recapture rates of marked individuals could be cause for concern. Green sunfish and mosquitofish dominated fish sampling results in 2014 (Timmons 2014). Native fish, bullfrogs, and nonnative fish inhabit several wetland areas in the San Rafael Valley, including the upper Santa Cruz River (Rosen *et al.* 2001, p. 17, Appendix I). Sonoran tiger salamanders (*Ambystoma mavortium stebbinsi*) also contribute to the prey base of northern Mexican gartersnakes in this area. Photo-documentation from the years 1999, 2001, and 2005 from several photo points along the upper Santa Cruz River depicted in Stingelin *et al.* (2006, Figure 3.1) reflect a trend of less water and more vegetation along the upper Santa Cruz River in recent years.

The foraging ecology of northern Mexican gartersnakes and past records suggest individuals move throughout the San Rafael Valley as they seek to explore regional wetland habitats for prey. The upper Santa Cruz River likely serves as a source for these individuals. We consider the upper Santa Cruz River, as well as tanks, springs, and wetlands with physically suitable northern

Mexican gartersnake habitat, within the greater San Rafael Valley to be occupied by the northern Mexican gartersnake based on historical and recent records, as well as our understanding of the subspecies' foraging ecology. This population is considered likely viable.

Table NMGS-2 (Section 3 of 5) Santa Cruz River Subbasin: Upper Santa Cruz River/San Rafael Valley Subbasin (Arizona)			
Record Year	**Locality Descriptor**	**Reference**	**Notes**
1986	Bog Hole Wildlife Management Area	Rosen and Schwalbe 1988, Appendix I	Nine specimens
1958	Sharp Spring		
1975			
1986		Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A	
1985	Upper 13 Reservoir	Rosen and Schwalbe 1988, Appendix I	
1979	Parker Canyon; 13 mi SE of Parker Canyon Lake	Holycross *et al.* 2006, Appendix A	5 specimens
1975	Lochiel vicinity	Rosen *et al.* 2001, p. 17, Appendix I; Holycross *et al.* 2006, Appendix A	4 specimens
1977	Lochiel vicinity		
1958	Sharp Spring		
1975			
1986			
2000			
2012	Pasture 9 Tank	C. Akins 2012, pers. comm.	Neonate
2012	Forest Service 799 Tank	T. Jones 2012d, pers. comm.	Two specimens; adult male, adult female
2007		T. Jones 2012b, pers. comm.	Adult female
2006	Upper Santa Cruz River	Stingelin *et al.* 2006, Table 1.3	
2008		Stingelin *et al.* 2009, p. 33)	55 specimens; 51 specimens were adults, one was a juvenile, and three were neonates
2010		Rorabaugh 2010, pers. comm.	Adult

2012		Lashway 2012, p. 5	24 specimens; one recapture from Stingelin *et al.* (2009, p. 33) 2008 effort; 1 neonate of 24 specimens
2015		Lashway 2015	29 snakes captured; 3 recaptures from 2008 survey and 2 recaptures from 2012 survey; 11 males and 18 females captured
2014		Timmons 2014	Captured in fish trap (alive or dead unreported)
2013	Private pond in Corral Canyon	Jones 2013, pers. comm.	
Predicted Population Status: Likely viable			

Scotia Canyon—There are numerous records of the northern Mexican gartersnake from the Peterson Ranch Pond site in Scotia Canyon in the Huachuca Mountains from 1981 to 2009 (Rosen and Schwalbe 1988, Appendix I; Holm and Lowe 1995, Appendix B; Rosen *et al.* 2001, pp. 15–16, Appendix I; Holycross *et al.* 2006, Appendix A; Frederick 2008b pers. comm.; J. Servoss 2009, pers. obs.). Data generated from comparative trapping and survey efforts from 1980-1982, 1993, and 2008 suggest a marked decline in this population over the last 30 years. In 2008, a multi-agency, multi-year effort was initiated within a five mi (8 km) radius of Scotia Canyon, including the Peterson Ranch Ponds and vicinity, to eradicate bullfrogs and reestablish Chiricahua leopard frogs (Frederick 2008, pers. comm.; 2008b, pers. comm.). This effort included many surveys of herpetofauna (reptiles and amphibians) to identify the presence of bullfrogs for eradication and monitor the status of reintroduced Chiricahua leopard frogs. With the reintroduction of Chiricahua leopard frogs to the Peterson Ranch Ponds in 2009 and their subsequent reproduction in 2010, we expect the northern Mexican gartersnake population will persist, and possibly improve, due to improved availability of prey and reduced predation by harmful nonnative species.

Santa Cruz River Subbasin (Section 4 of 5): Scotia Canyon (Arizona)			
Record Year	**Locality Descriptor**	**Reference**	**Notes**
1981	Peterson Ranch site	Rosen and Schwalbe 1988, Appendix I; Holm and Lowe 1995, Appendix B	Three specimens
1982		Holm and Lowe 1995, Appendix B	Six specimens
1987	Scotia Canyon	Holycross *et al.* 2006, Appendix A	
1993	Peterson Ranch site	Holm and Lowe 1995, Appendix B	39 specimens
2000		Rosen *et al.* 2001, Table 4	Three specimens
2008		Frederick 2008b	Adult

2009		J. Servoss 2009, pers. obs.	Adult
Predicted Population Status: Likely low density			

Parker Canyon—Historical records for the northern Mexican gartersnake in Parker Canyon were from Parker Canyon Lake in 1967 (Holycross *et al.* 2006, Appendix A) and 1986 (Rosen and Schwalbe 1988, Appendix I) and from Parker Canyon in 1968 and 1979 (Holycross *et al.* 2006, Appendix A). We are not aware of any dedicated northern Mexican gartersnake survey effort in Parker Canyon. The only survey known for Parker Canyon Lake was the Rosen and Schwalbe (1988) effort in 1986 that consisted of 3 person-search hours. Parker Canyon Lake is managed as a put-and-take fishery for rainbow trout and channel catfish and also supports a self-sustaining warm water fishery including harmful predatory species such as largemouth bass, bluegill, redear sunfish, green sunfish, black bullhead, and northern pike (FWS 2011b, p. 10-10, 10-15). These nonnative species may spill into the canyon proper below the dam or move up into pools above the lake where they contribute to the extant nonnative fish population. Parker Canyon below Parker Canyon Lake dam is best described as a spatially intermittent stream with several pools. There is approximately one river mi (1.6 km) of permanent water below the dam, and then the channel is ephemeral for approximately 4.5 river mi (7.2 km) to another perennial reach approximately 0.25 river mi (0.4 km) in length. It then, once again, becomes ephemeral until it joins the upper Santa Cruz River in the San Rafael Valley. The perennial reach below the Parker Canyon dam contains bullfrogs, crayfish, and nonnative, predatory fish species. Lower Parker Canyon also maintained longfin dace as of 2003 (Stefferud and Stefferud 2004, p. 433). Individual northern Mexican gartersnakes may migrate into Parker Canyon from populations that occur in Scotia Canyon or the San Rafael Valley which suggests the subspecies could be extant in Parker Canyon, likely as a low density population.

Santa Cruz River Subbasin (Section 5 of 5): Parker Canyon (Arizona)			
Record Year	**Locality Descriptor**	**Reference**	**Notes**
1968	Parker Canyon	Holycross *et al.* 2006, Appendix A	
1979	13 mi SE of Parker Canyon Lake		Five specimens
1967	Parker Canyon Lake		
1986	NE end of Parker Canyon Lake	Rosen and Schwalbe 1988, Appendix I	100 feet from lake shore under rock
Predicted Population Status: Likely low density			

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following northern Mexican gartersnake-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

Effects of the Action

The effects discussed below are attributed to the proposed action which are in addition to, and operate within, the background of regional climate change as part of the environmental baseline. The action area for northern Mexican gartersnakes includes the Las Cienegas NCA, Cienega Creek downstream of the Las Cienegas NCA and through Pima County's Cienega Creek Natural Preserve, and Sonoita Creek Ranch (acquisition property).

Effects to Northern Mexican Gartersnakes

Indirect, adverse effects to northern Mexican gartersnakes from the proposed action are anticipated to occur during mining operations and after they cease, and will continue for decades. With the exception of drinking, gartersnakes do not specifically require water in their life cycle; they do not need water to breathe (*i.e.* fish) or as a critical medium for a developmental life stage (*i.e.* larval amphibians). The primary cause of adverse effects from the proposed action is the long-term, permanent degradation to the gartersnakes' prey community due to the adverse, indirect effects from a lowering groundwater table (and therefore truncated surface flows) associated with the Rosemont Mine, predominantly post-closure and in perpetuity. If a primary prey species becomes rare or extirpated, the resident northern Mexican gartersnake population may become less resilient over time as a result of population-level effects described below. The primary gartersnake prey species affected include ranid frogs (Chiricahua and lowland leopard frogs) and fish (Gila chub, desert pupfish, Gila topminnow, and longfin dace). These effects are

anticipated to occur in both spatial and temporal contexts for the northern Mexican gartersnake within the proposed Cienega Creek Subbasin Unit proposed as critical habitat. Therefore, these effects will force resident northern Mexican gartersnakes to use other areas within the action area that continue to support an adequate prey population. As a net result and over time, there are expected to be fewer acres of otherwise suitable habitat for the gartersnake to forage.

Over time, after mine closure, and as groundwater discharge and thus, surface flow, begins to slowly but permanently disappear in upper Empire Gulch and become diminished in several reaches of Cienega Creek, pool (or backwater) habitat within these drainages will incrementally lose permanency, depth, area, and water volume during the driest periods of each year (see effects analysis presented for fish for details). For prey species at affected by groundwater drawdown, we expect fewer reproduction opportunities and lower overall reproduction success, resulting in lower overall recruitment into adult age classes, lower overall population sizes, and increased vulnerability for extirpation due to disease, drought, fire, or other stochastic events. Smaller pool area and lower volume within pools affect water chemistry by increasing water temperatures which lower dissolved oxygen levels. Lowered dissolved oxygen will affect Gila chub populations disproportionately compared to small-bodied Gila topminnow or desert pupfish as the latter are better equipped to persist under low dissolved oxygen conditions as a result of their evolutionary biology. Ranid frogs in their larval stages are also adversely affected by low dissolved oxygen levels.

Gila chub, larval and metamorphosed ranid frogs are more important than Gila topminnow as prey for northern Mexican gartersnakes because they achieve larger sizes and therefore provide more caloric energy per capture. Therefore, exaggerated effects to chub and ranid frog populations will have exaggerated effects to the northern Mexican gartersnake population. The primary resultant effect to northern Mexican gartersnakes is starvation. Starvation in northern Mexican gartersnakes leads to many physiological effects at the individual and population levels. These effects include reduced fitness, slower growth rates, lower fecundity, lower survivorship, and lower recruitment of gartersnakes into the reproductive size classes within the population. Ultimately, the physiological effects of starvation increase stress levels of affected gartersnakes making them more susceptible to disease and parasitism and weakening their ability to forage and reproduce successfully.

We expect significant losses of northern Mexican gartersnakes as an indirect effect from the anticipated degradation and ultimate disappearance of Empire Spring. Empire Spring is considered extremely important for the Chiricahua leopard frog metapopulation in the Las Cienegas NCA (see above discussion under *Status of Prey Communities in the Action Area: Ranid Frogs*) because its relatively stable year-round water temperatures buffer the debilitating effects of Bd, allowing for continued of survival adult leopard frogs at the spring to disperse and recolonize other habitats in the area via metapopulation dynamics. If lost, this vital site would be unable to act as a source population of frogs for the area which greatly increases the odds of extirpation of this metapopulation, most notably in years with significant Bd outbreaks and subsequent die-offs. Drummond and Marcias-Garcia (1983) found that within a varied prey community, northern Mexican gartersnakes primarily feed on ranid frogs. The loss or significant degradation of the resident Chiricahua leopard frog metapopulation in the area, as a result of the loss of a critical source population, would place significant nutritional strain on northern

Mexican gartersnakes and weaken the functionality of the habitat for recovery as a whole for northern Mexican gartersnakes, in perpetuity.

As stated above, area dimensions of affected pools are expected to shrink over time. As pool areas shrink, available space for reproduction of prey species and space required for development also shrinks which limits the abundance and biomass of prey species within each pool. Smaller pool sizes also increase prey population densities within each pool which increases predation success rates on gartersnakes and their prey from natural predators such as mammals, wading birds, etc. All of these effects are expected increase in both frequency and scope, over time, after mine closure.

Northern Mexican gartersnakes also use lentic habitats such as stock tanks, isolated springs, cienegas, etc. as habitat. Stock tanks are primarily fed by surface runoff in response to precipitation; others are fed by solar groundwater wells. Collectively, stock tanks within the Las Cienegas NCA are not expected to be affected by lowered groundwater levels which are expected to attenuate, to some degree, adverse effects to lotic habitat within the Las Cienegas NCA.

Effects to the Northern Mexican Gartersnake's Prey Species

The effects to northern Mexican gartersnakes' prey community are further detailed in the effects discussions which pertain to Gila chub, desert pupfish, Gila topminnow, and Chiricahua leopard frogs. Please review those discussions for additional details.

Proposed Conservation Measures

Sonoita Creek Ranch (Second Supplemental BA, Item B 1-9, pp. 41-42, February 2013)–The acquisition of Sonoita Creek Ranch and its subsequent management of the ponds for native aquatic species is expected to provide some level of beneficial effects to the low-density population of northern Mexican gartersnakes along Sonoita Creek. The level of benefit is contingent upon the number of individual gartersnakes, presumed extant in the Sonoita Creek system (based on the 2014 record), that eventually occur at the conservation property and whether management of the property provides suitable access to prey species and/or improves the prey community within the immediate region. In the event that bullfrogs inadvertently colonize and become established on the property, create a source population for subsequent dispersal, and immigrate to gartersnake-occupied habitat in the region, we expect adverse effects to the resident northern Mexican gartersnake community. This is because while larval or juvenile bullfrogs can provide a source of prey to resident gartersnakes, adult bullfrogs are a substantial predator of neonatal and juvenile gartersnakes, which negatively affects recruitment within the gartersnake population. Other conservation properties proposed for acquisition by the proponent have no effect on the northern Mexican gartersnake; i.e., the Davidson Canyon parcels are available for the establishment of water features, but no such actions have been specifically proposed.

Water Rights Acquisition (see May 2015 SBA, pp. 6-7 and measure FS-SSR-01 in Appendix B of the FEIS)– Rosemont Copper has acquired the rights to purchase 1,122

AFA of surface water rights on Cienega Creek currently held by and used on the Del Lago golf course. Portions of the water rights are specified to be transferred to an appropriate entity, as in-stream flow rights on upper Cienega Creek (150 AF), lower Cienega Creek (100 AF), and Davidson Canyon (46 AF). A large component (approximately 825 AF) of the water rights was envisioned in the FEIS and BO to be used below Pantano Dam, either as recharge or as part of an in-lieu fee project. The September 2014 HMMP does not specify where this remaining water would go, but does specify that it would be for a beneficial use within the Cienega Creek watershed, that it may be allocated to a restoration project at and downstream of the Pantano Dam, or that it may potentially be used in support of an in-lieu fee project.

With the exception of lower Davidson Canyon (no records of northern Mexican gartersnakes occur from there), these additional, potential surface flow protections may provide some additional benefit to the northern Mexican gartersnake as a function of benefits to its prey base in lower and upper Cienega Creek, respectively. Details regarding how, where, and whether these additional protections may manifest are unknown. Therefore, it is difficult to ascertain exactly how much, if any, direct or indirect benefit the gartersnake could experience. Regardless of location, these measures do nothing to minimize effects from the loss of Empire Spring and the subsequent effects to the Chiricahua leopard frog metapopulation as a result lowered population persistence in the face of disease outbreaks.

To facilitate the transfer, Rosemont will file an application to sever 250 AF of two of the water rights 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 wildlife agencies and Pima County. According to the second supplemental biological assessment from February 2013, "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 Natural Preserve." The second supplemental biological assessment predicts this effort will result in the creation of approximately 3,000 linear feet of additional surface flow and riparian vegetation within lower Cienega Creek within Pima County's Cienega Creek Natural Preserve. Current estimates suggest that baseflow generated from this effort will equal approximately one cubic feet per second and that depending on where within the Pima County CCNP the water is redirected downstream of the Pantano Dam and piped to the surface, its presence as available surface water could be tenuous. Ultimately, potential benefits to the northern Mexican gartersnake from this effort will be directly related to whether or not this created, 3,000 foot reach could support additional lowland leopard frogs and or Gila chub which are presumed to be the gartersnakes' preferred prey in the lowermost reach of Cienega Creek, upstream of Pantano Dam. Provided the new reach can sustain these prey species and remain free of harmful nonnative predators, we expect northern Mexican gartersnakes to use the new reach as occupied habitat, and benefit from this measure.

<u>Cienega Creek Conservation Fund</u> (Second Supplemental BA, Item E. 1, pp. 42-43, February 2013)–The project proponent has committed to an annual payment of $200,000 into a conservation fund for a period of 10 years. The fund will be used for projects "designed to

preserve and enhance aquatic and riparian ecosystems and protect and maintain habitat for federally listed aquatic and riparian species in the watershed." In particular, we expect this fund will restore and improve habitat as well as to supplement, as needed, on-going harmful nonnative species monitoring and removal in the Las Cienegas NCA which has been recently, and is currently, funded by the BLM. Given the ephemeral nature of Federal government funding year-to-year, it is possible that in some years, BLM may not be able to fund these efforts. In this event we expect this conservation fund will ensure these efforts do not lapse in any given year through the period of mine operations. To help ensure the conservation fund provides the maximum conservation benefit, we expect that not all of each annual dispersement ($200,000) will be spent in the same year, and encourage the majority of funds be saved over the long-term for when implementation of critical conservation activities such as harmful nonnative species monitoring and removal is at risk of not occurring in any given year. To the extent that the conservation fund ensures that habitat is restored and improved and that the Las Cienagas NCA remains harmful nonnative-free for the next several decades, we expect clear benefits to northern Mexican gartersnakes and their prey species.

Harmful Nonnative Species Management and Removal Program (see letter dated February 11, 2016, from Rosemont Copper Company to the Coronado National Forest)–The project proponent has committed to providing $3,000,000 for the establishment and implementation of a harmful nonnative species management and removal program. This program is described above in the Revised Conservation Measures subsection entitled Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal.

We consider the upper Santa Cruz watershed in the San Rafael Valley to be the first priority for implementation of this conservation measure, based on the potential benefit to the Huachuca water umbel and the aquatic vertebrate species under consultation (Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, and northern Mexican gartersnake) which all occur in the San Rafael Valley historically or currently. We estimate that the planning and implementation of nonnative plant control to benefit Huachuca water umbel in the San Rafael Valley may cost up to $200,000, which leaves approximately $2,800,000 for harmful nonnative species control in the San Rafael Valley to benefit the aquatic vertebrates under consultation.

For aquatic vertebrates, our best estimate of the costs for implementing this program in the San Rafael Valley is $259,000/year for the first five years (which includes $244,000/year for initial surveys and control efforts and $15,000/year for plan development and reporting) and $190,000/year for the remaining years until funding reaches zero (this includes $175,000/year for surveys and maintenance of preferred baseline conditions and $15,000 for annual report development). Figures for program implementation to benefit aquatic vertebrates include two full-time personnel and five seasonal personnel dedicated to this specific program's implementation. Collectively, these figures suggest the harmful nonnative management and removal program for vertebrate species could be implemented in the San Rafael Valley for approximately 13 years. There is no reasonable expectation that there will be enough funds available to commence a similar program for any other area or subbasin.

The harmful nonnative species community within the San Rafael Valley is influenced by several potential source populations, including the most significant contributors, spills from Parker

Canyon Lake and the intermittent hydrologic connection across the reach of the Santa Cruz River that is bisected by the International Boundary with Mexico. For these reasons, we do not anticipate or expect this program will reach a harmful nonnative species baseline of zero for any of the targeted species. Rather, we consider the program to act as a large-scale control program to maintain harmful nonnative populations near zero or at such a level as to allow native aquatic vertebrate populations the opportunity to achieve increased reproductive output, recruit successfully, and demonstrate positive population growth. We also recognize there are factors that contribute to population dynamics that are not linked to harmful nonnative species, such as disease, water quality, or water quantity, which are all outside of the purview of this program. For this reason, the only metric that will be used to demonstrate program success in minimizing the effect of take will be the catch rates of harmful nonnative species per unit effort. In our best professional judgment, we will consider this program as meeting its objective if during the final two years of implementation, averaged catch rates for each harmful nonnative species are at 10 percent or less of historical baseline capture rates for each type of habitat sampled and treated (lotic stream, stock tank, seep, spring, etc.).

A critical consideration of this programs' potential success in meeting objectives is whether other conservation partners who own land in the San Rafael Valley will allow access and otherwise cooperate, passively or actively, in program implementation. These other land owners include a private landowner who owns roughly a third of all land within the upper Santa Cruz River subbasin and who is actively pursuing finalization of a habitat conservation plan with us, and the State of Arizona who owns less than 5 percent of the land. The Coronado National Forest manages the remainder of lands in the programs' implementation area. We have no reason to suspect, based on recent coordination with these entities, that either of these non-Federal conservation partners will object to program implementation on their lands or prevent access to their lands.

There is no larger or more geographically pervasive factor negatively affecting to the status of the Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, or northern Mexican gartersnake, across their rangewide distributions, than harmful nonnative species. For this reason alone, it is our opinion that successful implementation of the Harmful Nonnative Species Management and Removal Program will have considerable conservation benefit to all native plant and animal species it aims to address. We expect, based on previous mid- and large-scale efforts to control and/or remove harmful nonnative species, without influence from disease, water quality, or water quantity on populations of consultation species, that populations of these native aquatic species will respond in a significant, demonstrably positive fashion.

It is important to note that northern Mexican gartersnakes, to some extent, depend on certain harmful nonnative species as prey, such as larval and juvenile bullfrogs, mosquitofish, and perhaps spiny-rayed fish in their smaller size classes. Therefore, to lessen the risk of starvation to the gartersnake population, it will be important to supplement the gartersnake's prey base with native prey species as this program is implemented. This will require close coordination with Chiricahua leopard frog headstarting facilities and safe harbor sites as well as with native fish hatcheries on timing their production of animals for release into the upper Santa Cruz River subbasin as well as identifying strategic release locations and times. We also expect that program implementation will result in incidental take of listed species in the upper Santa Cruz River

subbasin. This take will be addressed in future consultation.

We expect significant conservation benefits from this programs' implementation, and will be exploring any and all possible funding mechanisms with public and private stakeholders and cooperators to continue program implementation after this funding source is depleted (or approximately 13 years from the beginning of implementation). However, based on a historical review of conservation funding and actions in the San Rafael Valley, we have no reasonable expectation that such funding (outside of that directly associated with this consultation) will be secured. It is highly unlikely that other landowners in the San Rafael Valley, such as the State of Arizona or the private landowner, will have or be willing to contribute the funds necessary to continue effective monitoring and control of harmful nonnative species. Historically, the Coronado has never been able to provide funds that could approach the level necessary to implement a broad-scale harmful nonnative species removal program, and we do not see that changing in the future. One or two years without implementation of monitoring and control activities could result in reinvasion of harmful nonnative species into the area. A vastly improved baseline in the status of the native species under consultation will temper this effect to some degree, but ultimately harmful nonnative species have an ecological and evolutionary advantage over native species and will slowly begin to dominate the riparian and aquatic community within the San Rafael Valley without sustained implementation of this program. Therefore, while this program stands to greatly benefit populations of several listed aquatic plants and vertebrates under consultation, these benefits are only temporary, while the adverse effects of mining to the aquatic ecosystem of the Las Cienegas NCA subbasin are anticipated to worsen over time and last for decades.

Effects to Northern Mexican Gartersnake Proposed Critical Habitat

The primary constituent elements specified for proposed northern Mexican gartersnake critical habitat are specifically linked to northern Mexican gartersnake ecology and therefore effects described above accurately illustrate how attributes of critical habitat are expected to be affected. As a result of mining activities and as detailed above, we expect the quantity of water within upper Empire Gulch and affected reaches along Cienega Creek to be reduced, which in turn is expected to reduce the size and challenge the permanency of the gartersnakes' primary prey community in affected areas within the Las Cienegas NCA. Effects to the aquatic environment affect PCE 1.a. and 1.d. Effects to the native prey community affect PCE 3.

Primary constituent elements are elements of physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species. Primary constituent element 1 for proposed critical habitat for the northern Mexican gartersnake addresses the aquatic features within occupied habitat that are essential to the habitat adequately serving its role in supporting a resident northern Mexican gartersnake population. Specifically, primary constituent element 1.a. requires an adequate amount of pool and backwater habitat and a flow regime capable of adequately processing sediment within a system. Given that precipitation-induced flows are most likely to influence the movement of sediment within the Cienega Creek watershed where northern Mexican gartersnakes are extant, which are unaffected by any change in the groundwater level as a result of the proposed action, we do not expect any effects to sediment transport within the system. As stated previously in this biological opinion

(see "*Effects to Northern Mexican Gartersnakes,*" other sections), we do expect effects from mine operations are reasonably certain to occur to base flows within affected reaches of Cienega Creek and to at least one important spring source, Empire Spring. We described how a reduction in base flow is expected to influence the dimensions, volume, permanency, and suitability of pool and backwater habitat to ranid frog and native fish populations.

Primary constituent element 1.d. requires that aquatic habitat maintain water quality characteristics that support a native amphibian prey base. Above in "*Effects to Northern Mexican Gartersnakes*", we described how decreasing water volume within affected pools is expected to affect the depth and area of pools which therefore affects the permanency of pools as well as water temperature and dissolved oxygen levels. Over time and as average water temperatures rise within affected pools, dissolved oxygen levels will lower, removing available oxygen and affecting the respiratory capacity of developing larval leopard frogs. Reducing the respiratory efficiency of larval frogs is expected to reduce the rate of successful metamorphosis into juvenile terrestrial frogs and later into reproductive adults. This effect results in a net, and compounding, reduction in reproductive output within the resident ranid frog population over time.

As referenced previously, and based on groundwater modeling results, we anticipate that the effects to Empire Spring from groundwater drawdown associated with mine operation will occur, may become measurable before mine closure, and result in total desiccation of the spring at some point post-closure of the mine, thus removing the spring as habitat for Chiricahua leopard frogs. Also stated previously and reiterated here, Empire Spring is arguably the most important site for the continued persistence of Chiricahua leopard frogs in the area, because of its naturally warmer water temperature which is vital for allowing frogs to persist while still infected by Bd. Recent monitoring efforts (Hall *et al.* 2015) confirm the Chiricahua leopard frog metapopulation within the Las Cienegas NCA is vulnerable to Bd outbreaks, as evidenced by extreme die-off events at multiple sites within the area. Empire Spring is therefore critical to ensuring there remains a source population of frogs which can disperse and recolonize extirpated sites within the metapopulation after significant disease outbreaks and die-offs occur.

Ultimately and collectively, these effects to the aquatic habitat within the Las Cienegas NCA are expected to manifest in continually reduced prey populations over time, which adversely affects primary constituent element 3 for the northern Mexican gartersnake, "A prey base consisting of viable populations of native amphibian and native fish species." While we expect that native fish populations will continue to persist in the Las Cienegas NCA despite adverse effects to pool habitat in affected reaches of Cienega Creek, the eventual potential complete loss of Empire Spring, as a perennial source population for dispersing individuals, makes the future of Chiricahua leopard frogs within this at-risk metapopulation tenuous into the future without active management such as annually stocking head-started frogs or artificially creating similar thermal refugia (if possible) where frogs can survive the winter in the presence of Bd. Remaining pools in unaffected reaches, pools which retain demonstrable habitat value in affected reaches, and the presence of natural and groundwater well-fed stock tanks and ponds are expected to attenuate the effects of groundwater drawdown into the future. However, there is no attenuating factor that ameliorates the important disease-buffering role of Empire Spring from its degradation, and ultimately, its potential total loss. This potential, irreversible, adverse effect to primary constituent element 3 presents a significant challenge for this proposed subunit in meeting its

role in future recovery and conservation of the northern Mexican gartersnake.

Effects of Conservation Measures on Northern Mexican Gartersnake Proposed Critical Habitat

As stated previously, primary constituent elements that have been identified for the northern Mexican gartersnakes' proposed critical habitat are inextricably linked to the species ecology. Therefore, we only briefly discuss which primary constituent elements are expected to be affected by proposed conservation measures and refer the reader to the expanded discussion above on effects to the species itself from implementation of conservation measures.

Cienega Creek Water Rights Acquisition (see the September 26, 2014, HMMP and the Conservation Measures subsection of our October 30, 2013, BO for details)–The main objective of this conservation measure, which will be implemented in the Cienega Creek Subbasin Unit of proposed critical habitat, is to improve or secure streamflow into the future. Should the objective result in demonstrable gains in streamflow in Cienega Creek, we expect some level of benefit to PCE 1 (aquatic habitat) and potentially PCE 3 (native prey base).

Cienega Creek Conservation Fund (see the Conservation Measures subsection of our October 30, 2013, BO for details)–Specific activities funded by this conservation measure, which will also be implemented in the Cienega Creek Subbasin Unit, could vary widely but the principle objective is to improve riparian and aquatic habitat and help maintain a native community within the Las Cienegas NCA. Therefore, it is likely all PCEs for proposed critical habitat within this unit could benefit during the period of time for which conservation funds remain available. This period of time is uncertain.

Harmful Nonnative Species Management and Removal Program (see letter dated February 11, 2016, from Rosemont Copper Company to the Coronado National Forest; also described in the Revised Conservation Measures narrative, above)–The primary intent of this conservation measure is to remove harmful nonnative species from the upper Santa Cruz River Subbasin Unit of proposed critical habitat and improve the status of native aquatic species within the subbasin. This will significantly improve PCEs 3 (native prey base) and 4 (harmful nonnatives low or absent) for the period of time for which program funding remains available (or approximately 13 years from the start of implementation).

Cumulative Effects – Northern Mexican Gartersnake

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.

Examples of cumulative effects 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 harmful nonnative aquatic species, which can cumulatively adversely affect the northern Mexican gartersnake and its proposed critical

habitat. Additional cumulative effects on northern Mexican gartersnakes include ongoing activities in the watersheds in which the species occurs such as livestock grazing in the presence of harmful nonnative species 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 generally attenuated by the relatively minor amount of non-Federal lands in the action area.

Conclusions - Northern Mexican Gartersnake

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusions of non-jeopardy and no destruction or adverse modification, below, would remain valid.

After reviewing the current status of the northern Mexican gartersnake, the environmental baseline for the action area, the effects of the proposed Rosemont Mine Project to the northern Mexican gartersnake and its primary prey species, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the northern Mexican gartersnake nor destroy or adversely modify its proposed critical habitat. We make this finding for the following reasons:

1. The affected northern Mexican gartersnake population and its proposed critical habitat, within and downstream of the Las Cienegas NCA, represent a relatively small proportion of the species' rangewide distribution in the United States and Mexico. We estimate that approximately 10-15 percent of occupied habitat for the northern Mexican gartersnake occurs in the United States (Arizona and New Mexico) with the remainder occurring in Mexico. The action area currently represents 2 of 14 extant populations in southern Arizona and likely less than 10 percent of its distribution in the United States; appreciably less than that rangewide (this subspecies has a range that extends significantly into Mexico). Lastly, the proposed Cienega Creek Subbasin Unit represents just 50,393 out of 421,423 total acres (12 percent) of proposed critical habitat, most of which within this subunit is comprised of terrestrial and lentic habitat which are unaffected by the proposed action.

2. Proposed critical habitat primary constituent elements 1.a., 1.d., and 3 noted above are expected to be adversely affected as a result of the proposed action; primary constituent element 3 is discussed further in item 4 below. We anticipate, based on modeling, that broad-scale, permanent degradation may occur to the prey base of the northern Mexican

gartersnake within the action area, at an unknown point in the foreseeable future and as a result of a lowered groundwater table. This would cause irreversible effects to northern Mexican gartersnake habitat in certain identified reaches in upper Cienega Creek, as well as all of upper Empire Gulch. Habitat is important to the maintenance and recovery of northern Mexican gartersnake populations because it serves two primary roles: 1) to support an adequate prey base; and, 2) provide protective cover in the presence of harmful nonnative species. The action area is largely if not completely devoid of harmful nonnative species and provided that status continues, we do not expect that habitat's role as protective cover will be meaningfully affected. We do have concern about some habitat supporting the local Chiricahua leopard frog population into the future, particularly the potential loss of Empire Spring. We suspect that Empire Spring serves a critical and unique role in keeping metamorphosed frogs, which are exposed to Bd, alive over the winter to act as a source population of dispersing frogs within the metapopulation the next year. Specifically, we suspect the springs' warmer water temperatures increase survivorship of infected frogs, as Bd-related mortality in Chiricahua leopard frogs correlates strongly with colder water temperatures (die-off most frequently occur over the winter months). However, lentic habitat areas fed by precipitation (or solar groundwater wells) within the action area are not expected to be affected by the proposed action, nor are various reaches along Cienega Creek where groundwater discharge is considered strong enough to sustain surface flow. Therefore, there will remain habitat for leopard frogs elsewhere within and downstream of the Las Cienegas NCA. These areas not sensitive to lowered groundwater levels can provide feeding, breeding, and sheltering habitat for northern Mexican gartersnakes and their prey communities (with exception to Bd die-offs), maintaining general ecologic function.

3. The Las Cienegas NCA's and Pima County's Cienega Creek Natural Preserve's most unique and important attribute contributing to the conservation and recovery of northern Mexican gartersnakes is that each of these areas provides a native prey base in the absence of harmful nonnative species. This combination sets this area aside from all other currently or historically occupied areas in southern Arizona (and throughout most of the species' range in the United States), making it an important component of future conservation and recovery of the species. We also expect that the Las Cienegas NCA and Pima County's Cienega Creek Natural Preserve will continue to be managed for native species into the foreseeable future. Funding levels and mechanisms are expected to fluctuate over time, and may even cease in some years, which is expected to affect on-the-ground implementation of conservation programs. At a minimum, however, we expect Chiricahua leopard frog recovery activities to continue in this area into the foreseeable future. Recovery activities are likely to include head-starting and release programs following Bd-related die-offs within the Chiricahua leopard frog metapopulation.

4. Of the primary prey species available to northern Mexican gartersnakes in the action area (primary constituent element 3 of proposed critical habitat), we anticipate that Chiricahua leopard frogs (its most important prey species in the area) may be most affected by the proposed action. This is due to the potential degradation and eventual loss of Empire Spring habitat for Chiricahua leopard frog, a vital population which appears to be

resistant to the effects of Bd (see above discussion under Item 2). Although not guaranteed to continue in perpetuity, active recovery efforts may re-establish Chiricahua leopard frog populations through headstart-and-release techniques, but without Empire Spring's thermal refuge, the ability of metamorphosed frogs to survive the winter in the presence of Bd could be perpetually at risk from persistent, seasonal die-offs associated with Bd. Although fish and Chiricahua leopard frog populations are expected to be less robust as a result of degraded and lost habitat, the northern Mexican gartersnake is a prey generalist to some degree; therefore, we anticipate that northern Mexican gartersnake will exploit such alternative sources of prey in the action area as have been documented in a number of ecology settings throughout its range. These additional sources of prey in the action area may include earthworms, leeches, lizards, small rodents, and toads which are not expected to be affected by the proposed action because they don't depend heavily (or at all in some cases) on habitat affected by the action. These alternative prey sources are expected to help sustain the resident gartersnake population at a low density, despite being adversely affected by losses to the Chiricahua leopard frog and Gila chub populations. The anticipated persistence of Gila chub, the implementation of on-going recovery actions to help maintain the Chiricahua leopard frog population, and an array of resident, alternative prey species (not affected by the action) within the Las Cienegas NCA are expected to temper the anticipated effects to the northern Mexican gartersnake prey base to some degree. We have observed lowland leopard frog populations expand and contract in the action area over time, and there remains the possibility that, if extant, they may replace Chiricahua leopard frogs in vacated habitat, serving an important role as prey items for northern Mexican gartersnakes. We also note that both leopard frog species are vulnerable to Bd, and therefore both species may be similarly affected by the presence of Bd on the landscape.

5. The suite of conservation measures, especially the funding of the anticipated 13-year implementation of the Harmful Nonnative Species Management and Removal Program in the upper Santa Cruz River subbasin, is expected to substantially improve the baseline status for the northern Mexican gartersnake and its native prey community on a subbasin-level. Considering that the effects of the proposed mining action last into the foreseeable future, the ultimate, long-term benefit of this conservation measure remains contingent upon whether funding can be secured to maintain the program after the proponents' funds are depleted. We remain concerned, based on the conservation history of that subbasin, that additional funding may not be secured, but during the 13-year implementation, the status of the gartersnake and numerous native aquatic species is expected to be bolstered significantly.

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 and Terms and Conditions specified below.

INCIDENTAL TAKE STATEMENT – Northern Mexican Gartersnake

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 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). "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 - Northern Mexican Gartersnake

We anticipate that take of northern Mexican gartersnakes in the form of harm is reasonably certain to occur in upper Empire Gulch and various pools and aquatic sites within affected reaches of Cienega Creek, as a result of permanent, adverse effects to primary prey communities in these areas, from groundwater drawdown due to the mine.

We anticipate take in the form of harm (death directly due to starvation or secondary effects of starvation, weight loss, reduced fitness, forced dispersal, etc.) to northern Mexican gartersnakes to result from adverse effects to the species' prey base which we anticipate will result from modeled, mine-driven groundwater drawdown, throughout the modeled analysis period and potentially beyond. Reduced fecundity means that reproductive female gartersnakes will give birth to fewer offspring over time. The cumulative numbers of individual gartersnakes (and their subsequent offspring) that were never born as a result of reduced fecundity within this affected population is unknown and nearly impossible to accurately predict, even with advanced modeling. Therefore, these cumulative losses within the population are not included in the total anticipated number of taken individuals.

We also recognize the difficulty in monitoring the numbers of a cryptic, difficult-to-detect species such as the northern Mexican gartersnake. The analysis of the effects of the action emphasizes the reduction and potential loss of its prey base as the primary driver of adverse

effects to the gartersnake. For this reason, we are adopting the contents of the respective Incidental Take Statements for the Gila chub, Gila topminnow, desert pupfish, and Chiricahua leopard frog, using groundwater drawdown (as informed by monitoring well data) as a surrogate measure of incidental take for the northern Mexican gartersnake. The use of monitored ground water levels is an appropriate surrogate for take of northern Mexican gartersnakes because monitoring will inform the potential response of habitat to changing groundwater levels, which in turn, inform the potential response of aquatic vertebrates that serve as important gartersnake prey species, and therefore indirectly monitor potential population stress to resident gartersnakes from effects to its prey community. Northern Mexican gartersnakes prey on other species, but this suite of aquatic species, albeit threatened and endangered, is the only one for which we have a detailed analysis of changes in abundance due to the proposed action.

These Incidental Take Statements are incorporated herein via reference.

Effect of the Take – Northern Mexican Gartersnake

In this biological opinion, we determine that these levels of anticipated take are not likely to result in jeopardy to the species nor result in adverse modification of its proposed critical habitat for the reasons stated in the Conclusions section.

Reasonable and Prudent Measures - Northern Mexican Gartersnake

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)]. The effects to the northern Mexican gartersnake from implementation of the proposed action occur specifically within the Las Cienegas NCA and downstream through Pima County's Cienega Creek Natural Preserve. Although within the action area, both of these areas are outside the management jurisdiction of the USFS. Therefore, the following reasonable and prudent measure and its accompanying term and condition require the Forest Service to minimize the effect of incidental take of northern Mexican gartersnakes outside the defined action area, as authorized under section 7 of the Act.

The following reasonable and prudent measure is necessary and appropriate to minimize the effect of take on northern Mexican gartersnakes:

As detailed above, we are reasonably certain the principle effect of the proposed action on the northern Mexican gartersnake is manifested through effects to its prey base; primarily to the Chiricahua leopard frog which is considered a primary prey species for this gartersnake population. The diminishment or loss of this prey species over time will increase the vulnerability of the gartersnake population to extirpation, as a function of depressed resiliency. The effect of take on the northern Mexican gartersnake is therefore minimized by securing the regional prey base for this species. The principle factor keeping regional prey communities at low densities is harmful nonnative species. Harmful nonnative species include, but are not limited to, nonnative fish in the families Centrarchidae and Ictaluridae, American bullfrogs (*Lithobates catesbeianus*), and any species of crayfish. Therefore, the project proponent has committed to temporary funding of a harmful nonnative species removal and management

program, at a subbasin scale, within the San Rafael Valley. This will minimize the effect of take by helping ensure the long-term persistence of northern Mexican gartersnakes and their primary native prey species in the surrounding area. We consider the area identified for implementation to offer a reasonable likelihood of successfully minimizing the effect of incidental take of the gartersnakes, and provide the following terms and conditions to ensure a greater likelihood of program success.

Terms and Conditions - Northern Mexican Gartersnake

In order to be exempt from the prohibitions of section 9 of the Act, the USFS shall ensure that the proponent complies with the following terms and conditions, which implement the reasonable and prudent measure described above. This term and condition is non-discretionary.

1. The USFS and Corps shall ensure the harmful nonnative species program provides maximum conservation benefit and a higher likelihood of success:

    a. The program will have to demonstrate success by achieving a quantitative metric based on our best professional judgment: during the final two years of implementation, averaged catch rates for each harmful nonnative species are at 10 percent or less of historical baseline capture rates for each type of habitat sampled and treated (lotic stream, stock tank, seep, spring, etc.). If this metric is not met for any harmful nonnative species previously identified, an analysis evaluating the need to reinitiate formal consultation shall be conducted.

This reasonable and prudent measure, with its implementing terms and conditions, is designed to minimize the effect of 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 and/or Corps 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 measure and/or reinitiation of consultation.

Conservation Recommendation

As provided under section 7(a)(1) of the Act, we recommend that the Coronado National Forest and Corps seek local and regional, public and private, conservation collaborators, partnerships, and funding sources to secure and maintain viable populations of northern Mexican gartersnakes outside of, but adjacent to, Forest Service-managed land within the immediate region surrounding the action area. To best address effects of the proposed action where they occur, we urge the Coronado National Forest to implement this collaborative approach on the Las Cienegas NCA and Pima County's Cienega Creek Natural Preserve.

HUACHUCA WATER UMBEL

Status of the Species - Huachuca Water Umbel

The rangewide status of the Huachuca water umbel remains largely unchanged from that which was described in our October 30, 2013, BO. We did, however, subsequently complete the August 21, 2014, Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*) 5-Year Review: Summary and Evaluation (five-year review) (FWS 2014c) and include status information from that review. The taxon's critical habitat remains as described in the July 12, 1999, Final Rule (64 FR 37441); none is present within the action area.

We also include updated genetics and cultivation information. We note that the 5-year review represents a more-current synthesis of available information and threats to the taxon.

Listing History

On January 6, 1997, we listed the Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*) as an endangered species (FWS 1997); on July 12, 1999, 83.2 kilometers (km) (51.7 miles (mi)) of streams or rivers in Cochise and Santa Cruz Counties, Arizona, were designated as critical habitat (FWS 1999a). A Five-Year Review of the taxon was finalized in August, 2014, and recommended no change to the classification of the taxon as endangered (FWS 2014c).

Recovery Planning

There is a Draft Recovery Plan for the Huachuca water umbel (FWS 2016), which is currently under public review (until May 9, 2016). The Draft Recovery Plan identifies Recovery Criteria by which the species may be downlisted (from endangered to threatened) or delisted (recovered and no longer in need of the Act's protections). These criteria, which are subject to revision following the public participation and peer review processes, are described below.

<u>Recovery Criteria</u>

To downlist:

1. A minimum cumulative extent of 2,000 m2 (0.5 acre / 0.2 hectare) of naturally occupied habitat exists in the San Pedro Watershed, 20 percent of which occurs in tributary streams, springs, or cienegas; and a minimum of 2,000 m2 (0.5 acre / 0.2 hectare) in the Santa Cruz Watershed, 90 percent of which occurs in tributary streams, springs, or cienegas, distributed among the areas of Cienega Creek (35 percent), Sonoita Creek (10 percent), the San Rafael Valley uplands and mainstem (10 percent), and the western Huachuca Mountains (35 percent); and a minimum of 125 m2 (0.03 acre / 0.01 hectare) exists in the Rio Yaqui Watershed; this level of occupancy is sustained or improved for a minimum of 10 years over a 15 year period.
2. At least three separate introduced occurrences with a minimum cumulative extent of 150 m^2 (0.037 acre / 0.015 hectare) of occupied habitat are placed in each of the three United States.
3. Threats to the taxon and its habitat have been managed and reduced, and management is in place for a minimum of 20 years to ensure the persistence of occurrences with

minimum cumulative extent (as reflected by the achievement and maintenance of downlisting criteria 1 and 2 in each of the three United States watersheds;

4. A living collection of as many plugs as resources allows, collected from genetically distinct regions (e.g. Fort Huachuca/SPRNCA north; San Rafael / Las Cienegas/Sonoita; San Pedro Riparian National Conservation Area, south/San Bernardino), from both the San Pedro and the Santa Cruz watersheds is maintained in at least one botanical garden in southern Arizona for recovery and educational purposes; and
5. Seeds of *L. schaffneriana* ssp. *recurva* are collected following Center For Plant Conservation guidelines, which include collecting from no more than 10 percent of the standing seed crop from 50 individual seed bearing plants per population (if the population size permits), and collecting from a variety of microsites and physical characteristics within the stand of plants. These seeds are stored at both the Agricultural Research Service National Center for Genetic Resources Preservation in Fort Collins, Colorado and stored according to protocols at a local facility such as the Desert Botanical Gardens in Phoenix, Arizona, for long-term conservation and recovery purposes.

To delist:

To delist *L. schaffneriana* ssp. *recurva*, the criteria for down-listing must be met and the level of occupancy in the downlisting criteria must be sustained or increasing for a minimum of 20 years over a 30-year period.

Recovery Actions Needed

The Draft Recovery Plan also includes a list of actions required in order to achieve recovery of the taxon; these are as follows:

1. Maintain or enhance groundwater hydrography, as measured by stream gages, by reducing water withdrawal and increasing water conservation and recharge;
2. Preserve existing *L. schaffneriana* ssp. *recurva* occurrences and their seedbanks through the protection of occupied habitat, unoccupied corridors, and habitat quality;
3. Remove stressors such as trampling and invasive non-native plant competition to *L. schaffneriana* ssp. *recurva* occurrences;
4. Conduct research and monitoring that will facilitate better understanding of: a) the distribution and genetics of the taxon in both the United States and Mexico, b) population and metapopulation dynamics and trends, c) life history, d) response to threats, and e) other relationships key to recovery of the species;
5. Establish introduced *L. schaffneriana* ssp. *recurva* occurrences to help ensure the long-term survival of the taxon in southern Arizona;
6. Develop collaborative partnerships with Federal and State land managers, private landowners, museums and botanical gardens, seed storage facilities, and others; and provide outreach to the public as needed to accomplish recovery;
7. Promote the achievement of conservation and recovery in Mexico, resulting in long-term protection of *L. schaffneriana* ssp. *recurva* and its habitat;
8. In coordination with stakeholders, revise this plan as needed as new information comes to light so that the recovery strategy and actions implement recovery in as efficient a

manner as possible.

Terminology
Because this taxon is clonal in nature and it is not practicable to identify individuals, the term occurrence is used herein to denote concentrations of this taxon within a distinct locality that are relatively distant from other concentrations. Occurrences are more likely to share underground root systems, and are often separated from one another by morphological or hydrological features. Within occurrences, clusters of stems separated by areas without stems are denoted herein as patches. An occurrence can consist of one to many patches; patches can have one or a few stems or form carpets of stems.

Biology
Huachuca water umbel is a semi-aquatic to fully aquatic herbaceous perennial plant of the carrot family (Apiaceae). Hollow linear leaves that taper to a point are produced singly or in clusters at the top of short rhizomes. The leaves vary greatly in length from 2.5 to 33 centimeters (cm) (0.98 to 12.99 inches (in)) depending on their habitat, with shorter leaves typically found in drier environments and longer when submerged in water (Coulter and Rose 1902; Affolter 1985; FWS 2014a). Three to ten 1.0 to 2.0 millimeters (mm) (0.04 to 0.08 in) wide flowers are borne on an umbel that is always shorter than the leaves. Fruits are spherical and dry, 1.6 to 2.3 mm (0.6 to 0.09 in) long by 1.2 to 2.0 mm (0.04 to 0.08 in) broad, with five distinct spongy ribs that make the seeds buoyant and easily dispersed by water (Affolter 1985).

Life History
Huachuca water umbel reproduces both asexually and sexually. Asexual reproduction, likely the primary form of reproduction in this taxon (Vernadero Group and the Desert Botanical Garden 2012), provides a means of rapid expansion of available habitat. Sexual reproduction may be important for maintaining genetic diversity, evolutionary potential, and persistence in the taxon. Recent work on sexual reproduction in captivity showed significantly higher fruit production in plants growing in flowing water, verses those in a terrestrial situation, indicating that the best habitat to increase genetic variation is flowing water (Morrow 2015).

Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren *et al.* 1991). Germination occurs one to two weeks after seeds disperse (Gori 1995). Plants may also dislodge during flooding or other disturbance events with clumps then possibly re-rooting in a different site along aquatic systems.

Natural seed banks are important for the persistence of rare species, and observations in the field suggest Huachuca water umbel seed may remain viable for five to ten years, an important survival strategy during times of drought (Titus and Titus 2008a; Titus and Titus 2008b; Titus and Titus 2008c). Another important survival strategy of the Huachuca water umbel are its rhizomes, which enable occurrences to rapidly expand or contract in size between years, seasons, or both, in response to local environmental conditions, including temperature and water availability (FWS 1997; Vernadero Group 2011).

Genetics and Variability
Historical numbers of unique individuals represented in clonal occurrences for the taxon is

unknown. Vernadero Group and Desert Botanical Garden (2012) found that occurrences currently exhibit relatively low variability, with occurrences having 6-17 distinct genetic types, and generally more within population variability than between population variability. Existing occurrences are generally not dominated by a single clone. Genetic diversity/number of individuals represented in such intermixed clones may be significant in population dynamics and conservation (Harper 1977). Vernadero Group and Desert Botanical Garden (2012) note that conservation efforts should emphasize preservation of existing genetic diversity in Huachuca water umbel occurrences and the promotion of factors that will contribute to the establishment of new clones and/or sexually-produced seedlings, maintain dispersal pathways, and reduce habitat fragmentation.

Habitat

Huachuca water umbel is restricted to cienegas, rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content (FWS 1999a). The taxon is generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods (FWS 1997; FWS 1999a). In upper watersheds that generally do not experience scouring floods, Huachuca water umbel occurs in microsites where interspecific plant competition is low. At these sites, Huachuca water 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, Huachuca water umbel can occur in backwaters, side channels, and nearby springs.

Distribution/Abundance

Found between 855 and 2,170 meters (m) (2,805 and 7,120 feet [ft]) in elevation, the range of the taxon crosses the Sierra Madrean Region of southeastern Arizona and adjacent portions of Sonora, Mexico (Titus and Titus 2008c; Vernadero Group and the Desert Botanical Garden 2012). In the United States (U.S.), we are aware of 17 locations supporting extant occurrences of Huachuca water umbel, 8 locations where all Huachuca water umbel occurrences are considered extirpated, and 6 locations where no occurrences have been relocated in recent years. In the U.S., Huachuca water umbel occur on lands administered by the U. S. Army Fort Huachuca, the Forest Service, the Bureau of Land Management, the FWS, Arizona State Parks, Pima County, The Nature Conservancy, and private landowners. The majority of Huachuca water umbel occur along the San Pedro River, in the Huachuca Mountains, and along Cienega Creek in the San Pedro River and Santa Cruz River Watersheds. In Sonora, Mexico, we are aware of 21 locations supporting Huachuca water umbel occurrences, though most of these locations have not been revisited in recent years. In Mexico, most Huachuca water umbel occurs on private lands of the San Pedro River and its tributaries in the San Pedro River Watershed (Anderson 2006). Huachuca water umbel also occurs within the Santa Cruz, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Mexico.

Although we now are aware of many more occurrences of Huachuca water umbel than at the time of listing in both the U.S. and in Mexico, there are no occurrences that appear to be increasing in size and many are reported from single patches among competing vegetation or in aquatic habitat that is in danger of being lost to groundwater pumping or drought. Many other occurrences have not been relocated in many years and are believed extirpated due to changes in

suitability of habitat.

Threats

Threats to the taxon identified through research and consultations that could potentially impact Huachuca water umbel include: aquatic habitat degradation; wildfire and resulting sedimentation; invasive, nonnative plant competition; livestock grazing; and recreation (Factor A) (the present or threatened destruction, modification, or curtailment of its habitat or range) and the effects of drought and climate change (Factor E) (other natural or manmade factors affecting its continued existence). See the Final Rule listing the species (62 FR 665-689) for additional information on the threat factors (A through E) evaluated during listing

Aquatic habitat degradation - Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, nonnative species introductions, urbanization, wood cutting, wildfires, and recreation all contribute to aquatic habitat loss and degradation within the historical range of Huachuca water umbel (Hendrickson and Minckley 1984; Bahre 1991; Hereford 1993).

Wildfire and resulting sedimentation - Fire would generally not burn the wetland habitat of Huachuca water umbel due to high humidity; however it has the potential to burn adjacent upland habitats, especially those invaded by nonnative grasses, causing indirect effects on Huachuca water umbel and its habitat throughout the range of the taxon (FWS 2009). Effects include increased runoff of floodwaters, deposition of debris and sediment originating in the burned area, and potential for scouring of individual Huachuca water umbel plants and habitat (FWS 2014b).

Invasive, nonnative plants - Invasive nonnative plants have increased their presence within aquatic habitat of southeastern Arizona, and this invasion and expansion of infestations are expected to continue in the future. Because Huachuca water umbel is sensitive to competition from both native and nonnative herbaceous plants, the continued increase in nonnative species will lead to a decrease in the presence of Huachuca water umbel throughout the range of the taxon.

Livestock grazing – Huachuca water umbel are affected by livestock grazing in the following ways: 1) trampling, 2) direct impacts from construction of range improvement projects, 3) changes in stream geomorphology that lead to erosion, sedimentation, and downcutting, 4) watershed degradation and resulting adverse effects to stream hydrology, and 5) consumption (FWS 1999b; Anderson 2006). Observations of Huachuca water umbel response to grazing indicate the taxon is capable of experiencing light to moderate grazing with negligible impact (Simms pers. comm. October 26, 2011; Anderson 2006; Edwards pers. comm. February 21, 2001; Rorabaugh 2013). More intensive grazing or that during dry periods when cattle spend a disproportionate amount of their time, if not controlled, in riparian areas, may result in harmful effects to Huachuca water umbel and other riparian obligates (Edwards pers. comm. February 21, 2001; FWS 2002; Krueper 1996; Malcom and Radke 2008; FWS 2014a).

Recreation - Riparian areas and cienegas offer important recreational opportunities for the

residents of southern Arizona and northern Sonora (FWS 1997). This visitation is expected to increase in the future with increases in human population, as well as drought conditions and the desire to be near water. Recreational activities, if poorly managed, can result in soil compaction, streambank destabilization, erosion and sedimentation, increases in the presence of invasive nonnative plant species, and trampling of Huachuca water umbel and other riparian plant species, thus reducing habitat quality.

Drought and climate change - Huachuca water umbel evolved in the Southwest and has persisted in many locations throughout its range through historical droughts such as those of the 1950s, yet, given the severity and persistence of the present multi-decade drought (Bowers 2005; Garfin *et al.* 2013; CLIMAS 2014), it is unknown how long Huachuca water umbel will maintain viability in de-watered habitat. It has been suggested that seed from this taxon may persist for five to ten years in such situations (Titus and Titus 2008a; Titus and Titus 2008b; Titus and Titus 2008c). Projections for the southwestern U.S. are that precipitation will be less in the future (Seager *et al.* 2007; Karl *et al* 2009) and that temperatures will rise (Overpeck *et al.* 2013; Karl *et al.* 2009). In addition, in a warmer environment, an enhanced hydrologic cycle is expected; rainfall events are to be less frequent, but more intense, and larger flood events more common (Karl *et al.* 2009). Such large floods can destroy Huachuca water umbel patches, and even entire occurrences, if no niches in backwaters are present to ensure recolonization.

The most direct threats from climate change to the Huachuca water umbel (related to loss of wetted habitat and increased stress) are increased fragmentation within and between hydrological units, decreased numbers of individuals impairing occurrence viability, and over time, incremental reduction of genetic variation important for genetic adaptation.

Small occurrence size - Habitat degradation over historical time has resulted in decreased number and size of Huachuca water umbel occurrences, potentially decreasing viability and genetic diversity of these occurrences. Occurrences are in many cases isolated, which makes the chance of natural recolonization after extirpation less likely. The clonal nature of the taxon, combined with small patch sizes, may result in less genetic diversity than in a non-clonal species, further aggravating vulnerability. The work of the Vernadero Group and the Desert Botanical Garden (2012) indicates that the taxon is more vulnerable to extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of Huachuca water umbel 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 many occurrences or cause extinction.

Critical Habitat

Seven Critical Habitat units have been designated for Huachuca water 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 Huachuca water 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 Huachuca water 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 Huachuca water umbel expansion;
3. A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for Huachuca water 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 occurrence 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 Huachuca water umbel is appreciably diminished. Such activities are also likely to jeopardize the continued existence of the taxon.

Environmental Baseline - Huachuca Water Umbel

The status of Huachuca water umbel in the action area is substantively the same as what appeared in the October 30, 2013, BO, minor refined information since that time has been included in the SBA of 2015. The May 2015 SBA based its analyses on named stream reaches (see Effects to Aquatic Ecosystems section, above). Huachuca water umbel has been documented in Cienega Creek Reaches 3, 5 through 8, although only CC5 and CC7 are Key Reaches subject to detailed analyses of effects to discharge and pools. We note that Huachuca water umbel has, in the past, been detected in lower Empire Gulch (EG2) (Warren, pers. comm. 1996) and that is has been reestablished by the BLM in the Cieneguita Wetlands (CGW, subject only to pool-related

effects analyses).

We have also elected to incorporate information from the taxon's five-year review (see status of the species section above) so that the revised effects analysis found in the Effects to Aquatic Ecosystems section, above, can be compared to the most-current information regarding the presence of the taxon.

Cienega Creek and Empire Gulch

Cienega Creek and its tributary, Empire Gulch, support or have supported numerous occurrences and more than 100 patches of Huachuca water umbel (BLM 2012). There are multiple occurrences of Huachuca water umbel from Empire Gulch, Gardner Canyon, Mattie Canyon, and Narrows Powerlines Road areas in Cienega Creek within Las Cienegas NCA that have been detected as early as 1991, although these were not considered in the critical habitat designation of 1999 (Rebman 1991, entire; Warren. pers. comm. April 4, 1996; 64FR 37441, entire). In addition, there is one occurrence nearby the Narrows in Fresno Canyon on State Land. All of these occurrences are monitored regularly by personnel of the Bureau of Land Management and were last measured in full in 2011 when approximately 100 patches were detected over a 12.9 km (8 mi) section of creek (BLM 2011). In 2014, a partial survey was conducted with similar results, though the area was reported to be drier than in the past (M. Radke pers. comm. June 2014).

Huachuca water umbel occurring on Pima County lands along Cienega Creek within the Cienega Creek Natural Preserve are monitored periodically by County personnel. A single Huachuca water umbel occurrence was detected in lower Cienega Creek in 2001 when researchers noted a few leaves that did not persist beyond the season in which they were discovered (EEC 2001, p. 9). A survey in June 2006 revealed no Huachuca water umbel at this site and a deeply entrenched stream channel 7 to 9 ft below the former marsh (Titus and Titus pers. comm. June 20, 2006). A 2013 survey indicated no plants at this location and Huachuca water umbel is believed to be extirpated (Powell pers. comm. October 1, 2013).

Overall, the Cienega Creek subwatershed presently supports roughly 12 percent of the total known geographic range and extent of plant material of Huachuca water umbel and supports approximately 26 percent of the known range within the Santa Cruz River Watershed. The Cienega Creek subwatershed is centrally located in the range and has significant genetic variability that is important to the management of the taxon for sustainability, resilience and recovery.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following Huachuca water umbel-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as

applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weakness of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

Effects of the Proposed Action - Huachuca Water Umbel

Surface water in alluvial reaches of Cienega Creek, Empire Gulch, and Cieneguita Wetlands exists 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 taxon's ability to access water, individual patches would senesce and eventually die unless they could: (1) gradually move to more moist microsites via the spread of rhizomes and/or (2) move entire patches via flood and colonize new, well-watered reaches.

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. A subsequent analysis of effects to riparian vegetation, of which the taxon is a component, appears in the Effects to Riparian Ecosystems section. These analyses are incorporated herein via reference.

Again, Huachuca water umbel has been documented in Cienega Creek Reaches 3, and 5 through 8, although only CC5 and CC7 are Key Reaches subject to the SIR and May 2015 SBA's detailed analyses of effects to discharge and pools (see the Effects to Aquatic Ecosystems section and the SIR for detailed explanations of Key Reaches and their selection criteria). Our subsequent analyses will, where necessary, interpolate effects modeled in unoccupied Key Reaches situated upstream of occupied, non-modeled reaches. This approach is corroborated by Table 3 in the May 2015 SBA, specifically the information in the column entitled Specific

Technique to Analyze Impact of Upstream Flow Losses.

We also note that Huachuca water umbel has, in the past, been detected in lower Empire Gulch (EG2) (Warren, pers. comm. 1996) and in the Pima County CCNP (within CC13). The taxon has also been reestablished by the BLM in the Cieneguita Wetlands (CGW, subject only to pool-related effects analyses in the SIR and May 2015 SBA).

Huachuca water umbel is a semi-aquatic to aquatic, emergent plant and as such, it tends to occur in shallow waters within cienegas and along the margins of perennial streams. The May 2015 SBA contained no data by which to evaluate changes in the wetted length of affected streams, nor are we aware of any methodology by which Huachuca water umbel presence or abundance can be correlated with stream discharge. Increases in the number of days with zero flow, particularly if they are capable of changing a stream from perennial to intermittent or ephemeral, are a useful surrogate for evaluating effects to Huachuca water umbel habitat. Similarly, the May 2015 SBA included no data regarding the lateral perimeter of pools. The percent of pool surface area remaining is a useful substitute for this metric, though we note that perimeter and area do not vary linearly. For these reasons, our analyses will focus on two discharge-related metrics (zero flow days) and flow status (perennial, intermittent, or ephemeral) and one pool-related metric (percent surface area remaining).

Again, the May 2015 SBA states that Huachuca water umbel occurs in CC3, CC5, CC6, CC7, and CC8. Of these, only CC5 and CC7 were subject to detailed discharge and pool analyses. We have elected to consider not only CC5 and CC7, but to also consider effects to reaches CC2 and CC4 given their upstream and midpoint locations relative to the other sites, respectively. We are also including CC13 (extirpated, but present in the past per EEC 2001, Titus and Titus pers. comm. 2006, and Powell pers. comm. 2013), EG2 (based on past occurrence per Warren, pers. comm. 1996) , and CGW (based on BLM establishment of the taxon). Note that CGW is subject only to pool-based analysis.

Detailed analyses of zero-flow days, flow status, and pool surface area are found in the Effects to Aquatic Ecosystems section and in Table A-2, A-4, and A-8, respectively, above. The analyses will be summarized briefly here, and the relevant tabular data are also summarized in Tables H-1, H-2, and H-3, below, for only those reaches that support Huachuca water umbel or are situated upstream of reaches that do.

Table H-1 (Excerpt from Table A-2 and SBA Table D-11): Results of stream flow analysis for 95th percentile range – number of days with zero flow per year for sites in the vicinity of or occupied by Huachuca water umbel.

Key Reach	Scenario	End of Mine	10 Years	20 Years	50 Years	100 Years	150 Years
CC2	Climate Change	0	0	0	0	0	0
CC2	Mine and Climate Change	0	0	0	0	0	0
CC4	Mine Only	0	0	0	0	0	0
CC4	Climate Change	0	0	0	0	0	0
CC4	Mine and Climate Change	0	0	0	0	0	0
CC5	Mine Only	0-2	2-3	2-3	2-3	2-3	2-3

CC5	Climate Change	5	5	5	5	5	5
CC5	Mine and Climate Change	5	5-8	5-8	5-8	5-8	5-9
CC7	Mine Only	0-2	2-3	2-3	2-3	2-3	2-3
CC7	Climate Change	23	23	23	23	23	23
CC7	Mine and Climate Change	23	23-28	23-28	23-28	23-31	23-31
CC13	Mine Only	0	0	0	0	0	0
CC13	Climate Change	23	23	23	23	23	23
CC13	Mine and Climate Change	23	23	23	23	23	23
EG2	Climate Change	0	0	0	0	0	0
EG2	Mine and Climate Change	0	0	0	0	0	0

Table H-2 (Excerpt from Table A-4 and Table D-13): Results of stream flow analysis for 95th percentile range – flow status for sites in the vicinity of or occupied by Huachuca water umbel.

Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	P	P	P	P	P	P
CC2	Climate Change	P	P	P	P	P	P
CC2	Mine and Climate Change	P	P	P	P	P	P
CC4	Mine Only	P	P	P	P	P	P
CC4	Climate Change	P	P	P	P	P	P
CC4	Mine and Climate Change	P	P	P	P	P	P
CC5	Mine Only	P	P	P	P	P	P
CC5	Climate Change	P	P	P	P	P	P
CC5	Mine and Climate Change	P	P	P	P	P	P
CC7	Mine Only	P	P	P	P	P	P
CC7	Climate Change	P	P	P	P	P	P
CC7	Mine and Climate Change	P	P	P	P	P-I	P-I
CC13	Mine Only	P	P	P	P	P	P
CC13	Climate Change	P	P	P	P	P	P
CC13	Mine and Climate Change	P	P	P	P	P	P
EG2	Mine Only	P	P	P	P	P	P
EG2	Climate Change	P	P	P	P	P	P
EG2	Mine and Climate	P	P	P	P	P	P

	Change						
Notes: P = Perennial (<30 no-flow days per year); I = Intermittent (30–350 no-flow days per year); E = Ephemeral (>350 no-flow days per year)							

Table H-3 (Excerpt from Table A-8 and SBA Table D-26): Results of refugia pool analysis for 95 percentile range – median* percent remaining surface area of pools in the vicinity of or occupied by Huachuca water umbel.

Key Reach	Scenario	End of Mine	10	20	50	100	150
CC2	Mine Only	99	92-99	92-99	92-99	92-99	89-99
CC2	Climate Change	57	57	57	57	57	57
CC2	Mine and Climate Change	57	55-57	55-57	55-57	55-57	55-57
CC4	Mine Only	100	98-100	98-100	98-100	98-100	97-100
CC4	Climate Change	68	68	68	68	68	68
CC4	Mine and Climate Change	68	67-68	67-68	67-68	67-68	67-68
CC5	Mine Only	99	98-99	98-99	98-99	98-99	98-99
CC5	Climate Change	75	75	75	75	75	75
CC5	Mine and Climate Change	75	74-75	74-75	74-75	74-75	74-75
CC7	Mine Only	100	98-100	98-100	98-100	96-100	94-100
CC7	Climate Change	71	71	71	71	71	71
CC7	Mine and Climate Change	71	69-71	70-71	69-71	68-71	67-71
CC13	Mine Only	99-100	91-100	91-100	91-100	91-100	91-100
CC13	Climate Change	29	29	29	29	29	29
CC13	Mine and Climate Change	29	28-29	28-29	28-29	28-29	28-29
CC15	Mine Only	100	92-100	92-100	92-100	92-100	92-100
CC15	Climate Change	63	63	63	63	63	63
CC15	Mine and Climate Change	63	61-63	61-63	61-63	61-63	61-63
EG1	Mine Only	78-100	61-100	47-100	7-100	2-100	N-93
EG1	Climate Change	52	52	52	52	52	52
EG1	Mine and Climate Change	38-52	26-52	14-52	2-52	2-52	N-48
EG2	Mine Only	100	98-100	98-100	97-100	93-100	89-100
EG2	Climate Change	73	73	73	73	73	73
EG2	Mine and Climate Change	73	72-73	72-73	70-73	67-73	64-73
CGW	Mine Only	99-100	94-100	93-100	81-100	64-100	52-100
CGW	Climate Change	51	51	51	51	51	51
CGW	Mine and Climate Change	51	50-51	49-51	45-51	38-51	29-51

N - Indicates that no pools are predicted to remain
* In this case, 100 percent indicates that the pool retains all of its original volume; lower percentages indicate the percentage left of the original volume. For instance, a statistic of 80 percent would mean that the pool retains 80 percent of its original volume, and has lost or shrunk by 20 percent. The median is calculated only from those pools predicted to remain.

Upper Cienega Creek – Key Reaches CC2 and CC3

Key Reach CC2 was subject to detailed hydrologic analyses but is not known to be occupied by Huachuca water umbel. Reach CC3, situated immediately downstream of and adjacent to CC2, is occupied by Huachuca water umbel, but was not subject to hydrologic analyses. The information found in Table 3 in the May 2015 SBA indicates that the hydrology of CC3 is affected by the effects modeled for CC2.

Reach CC2 shows no days with zero flow under current baseline conditions. The effects of the mine, climate change, and both effects combined result in no increase in zero-flow days, and Cienega Creek is anticipated to remain perennial in this reach.

The retention of perennial flow does not necessarily indicate the effects of flow diminishment on pools. The 95th percentile analyses of the percent remaining pool surface area again indicate surface area losses in CC2 begin at the cessation of mining and increase over time. Mine drawdown may leave 89 percent area remaining at 150 years while climate change leaves as little as 57 percent at the same time step. Combined, as little as 55 percent of the initial pool area may remain 150 years after mining. If it assumed that effects in reaches CC2 are similar to and/or propagate downstream to reach CC3, then these represent measurable adverse effects to Huachuca water umbel. Note that the Specific Technique to Analyze Impact of Upstream Flow Losses column in Table 3 in the May 2015 SBA assumes for analytical purposed that outflow from CC2 contributes to inflow to CC4. It is therefore also reasonable to assume that outflow from CC2 contributes to inflow to CC3, which is situated between CC2 and CC4.

Upper Cienega Creek – Key Reaches CC5 and CC7

Reaches CC5, CC6, and CC7 are occupied by Huachuca water umbel, but CC6 was not subject to hydrological analyses in the May 2015 SBA. Table 3 in the May 2015 SBA states that CC7 is influenced by flow from reach CC5, which is located upstream. It is therefore highly likely that effects to CC5 would propagate downstream through CC6 as well.

Reaches CC5 and CC7 exhibit an average of 2 days with zero stream flow per year under present-day baseline conditions. Mine drawdown alone, absent the modeled effects of climate change, could increase zero-flow days up to 3 days per year under the 95th percentile analyses. Climate change absent the mine's impacts could result in 5 additional days with zero stream flow per year in CC5, and 23 additional days with zero stream flow per year in CC7.

The 95th percentile analyses of mine drawdown plus climate change would result in up to 9 days with zero stream flow per year in CC5 and up to 31 days with zero stream flow per year in CC7. Flow status would remain perennial in CC5 under the proposed mine-plus climate change scenarios; flow status in CC7 also largely remains perennial for most scenarios, but by 100 and 150 years after mine closure, the higher range of the 95th percentile analysis indicates a possible shift to intermittent flow for the mine-plus-climate change scenario. Given the positioning of CC6 between reaches with somewhat divergent flow status, we assume that CC6 will remain perennial under the mine-plus-climate change scenario (as with its contributing reach, CC5), with a possible shift to intermittent status (evident in the reach to which it contributes, CC7) at 150 years, if not by 100 years. A transition to intermittent flow, defined as from 30 to 350 zero flow days per year, is an adverse effect to Huachuca water umbel. The effect is particularly notable in that it is likely the zero-flow days will occur during the summer growing season, when flows are already at their lowest.

The 95th percentile results for median remaining pool surface area indicate that, at 150 years, mine drawdown is anticipated to leave 98 percent of the pool area remaining in CC5 and 94 percent in CC7. Climate change will leave 75 percent in CC5 and 71 percent in CC7 at 150

years. Combined, mining and climate change are modeled to result in 74 percent and 67 percent median pool surface area remaining 150 years in reaches CC5 and CC7, respectively.

Climate change is the predominant factor in declining flows and loss of pool surface area in CC5 and CC7; the proposed action only intensifies the effects to a moderate degree (see previous key-reach analyses and Tables H-1 and H-3, above for the specific values). Again, Table 3 in the May 2015 SBA states that flow in CC7 is influenced by CC5; making it very likely that CC5 also influences CC6. Given that reach CC6 is likely to exhibit similar effects to reach CC 5 upstream and/or CC7 downstream, then the incremental effects of mine drawdown there are also similar; small and difficult to measure. With respect to assumption of flow contributions to CC6, we again refer to the Specific Technique to Analyze Impact of Upstream Flow Losses column in Table 3 in the May 2015 SBA assumes for analytical purposed that outflow from CC5 contributes to inflow to CC7. It is therefore also reasonable to assume that outflow from CC5 contributes to inflow to CC6, which is situated between CC5 and CC7.

Lower Cienega Creek – Key Reach CC13

Key Reach CC13 is located within the Pima County CCNP, and as stated previously, Huachuca water umbel has been detected here in the past. The May 2015 SBA's 95th percentile analyses for CC13 shows that mine drawdown alone would result in no increase in zero stream flow days at any time step from the end of mining to 150 years. Climate change by itself would result in 23 additional days exhibiting zero stream flow per year at every time step in CC13. In combination, mine drawdown plus climate change would result in 23 days with zero stream flow per year in CC13 (no change from climate change-only results). Reach CC13 would therefore remain perennial.

Under the 95th percentile analysis, the mine-only effect is the retention of 91 percent of median surface area in CC13 at 150 years. Climate change effects are of a greater magnitude in CC13; 29 percent of pool surface area will remain. Mining and climate change combined will leave as little as 28 percent of pool surface area remaining in key reach CC13.

Again, as is the case in CC5 and CC7, above, climate change is the primary driver of declining flows and loss of pool surface area in CC13 over time; the proposed action makes only an incremental contribution to losses from the present-day baseline condition. We cannot definitively ascertain the magnitude of this effect to the Huachuca water umbel.

Lower Empire Gulch – Key Reach EG2

Discharges in lower Empire Gulch, in which Huachuca water umbel has been detected, appear to be less affected by mine drawdown than upstream in EG1. Mine drawdown, climate change, or both scenarios combined are modeled to exhibit no days of zero flow noted under any of the 95th percentile modeling scenarios. This equates with no change from the baseline, and flow status would remain perennial.

The 95th percentile analyses of the losses of pool surface area due to mine drawdown alone predict that as little as 89 percent of pool surface area will remain intact at 150 years, with all

other times steps at a less than 10 percent loss. Climate change is the predominate factor in surface area losses in EG2 pools, leaving 51 percent of the area at all modeled intervals.

Together, climate change and mine drawdown will leave 51 percent of pool surface area intact at the end of mining; this trend proceeds until reaching 29 percent at 150 years. Pools in lower Empire Gulch are anticipated to experience measurable adverse effects, although lower in magnitude relative to upstream reaches (EG1). These effects are driven by climate change, although mine drawdown does make a measurable, incremental contribution. The magnitude of this incremental effect in terms of Huachuca water umbel is difficult to definitively measure, but is anticipated to result in reduced vigor and extent of the taxon's occurrences.

Cieneguita Wetlands

The Cieneguita Wetlands ponds, in which Huachuca water umbel have been established by the BLM, were not subject to a zero-flow day analysis, but were subject to pool-related analyses. As stated in the Effects to Aquatic Ecosystems section, above, mine drawdown alone is anticipated to modestly effect pool surface area up to 20 years post mining, but this effect will increase to 81 percent surface area remaining at 50 years, 65 percent at 100 years, and 52 percent at 150 years. Climate change is predicted to leave 51 percent pool volume remaining in CGW throughout the modeled period. The combined effects of mine drawdown and climate change are predicted to leave as little as 39 and 29 percent of pool surface area intact, at 100 and 150 years, respectively. This is a measurable adverse effect to Huachuca water umbel.

Other Effects

The detailed hydrologic modeling provides a method whereby the effects of the proposed action can be quantified. We, however, remain concerned with a certain adverse effect that is not readily quantified in this manner. As discussed in the effects analysis for the southwestern willow flycatcher in our October 30, 2013 BO, near-stream (alluvial) groundwater drawdown and reduced surface flows characterize the most visible aspect of riparian effects, but don't necessarily describe their full extent. Moreover, the southwestern willow flycatcher analysis in the prior BO 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.

The May 2015 SBA quantified pool losses in terms of number (see Table A-5, above) and surface area (see Table A-9, above). These losses have the practical effect of reducing the wetted length of stream. 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.

This would be expected to be accompanied by reduced numbers of unique individuals and increased fragmentation and isolation. Such fragmentation and isolation increases the risk of genetic erosion that may reduce plant vigor necessary for successful longer-term genetic adaptation to changing conditions (Vernadero Group and Desert Botanical Garden 2012).

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, creating a relatively larger differential between low flows and peak flows. Vegetation that establishes itself at a lower elevation and closer to the thalweg (deepest, central line of a channel) in the pioneer zone of a narrowed low-flow channel will be subject to scouring from the unaffected peak flows, which act as channel-forming agents. 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 occurrences and may result in extinctions locally (Warren *et al.* 1991; Warren *et al.* 1989).

Summary of Adverse Effects and Effects to Recovery - Huachuca Water Umbel

Huachuca water umbel plants occurring along Cienega Creek in reaches CC3, CC5, CC6, CC7, and CC8 are anticipated to experience a decreased extent of occurrence and reduced vigor of remaining occurrences over time. These effects are due primarily to the effects of climate change on stream flow and, by extension, pools. The relative effect of mine drawdown varies by reach; it is minimal in lower Empire Gulch and the mainstem of Cienega Creek, moderate in the Cieneguita Wetlands, and severe in upper Empire Gulch.

Reach CC3 was not specifically modeled, but in reach CC2, upstream, the mine would reduce pool surface area by 11 percent while climate change reduces it by 43 percent. The effects of the mine are additive to the effects of climate change and so the net, incremental effect of mine drawdown is to slightly reduce the ability for Huachuca water umbel to persist and associated expected reduction in genetic variability in reach CC2 over the long term.

In reaches CC5 and CC7, the only occupied reaches subject to detailed modeling, mine drawdown would result in 2 percent and 6 percent losses of pool surface area, respectively. Climate change would precipitate 25 percent and 29 percent losses of pool surface area in reaches CC5 and CC7, respectively. The effects of the mine are additive to the effects of climate change and so the net, incremental effect of mine drawdown is to slightly reduce the resilience of Huachuca water umbel in reaches CC5, CC7 and, by inference CC6, with an associated expected reduction in genetic variability in the face of climate change.

Huachuca water umbel occurring in or near lower Empire Gulch is also anticipated to experience reduced vigor and extent, but a larger proportion of the effects are the result of mine drawdown. In EG2, mine drawdown is anticipated to cause an 11 percent reduction in pool surface area while climate change will reduce pool area by 27 percent. Mine drawdown is therefore an appreciable contributor to the up-to 36 percent loss of pool surface area anticipated to occur as a result of mine operations and climate change. The net, incremental effect of the proposed action is significant degradation of aquatic habitat and an appreciable diminishment of Huachuca water umbel's ability to persist combined with a loss of genetic variability impairing adaptation potential, at recent levels of abundance or extent.

In the Cieneguita Wetlands, and at 150 years post-mining, climate change alone will reduce pool surface area by 49 percent from present-day, baseline conditions, leaving 51 percent remaining. The mine alone could result in as little as 52 percent of pool surface area remaining at 150 years (48 percent remaining). Combined, mining and climate change will leave as little as 31 percent of the present-day pool volume intact. Mine drawdown is therefore responsible for approximately one-third of the effects to Huachuca water umbel at this site, and will significantly degrade aquatic habitat and appreciably reduce the ability for the taxon to persist in the future.

We compared Huachuca water umbel occurrence data from the AGFD Heritage Data Management System (HDMS) (Schuetze, pers. comm. August 5, 2014) with the geographic extent of the key reaches (see the Effects to Aquatic Ecosystems section, above) and determined that 423 acres of Huachuca water umbel occurrences will be permanently adversely affected by the proposed action. The HDMS minimum polygon size for a Huachuca water umbel occurrence is 8 acres, which is why the affected area of occurrences exceeds the area actually occupied by patch-based occurrences of the taxon.

The adverse effects to the habitat for Huachuca water umbel described above also represent effects to the taxon's recovery potential. The mine-driven drawdown's effects to the taxon's habitat reduce the potential for downlisting criterion 1 (minimum cumulative extent of naturally-occupied habitat, including within in the Santa Cruz Watershed) and criterion 3 (no less than 20 years of management and reduction of threats). Given that the potential to achieve downlisting criteria 1 and 2 is reduced, the potential to achieve the sole downlisting criterion (meeting the criteria for downlisting and sustaining or increasing the occupancy level in the downlisting criteria for a minimum of 20 years over a 30 year period) is also reduced.

Downlisting criterion 2 (placement of introduced occurrences), criterion 4 (maintenance of living plants from diverse locations in botanical gardens), criterion 5 (collection and storage of Huachuca water umbel seeds from diverse locations) are not anticipated to be adversely affected by mine-driven hydrologic changes.

An additional analysis of the proposed action's effects to the recovery potential of Huachuca water umbel involves determining the manner and extent to which the necessary actions (see Actions Needed, above) can be implemented within the action area. The mine-driven groundwater drawdowns and reductions in surface flow will reduce the ability to implement needed action 1 (maintenance or enhancement of groundwater hydrography) and needed action 2 (preservation of existing Huachuca water umbel occurrences and habitat quality). The remaining actions needed are not anticipated to be affected.

Effects of the Proposed Conservation Measures - Huachuca Water Umbel

The proposed action described in the October 30, 2013 BO, included: (1) eight conservation measures specifically pertaining to aquatic species; (2) a Cienega Creek subwatershed restoration and water right protection program; and (3) the restoration of isolated ponds within the Sonoita Creek Ranch. The Sonoita Creek Ranch component of the conservation measures was more-definitively described in the September 2014 HMMP (see the U.S. Army Corps of Engineers

Habitat Mitigation and Monitoring Plan section in the Description of the Proposed Action, above). Additionally, a new conservation measure, entitled Revised Conservation Measure 2 – Harmful Nonnative Species Management and Removal (see Description of the Proposed Conservation Measures, above) was recently added.

We stated in the October 30, 2013 BO that the benefits of the various conservation measures associated with Huachuca water umbel were prospective, and of minimal incremental value for the taxon, and could not be definitively assigned any mitigative value. This remains our position for the initial eight conservation measures specifically pertaining to aquatic species and the Cienega Creek subwatershed restoration and water right protection program. As stated above, however, we have since published a Draft Recovery Plan for the Huachuca water umbel. We will therefore supplement our initial analysis of the initial eight conservation measures specifically pertaining to aquatic species and the Cienega Creek Watershed subwatershed restoration with analyses of the respective programs' contribution to recovery.

Five 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; APP) 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. Of the remaining three conservation measures, one was an incorporation of the Sonoita Creek Ranch and Cienega Creek Watershed measures while the two other provided specific details regarding implementation of the latter.

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 remains unknown.

We anticipate that these eight actions may make minimal contributions to downlisting criterion 1 (minimum cumulative extent of naturally-occupied habitat, including within in the Cienega Creek watershed) and criterion 3 (no less than 20 years of management and reduction of threats). We anticipate that the eight conservation actions will have no specific beneficial or adverse effects to any of the remaining three downlisting criteria or the sole delisting criterion. Given that there is a potential contribution to achieving downlisting criteria 1 and 2, the potential to achieve the sole downlisting criterion (meeting the criteria for downlisting and sustaining or increasing the occupancy level in the downlisting criteria for a minimum of 20 years over a 30 year period) is also minimally enhanced. We do note, however, that the adverse effects of mine drawdown may outweigh or reduce the magnitude of these conservation measures' benefits.

We also anticipate that implementation of the eight aquatic species conservation measures will

make a small, incremental contribution to implement the ability to accomplish the Actions Needed (see above) in order to achieve recovery of Huachuca water umbel. Specifically, the water quality-related aspects of the measure may assist in implementing downlisting criterion 2 (preservation of the taxon's habitat quality via compliance with the APP and NPDES) and criterion (geomorphic studies could contribute to the understanding of relationships key to recovery of the species). We anticipate no beneficial or adverse effects to the remaining needed actions. Again, the adverse effects of mine drawdown may exceed and/or reduce the contributions made by these conservation measures.

The Cienega Creek Watershed conservation measure, analyzed in the October 30, 2013 BO, 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 up to 3,000 linear feet of riparian restoration 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 a designated conservation partner.

As stated in the October 30, 2013 BO, 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 was, and is, considered speculative.

The proposed establishment and funding of the Cienega Creek Watershed Conservation Fund is anticipated to make incremental contributions to achievement of downlisting criterion 1 (minimum cumulative extent of naturally-occupied habitat, including within in the Santa Cruz watershed), criterion 2 (placement of introduced occurrences) and criterion 3 (no less than 20 years of management and reduction of threats). Given that there is a small potential contribution to achieving downlisting criteria 1, 2, and 3, the potential to achieve the sole downlisting criterion (meeting the criteria for downlisting and sustaining or increasing the occupancy level in the downlisting criteria for a minimum of 20 years over a 30 year period) is also enhanced to a small degree.

The successful implementation of the proposed Cienega Creek Watershed Conservation Fund is also anticipated to make a small improvement in the ability to implement needed action 1 (maintenance or enhancement of groundwater hydrography), needed action 2 (preservation of unoccupied corridors and possibly, seedbanks) and needed action 5 (establishment of introduced Huachuca water umbel occurrences). The remaining actions needed are not anticipated to be affected.

We also anticipate mitigative value for the revised version of the Sonoita Creek Ranch project and the newly-proposed Harmful Nonnative Species Management and Removal program.

There have been two changes (relevant to the Huachuca water umbel) in the Sonoita Creek

Ranch conservation measure as analyzed in the FEIS and October 30, 2013 BO. First, the acreage to be enhanced increased from 1,200 acres to 1,580 acres. Within this acreage, approximately 6 surface acres of ponds containing wetlands will be restored. The second change is that Rosemont has stated that Huachuca water umbel will be included in the vegetation component of the restoration. We cannot definitively determine the length of pond banks or area of wetlands that will be suitable for Huachuca water umbel, but we anticipate that the site will eventually contain a patch or patches of the species and thus become a new occurrence (see Terminology section, above) of the species. While any Huachuca water umbel occupancy in the ponds at Sonoita Creek Ranch would be mapped in HDMS as an 8-acre occurrence, that acreage figure far exceeds the fractions of an acre along the 6-acre ponds' shallow periphery in which the taxon could be established and persist. There is no Huachuca water umbel critical habitat present on the site. Critical habitat is present at Cottonwood Spring, but this is located north (and upstream) from the conservation lands.

The successful implementation of the pond portion of the proposed Sonoita Creek Ranch conservation measure has the potential to contribute to achievement of downlisting criterion 1, should the taxon already be present there (minimum cumulative extent of naturally-occupied habitat, including within in the Santa Cruz watershed), criterion 2, should the taxon be absent but become established (placement of introduced occurrences), and criterion 3 (no less than 20 years of management and reduction of threats). Given that there is a potential contribution to achieving downlisting criteria 1 or 2, the potential to achieve the sole downlisting criterion (meeting the criteria for downlisting and sustaining or increasing the occupancy level in the downlisting criteria for a minimum of 20 years over a 30 year period) is also enhanced. Implementation of the Sonoita Creek Ranch conservation measure will result in no improvements to, nor diminish the ability to achieve downlisting criterion 4 (maintenance of living plants from diverse locations in botanical gardens) or criterion 5 (collection and storage of Huachuca water umbel seeds from diverse locations).

The successful implementation of the proposed Sonoita Creek Ranch conservation measure will improve the ability to implement needed action 1 (maintenance or enhancement of groundwater hydrography), needed action 2 (preservation of unoccupied corridors and possibly, seedbanks) and needed action 5 (establishment of introduced Huachuca water umbel occurrences). The remaining actions needed are not anticipated to be affected.

The Harmful Nonnative Species Management and Removal program has been subjected to a hypothetical analysis in order to determine its contribution to the conservation of Huachuca water umbel. Rosemont has proposed to provide $3,000,000 to implement nonnative species management, both plant and animal. We elected to apportion $200,000 to the control of nonnative plants, which, depending on the species, compete directly with Huachuca water umbel, alter stream hydrology, or increase fire risk within wetlands. Subsequent augmentation of Huachuca water umbel patches would also occur. Critical habitat is present within the area in which treatments will occur (within Scotia Canyon and Bear/Lone Mountain Canyons).

We first worked with USFS staff to generate cost estimates for herbicide application. It must be noted that herbicide application was selected for its potential to control larger infestations of invasive plants such as Johnsongrass (*Sorghum halepense*). We are aware that such herbicide

applications could adversely affect extant Huachuca water umbel, as well as, threatened and endangered animal species. Herbicide application is but one potential restoration measure, and it was selected specifically because it would involve the greatest environmental compliance costs. Other potential uses of the $200,000 could exhibit lower costs per acre and thus, result in a larger areal extent of beneficial effects.

We examined Huachuca water umbel occurrences on the Sierra Vista Ranger District (RD) of the Coronado NF. These sites are well outside of the area affected by the proposed action's groundwater drawdowns and represent locations in which incremental improvements in the status of Huachuca water umbel (via reduction of competitive, nonnative plant species) are likely to be achieved . The following are the sites and occurrence acreage values calculated using HDMS data that resulted from this analysis: Sunnyside (125 acres); Turkey Creek (45 acres); Bear/Lone Mountain (107 acres); Scotia (189 acres); O'Donnell (10 acres); Sycamore (8 acres); and Cave Creek (46 acres). The total acreage among all of these Sierra Vista (RD) occurrences is 538 acres. As stated previously, AGFD HDMS data utilize an 8-acre minimum polygon size for a Huachuca water umbel occurrence; this is why the to-be-treated acreage exceeds the area occupied by patch-based occurrences of the taxon.

To determine the cost of survey and herbicide treatment, we consulted with the USFS. The Forest Service provided us a cost of $74/acre for survey and $200/acre for herbicide + application on 538 acres of occurrences ($274 x 538 = $147,412). We anticipate that planning and compliance costs, in general, could represent up to approximately one third of a project total (in this case, $48,647). The total cost of implementing such a nonnative plant removal program would be $196,058. While we employed herbicide application-based treatments for cost estimation purposes, we reiterate that herbicide treatment of nonnative plants is only one method by which to improve the status of Huachuca water umbel, and does not necessarily represent the only method that will ultimately be implemented. We also reiterate that herbicide treatment – and any other treatment for that matter – may require further consultation on effects to Huachuca water umbel and possibly, other threatened and endangered species.

As stated above in the Summary of Adverse Effects section, the proposed action will permanently, adversely affect up to 423 acres of Huachuca water umbel occurrences in the Cienega Creek watershed. The proposed action will beneficially, and to an extent temporarily, affect up to 538 acres of Huachuca water umbel occurrences in multiple watersheds. The 538 beneficially-affected acres of occurrences is associated with the Harmful Nonnative Species Management and Removal program, which we have envisioned as a single, relatively large-scale action (see cost estimate calculations, above). We anticipate that harmful nonnative species will become reestablished within some, if not all of the 538 acres at some point over the 150-year term of hydrologic modeling that forms the basis for the Huachuca water umbel effects analysis. The net effect, at up to 150 years post mining, is thus the adverse effects to up to 423 acres of occurrences. The effects of this net loss would be minimized if the Cienega Creek Watershed Conservation Fund and Sonoita Creek Ranch conservation measures result in the establishment of functionally permanent Huachuca water umbel occurrences, though we anticipate these will be relatively small in areal extent (i.e. small fractions of an acre).

The successful implementation of the Harmful Nonnative Species Management and Removal

program has the potential to temporarily (the program is not perpetual) contribute to achievement of downlisting criterion 2 (placement of introduced occurrences). Given that the potential contribution to achieving downlisting criterion 2, the potential to achieve the sole downlisting criterion (meeting the criteria for downlisting and sustaining or increasing the occupancy level in the downlisting criteria for a minimum of 20 years over a 30 year period) will not be permanently precluded. The Harmful Nonnative Species Management and Removal program will result in no improvements to, nor diminish the ability to achieve downlisting criterion 1 (minimum cumulative extent of naturally-occupied habitat, including within in the Santa Cruz watershed), criterion 3 (no less than 20 years of management and reduction of threats), criterion 4 (maintenance of living plants from diverse locations in botanical gardens), or criterion 5 (collection and storage of Huachuca water umbel seeds from diverse locations).

The successful implementation of the proposed Harmful Nonnative Species Management and Removal program will improve the ability to implement needed recovery action 2 (preservation of existing Huachuca water umbel occurrences and habitat quality) and needed action 5 (establishment of introduced Huachuca water umbel occurrences) for as long as implementation is underway. The remaining actions needed are not anticipated to be affected.

Recovery Tipping Point

The tipping point at which recovery of Huachuca water umbel would be precluded requires that we determine the likelihood that the proposed action's 423 acres of permanent adverse effects will appreciably impede or preclude the achievement of the draft recovery criteria; and if so, are the impediments and/or preclusions of such a scale and/or magnitude that the taxon can no longer be recovered?

A tipping point and recovery analysis cannot be conducted for Huachuca water umbel critical habitat within the adversely-affected area in the Cienega Creek watershed, as none has been designated there. Critical habitat does exist in the area in which the Harmful Nonnative Species Management and Removal program will be implemented, but these effects, as stated above, are at least temporarily beneficial. Critical habitat also exists at Cottonwood Spring, located north and upstream of the Sonoita Creek Ranch; this portion of critical habitat will not be affected.

As previously stated, the 423 acres of adverse effects are the result of reductions in the wetted perimeter and length of streams occupied by patch-based occurrences of Huachuca water umbel. The 423-acre area is composed of individual Huachuca water umbel occurrences and surrounding stream and watersheds which were based, for analytical purposes, on the 8-acre AGFD HDMS minimum polygon size per occurrence. In other words, Huachuca water umbel patches do not occupy the entire 423-acre affected area, and there are not 423 acres of individual patches being affected.

We have also anticipated that the affected streams in the Cienega Creek mainstem and lower Empire Gulch are unlikely to be completely dewatered, even considering modeled climate change scenarios (see Effects to Aquatic Ecosystems section and the analysis of effects to the species, above). It is therefore likely that individual Huachuca water umbel occurrences will persist, albeit in unknown numbers and extent. For these reasons, we have determined that the

area-based draft recovery criteria can still be met within the area affected by the proposed action. Specifically, we anticipate that draft recovery (downlisting) criterion 1, which requires that 0.5 acre of Huachuca water umbel occurrences persist in the Santa Cruz watershed, 35 percent (0.175 acre) of which are in Cienega Creek, can still be achieved, despite diminished flows. It must be noted, that while 0.175 acre of Huachuca water umbel occurrences appears small in terms of areal extent, it can nevertheless represent numerous patches of the taxon. For example, in 2011, throughout all of Cienega Creek, approximately 100 patches represented approximately 0.34 acres of occurrence (BLM 2011).

The retention of admittedly-reduced flows, and lack of complete dewatering in Cienega Creek and lower Empire Gulch, also will not preclude achievement of draft recovery (downlisting) criterion 2, which requires there exist at least three separate introduced occurrences with a minimum cumulative extent of 0.037 acre of occupied habitat in each of the three occupied watersheds in the United States (Yaqui, San Pedro, and Santa Cruz). In this case, Cienega Creek is but a portion of the larger Santa Cruz River watershed, and we anticipate sufficient opportunities will remain in other locations, if not in Cienega Creek itself. Furthermore, implementation of the Sonoita Creek Ranch and/or Cienega Creek Watershed Conservation Fund could also directly result in the establishment of introduced Huachuca water umbel occurrences.

The sole delisting criterion requires that all downlisting criteria be met and the level of occupancy in the downlisting criteria be sustained or increasing for a minimum of 20 years over a 30 year period. Given that the ability to achieve downlisting criteria 1 and 2 is likely to be retained, we have determined that the proposed action will not preclude the delisting of Huachuca water umbel.

To summarize the tipping point determination in general terms, the Cienega Creek system is one of three medium-scale watersheds in which Huachuca water umbel occurs (the others being the San Pedro and Yaqui river watersheds). These systems are all likely to experience diminished environmental conditions (relative to the present day) from regional climate change and increasing withdrawals of groundwater for human needs. At the most coarse scale, we feel that it is reasonable to state that recovery of Huachuca water umbel would be precluded if the taxon were to be extirpated from one or more of these watersheds; draft recovery criteria 1 and 2 specifically address this issue). Such extirpation would likely require long-term losses of surface water in habitats occupied by the taxon; the proposed action, alone or combined with climate change will not result in such losses. Conversely, we feel that recovery of the taxon could be achieved if the surface flows in these watersheds were secured, if not increased in volume and length, in perpetuity (see draft recovery criterion 3); the proposed action will make incremental contributions – both temporary and permanent - to this end. We have determined that the diminished flows in the Cienega Creek system that are likely to result from the proposed action, when considered in addition to the future effects of climate change, are not of sufficient scale (stream length and potential number of individuals within 423 acres of occurrences) to preclude recovery at the Cienega Creek watershed, Santa Cruz watershed, or rangewide scales.

The long-term (up to 150 years and beyond) adverse effects of the proposed action are permanent, but the affected area within the action area is small compared to the range of the Huachuca water umbel. The beneficial effects of the Sonoita Creek Ranch conservation measure

are permanent, but very small in scale. The beneficial effects of the Harmful Nonnative Species Management and Removal conservation measures are similar in scale to the adverse effects and, while finite in duration, are anticipated to temporarily reduce the negative impact of the action, including within Huachuca water umbel critical habitat in the Scotia Canyon and Bear/Lone Mountain Canyon units. Lastly, while not given great analytical weight in our analysis and determinations, we do feel that the Cienega Creek Subwatershed Fund, should it achieve its stated goals and incorporate suggested conservation recommendations for the taxon into its plans, could make incremental contributions to Huachuca water umbel recovery that would be expected to help compensate for mine related contractions and losses.

Overall, it is the scale of the adverse effects that informs our conclusion that it is unlikely that the proposed action would cause large-scale physical alteration to the taxon's habitat, thus making it unlikely that a tipping point away from recovery would be reached. Quantitatively, the Cienega Creek subwatershed presently supports roughly 12 percent of the total known range of Huachuca water umbel. The proposed action will likely reduce this percentage but is unlikely to drive it below the 0.125 acre required to meet draft recovery criterion 1. The Harmful Nonnative Species Management and Removal program will temporarily enhance approximately 16 percent of the known occurrences of Huachuca water umbel. Establishment of Huachuca water umbel at Sonoita Creek Ranch would occur on some portion of the 6 acres of ponds and wetlands at the site, making an incremental contribution to the 0.037 acre of introduced occurrences in draft recovery criterion 2.

Alternately, given that climate change and the cumulative effects of groundwater use and invasive nonnative species are acting on the Huachuca water umbel at the rangewide scale, it is possible that the taxon's overall abundance will decline while the percentage represented in the Cienega Creek subwatershed will be only somewhat reduced based on climate change models. If declines elsewhere are significant, this will increase the significance of maintaining and managing the 423 acres of adversely affected Cienega Creek subwatershed occurrences in numbers, extent and genetic variability; particularly in light of its geographic center in the range. Further, rangewide declines may also reduce the extent of Huachuca water umbel within the small area at Sonoita Creek Ranch and the 538 acres of lands (and critical habitat units in the Scotia Canyon and Bear/Lone Mountain Canyon units) temporarily benefitting from the Harmful Nonnative Species Management and Removal program. This would reduce the value of the conservation measures in proportion to the adverse effects.

Regardless of which of the aforementioned scenarios occurs, the net adverse effects (Cienega Creek's permanent effects less the temporary effects of conservation measures) that occur in the action area do not reach the tipping point; the scale where recovery of the taxon would be delayed or precluded.

Cumulative Effects - Huachuca Water Umbel

The Cumulative Effects section for the Huachuca water umbel remains as described in the October 30, 2013 BO, and is incorporated herein via reference.

Conclusion - Huachuca Water Umbel

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted, the conclusion of non-jeopardy, below, would remain valid.

The magnitude of the proposed action's adverse effects to streams and wetlands in which Huachuca water umbel occurs have been modeled, as have the effects of climate change. While it is unlikely that observed conditions will conform precisely to the 95th percentile results relied upon in this consultation, the data do represent the best available information regarding the future status of the physical habitat for the taxon. We therefore anticipate that an indeterminate number of individual Huachuca water umbel patches occurring along Cienega Creek in Key Reaches CC3, CC5, CC6, CC7, and CC8; in lower Empire Gulch (EG2); and in the Cieneguita Wetlands (CGW) will experience a decreased extent of occurrence and reduced vigor of remaining occurrences in Cienega Creek over time, and that Huachuca water umbel occurrences will be reduced to various extents at the reach scale.

It is, however, unlikely that the proposed action will result in large-scale reductions of perennial stream reaches in the Cienega Creek portion of the action area and thus, Huachuca water umbel is unlikely to be extirpated from the greater Cienega Creek subwatershed. Lastly, the mitigative value of two of the proposed conservation measures (Sonoita Creek Ranch ponds and the Harmful Nonnative Species Management and Removal program) are likely to result in the restoration of Huachuca water umbel to a new site and some enhancement of existing occurrences, respectively. The Cienega Creek subwatershed restoration and water right protection program could result in long-term protection of stream flows if the measure is fully implemented and successful. The Harmful Nonnative Species Management and Removal program is anticipated to result in enhanced conditions within Huachuca water umbel critical habitat units in the Scotia Canyon and Bear/Lone Mountain Canyon units.

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 construction and operation of the proposed Rosemont Mine project is not likely to jeopardize the continued existence of the taxon. Our rationale for this conclusion is as follows:

1. Modeled declines in groundwater elevation will result in decreases in stream discharge from the end of mining to at least 150 years later. These flow losses, in turn, precipitate degradation of the aquatic habitat in which Huachuca water umbel occurs. If the modeled increases in the frequency of zero-flow days and losses of pool surface area are valid, these losses will be potentially severe in the Cieneguita Wetlands and Empire Gulch, minimal in the upper and downstream reaches of the mainstem of Cienega Creek, and will reduce the vigor, extent, and genetic variation of individuals within 423 acres of

Huachuca water umbel occurrences in the affected areas.

2. These 423 acres of effects to Huachuca water umbel represent roughly12 percent of its known range. The effects are not likely to jeopardize the taxon because it occurs elsewhere in the Santa Cruz, San Pedro, and Yaqui river watersheds in sites unaffected by the proposed action.
3. Implementation of the Harmful Nonnative Species Management and Removal program could improve the status of Huachuca water umbel occurrences on 538 acres, potentially improving the species' status within approximately 16 percent of its known range.
4. A new Huachuca water umbel occurrence is likely to be established in the Sonoita Creek Ranch ponds, further minimizing the adverse effects of the proposed action.
5. The relatively wide distribution of the Huachuca water umbel within distinct watersheds and the low likelihood that the proposed action will extirpate the taxon entirely from the Cienega Creek subwatershed mean that the proposed action is unlikely to pass the tipping point (i.e. precipitate appreciable delays in or preclusion of implementation of the draft recovery criteria).
6. 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.
7. Rosemont will sever and transfer downstream senior water rights to upstream reaches of Cienega Creek via the Cienega Creek Watershed program. Once 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 subwatershed. If the water rights cannot be successfully severed and transferred, reinitiation of formal consultation may be warranted.
8. 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 taxon 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; maliciously damage or destroy any such species on any such area; or damage or destroy any such species on any other area in knowing violation of any law or 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.

The National Fish Wildlife and Plants Climate Adaptation Strategy (National Fish, Wildlife, and Plants Climate Adaptation Partnership 2012) emphasizes the importance of species specific management of populations for improved sustainability (Action 2.2.3 and 2.3.1) to address climate change impacts, including proactive measures to obtain and secure genetic diversity through seed banking and propagation (Actions 2.3.3 and 2.3.4). Employing these approaches and techniques can significantly improve the prospects for sustainability and adaptation for the hydrological units being impacted and for the species.

1. The FWS recommends that the USFS and Corps ensure that Rosemont survey for Huachuca water umbel in the existing ponds at the Sonoita Creek Ranch prior to initiating construction; the species already occurs and/or has occurred in the Sonoita Creek watershed (FWS 2014: 7).
2. The FWS recommends that the USFS and Corps ensure that Rosemont monitors Huachuca water umbel transplanted to the Sonoita Creek Ranch ponds for success, and supplement the transplants with additional plants until a self-sustaining occurrence has been established. Care should be given to ensure proper genetic matching of plant materials for all introduced or augmented occurrences.
3. The FWS recommends that the USFS and Corps ensure that Rosemont augment occurrences of Huachuca water umbel with the Huachuca Mountains on Forest Service land and /or work collaboratively with other land managers to introduce or augment occurrences of Huachuca water umbel in other suitable habitat. Transplants will be monitored by Rosemont for success, and supplemented with additional transplants until self-sustaining occurrences have been established. Care should be given to ensure proper genetic matching of plant materials for all introduced or augmented occurrences.
4. The FWS recommends that for reaches where the extent and numbers of individuals present are expected to be negatively impacted, that a program be developed to grow/cultivate representative samples of the water umbel to produce seed, get the resultant seed banked in long-term cryogenic storage—and explore the feasibility of cryogenic storage of rhizomes for future needs. Achieving this *ex-situ* resource will provide material to meet restoration needs to maintain occurrence viability and genetic variation in the watershed, optimizing sustainability and resilience for future adaptation.
5. The FWS recommends that the USFS continue to collect monitoring data regarding Huachuca water umbel occurrences on the Coronado National Forest.
6. The FWS recommends that the USFS and Corps provide comments when the draft recovery plan for the Huachuca water umbel is released, and that such comments include a synthesis of the monitoring data discussed under Recommendation 2, above.
7. The FWS recommends that the USFS continue with its ongoing efforts to arrest erosion and restore ecosystems on streams on the Coronado National Forest within which Huachuca water umbel occurs. We recommend specific attention to areas invaded by Johnsongrass (*Sorghum halepense*).
8. The FWS recommends that the USFS explore remedies to resolve cattle congregation in Huachuca water umbel habitat during critical, dry periods.
9. The FWS recommends that the USFS 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.

10. The FWS recommends that the USFS invasive nonnative plant management program include control for those species particularly impacting habitat quality for Huachuca water umbel noted to be problematic in the 5 year status assessment.

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.

WESTERN YELLOW-BILLED CUCKOO

Status of the Species

Description

Adult yellow-billed cuckoos have moderate to heavy bills, somewhat elongated bodies and a narrow yellow ring of colored bare skin around the eye. The plumage is grayish-brown above and white below, with reddish primary flight feathers. The tail feathers are boldly patterned with black and white below. They are medium-sized birds about 12 inches in length, and about 2 ounces in weight. Males and females differ slightly; the males have a slightly smaller body size, smaller bill, and the white portions of the tail tend to form distinct oval spots. In females the white spots are less distinct and tend to be connected (Hughes 1999).

Morphologically, the yellow-billed cuckoos throughout the western continental United States and Mexico are generally larger, with significantly longer wings, longer tails, and longer and deeper bills (Franzreb and Laymon 1993). Birds with these characteristics occupy the Western Distinct Population Segment (DPS) and we refer to them as the western yellow-billed cuckoo. Only the Western DPS was listed as a threatened species (FWS 2014b). Yellow-billed cuckoos in the west arrive on the breeding grounds 4 to 8 weeks later than eastern yellow-billed cuckoos at similar latitude (Franzreb and Laymon 1993, Hughes 1999).

Distribution

The yellow-billed cuckoo is a member of the avian family Cuculidae and is a Neotropical migrant bird that winters in South America and breeds in North America. The breeding range of the entire species formerly included most of North America from southeastern and western Canada (southern Ontario and Quebec and southwestern British Colombia) to the Greater Antilles and northern Mexico [American Ornithologists Union (AOU) 1957, 1983, 1998].

Based on historical accounts, the western yellow-billed cuckoo was formerly widespread and locally common in California and Arizona, more narrowly distributed but locally common in New Mexico, Oregon, and Washington and uncommon along the western front of the Rocky Mountains north to British Columbia (AOU 1998, Hughes 1999). The species may be extirpated from British Colombia, Washington, and Oregon (Hughes 1999). The western yellow-billed cuckoo is now very rare in scattered drainages in western Colorado, Idaho, Nevada, and Utah, with single, nonbreeding birds most likely to occur (FWS 2014a, 2014b). The largest remaining breeding areas are in southern and central California, Arizona, along the Rio Grande in New Mexico, and in northwestern Mexico (FWS 2014b).

Phillips *et al.* (1964) described the species a common resident in the (chiefly lower) Sonoran zones of southern, central, and western Arizona at the time of publication. The yellow-billed cuckoo now nests primarily in the central and southern parts of the state.

Yellow-billed cuckoos spend the winter in South America, east of the Andes, primarily south of the Amazon Basin in southern Brazil, Paraguay, Uruguay, eastern Bolivia, and northern

Argentina (Ehrlich *et al.* 1992, AOU 1998). Wintering yellow-billed cuckoos generally use woody lowland vegetation near fresh water. However, wintering habitat of the western yellow-billed cuckoo is poorly known.

Habitat

Western populations of yellow-billed cuckoos are most commonly found in dense riparian woodlands, consisting primarily of cottonwood (*Populus fremontii*), willow (*Salix* spp.), and mesquite (*Prosopis* spp.), along riparian corridors in otherwise arid areas (Laymon and Halterman 1989, Hughes 1999). Occupied riparian habitat in Arizona may also contain box elder (*Acer negundo*), Arizona alder (*Alnus oblongifolia*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), oak (*Quercus* spp.), netleaf hackberry (*Celtis reticulata*), velvet ash (*Fraxinus velutina*), Mexican elderberry (*Sambuccus mexicanus*), tamarisk (*Tamarix* spp.; also called salt cedar), acacia (*Acacia* spp.), and seepwillow (*Baccharis glutinosa*)(Corman and Magill 2000, Corman and Wise-Gervais 2005, FWS unpubl. data). Tamarisk may be a component of breeding habitat, but there is usually a native riparian tree component within the occupied habitat (Gaines and Laymon 1984, Johnson *et al.* 2008, McNeil *et al.* 2013, Carstensen *et al.* 2015). Although cuckoos are most commonly found in gallery riparian forest, in Arizona they may also use narrow bands of riparian woodland [Arizona Game and Fish Department (AGFD) 2015, Cornell Lab of Ornithology 2016]. Adjacent habitat on terraces or in the upland (such as mesquite) can enhance the value of these narrow bands of riparian woodland.

In most of the range, western yellow-billed cuckoos primarily breeds in riparian habitat along low-gradient (surface slope less than 3 percent) rivers and streams, and in open riverine valleys that provide wide floodplain conditions (greater than 325 feet). However, in the southwest, cuckoos can also breed in higher gradient drainages, and narrower and drier reaches of riparian habitat.

Western yellow-billed cuckoos in Arizona will also use areas of mesquite and oak woodlands some distance from riparian gallery forests, including in the mountains of southeastern Arizona. Recent surveys found yellow-billed cuckoos with some regularity in these non-traditional habitats (Corman and Magill 2000; WestLand Resources, Inc. 2013a, 2013b, , 2015a, 2015b, 2015c; Tucson Audubon 2015a, 2015b).

Throughout the western yellow-billed cuckoo range, a large majority of nests are placed in willow trees, but cottonwood, mesquite, walnut, box elder, sycamore, hackberry, oak, alder, soapberry (*Sapindus saponaria*), acacia, and tamarisk are also used (Laymon 1980, Hughes 1999, Corman and Magill 2000, Corman and Wise-Gervais 2005, Holmes *et al.* 2008, Tucson Audubon 2015a, Tucson Audubon 2015b, FWS unpublished data).

Within the boundaries of the western distinct population segment (DPS) (see Figure 2 at 78 FR 61631), cuckoos occur from sea level to 7,000 feet (or slightly higher in western Colorado, Utah, and Wyoming) in elevation. The moist conditions that support riparian plant communities that provide western yellow-billed cuckoo habitat typically exist in lower elevation, broad floodplains, as well as where rivers and streams enter impoundments. In southeastern Arizona, however, cuckoos are also found nesting along more arid ephemeral and intermittent drainages

with sycamore, mesquite, walnut, hackberry, alder, or mixed oak assemblages (Corman and Magill 2000; Corman and Wise-Gervais 2005;WestLand Resources, Inc. 2013a, 2013b, , 2015a, 2015b, 2015c; American Birding Association 2014; AGFD 2015; Tucson Audubon 2015a, 2015b; Cornell Lab of Ornithology 2016). In the extreme southern portion of their summer range in the States of Sonora (southern quarter) and Sinaloa, Mexico, western yellow-billed cuckoos also nest in upland thorn scrub and dry deciduous habitats away from the riparian zone (Russell and Monson 1988), although their densities are lower in these habitats than they are in adjacent riparian areas.

Habitat for the western yellow-billed cuckoo in much of its range is largely associated with perennial rivers and streams that support the expanse of vegetation characteristics needed by breeding western yellow-billed cuckoos. The range and variation of stream flow frequency, magnitude, duration, and timing that will establish and maintain riparian habitat can occur in different types of regulated and unregulated flows depending on the interaction of the water and the physical characteristics of the landscape (Poff *et al.* 1997; FWS 2002). Hydrologic conditions at western yellow-billed cuckoo breeding sites can vary widely between years and during low rainfall years, water or saturated soil may not be present. Cuckoos may move from one area to another within and between years in response to hydrological conditions. They may also nest at more than one location in a year. Some individuals also roam widely (several hundred miles), apparently assessing food resources before selecting a nest site (Sechrist *et al.* 2012).

Humid conditions created by surface and subsurface moisture appear to be important habitat parameters for western yellow-billed cuckoo. The species has been observed as being restricted to nesting in drainages where humidity is adequate for successful hatching and rearing of young (Hamilton and Hamilton 1965, Gaines and Laymon 1984, Rosenberg *et al.* 1991).

At the landscape level, the available information suggests the western yellow-billed cuckoo requires large tracts of willow-cottonwood or mesquite forest or Madrean evergreen woodland for their nesting season habitat. Habitat can be relatively dense, contiguous stands, irregularly shaped mosaics of dense vegetation with open areas, or narrow and linear. The association of breeding with large tracts of suitable riparian habitat is likely related to home range size. Individual home ranges during the breeding season average over 40 hectares, and home ranges up to 202 hectares have been recorded (Laymon and Halterman 1987, Halterman 2009, Sechrist *et al.* 2009, McNeil *et al.* 2011, McNeil *et al.* 2012). Within riparian habitat, western yellow-billed cuckoos require relatively large (>20 hectares), patches of multilayered habitat for nesting, with optimal size generally greater than 80 hectares (Laymon and Halterman 1989). The multilayered canopy provides shade and traps moisture to create the relatively cooler and more humid streamside conditions which are believed to be important for nesting success. They are also known to nest in early to mid-successional native riparian habitat.

In addition to the dense nesting grove, western yellow-billed cuckoos need adequate foraging areas near the nest. Foraging areas can be less dense or patchy with lower levels of canopy cover and may be a mix of shrubs, ground cover, and scattered trees (Carstensen *et al.* 2015, Sechrist *et al.* 2009, FWS, unpublished data). Cuckoos often forage in open areas, woodlands, orchards and adjacent streams (Hughes 1999), which include stands of smaller mesquite trees and even tamarisk (Rosenberg *et al.* 1991). In Arizona, adjacent habitat is usually more arid than occupied

nesting habitat. This adjacent habitat can be used for foraging where large insects are produced. Habitat types include Sonoran desertscrub, Mojave desertscrub, Chihuahuan desertscrub, chaparral, semidesert grassland, plains grassland, and Great Basin grasslands (Brown and Lowe 1982, Brown 1994, Brown *et al.* 2007).

Hydroriparian and Xeroriparian Cuckoo Habitat. Large expanses of gallery riparian woodland (hydroriparian) habitat supports greater densities of cuckoos than less dense reaches of scattered riparian trees (cottonwood, willow, walnut, ash, mesquite) or xeroriparian woodlands of mesquite, oak, acacia, hackberry, desert willow, and juniper (Halterman *et al.* 2015, McNeil *et al.* 2013, Sechrist *et al.* 2009). However, these less dense reaches of scattered riparian trees and xeroriparian woodlands are also important to yellow-billed cuckoos as nesting substrate, foraging habitat (WestLand Resources, Inc. 2013a and 2013b), and as a buffer between more hydric sites and the adjacent, xeric uplands, which decreases the edge/interior ratio of a given hydroriparian patch.

Migration habitat. Migration habitat needs are not well known, although they appear to include a relatively wide variety of conditions. Migrating yellow-billed cuckoos have been found in coastal scrub, second-growth forests and woodlands, hedgerows, forest edges, and in smaller riparian patches than those used for breeding.

Presence in Arizona

In a survey in 1999 that covered 265 mi (426 km) of river and creek bottoms (a subset of statewide cuckoo habitat), 172 yellow-billed cuckoo pairs and 81 single birds were located in Arizona (Corman and Magill 2000). Drainages with greater than 10 yellow-billed cuckoo detections are found at 12 locations in Arizona: Bill Williams River, Colorado River, Gila River, Upper Cienega Creek, Hassayampa River, San Pedro River, Santa Maria River, Verde River, Sonoita Creek, Santa Cruz River, Altar Valley, and Agua Fria River. Sites with smaller populations are found at the Roosevelt Lake complex, Upper Tonto Creek, Pinto Creek, Sycamore Creek in Pajarito Mountains, Oak Creek, Lower Cienega Creek, Babocomari River, Pinal Creek, Bonita Creek, San Bernardino National Wildlife Refuge, Hooker Hot Springs, Big Sandy River, and many smaller drainages. Cuckoos have also been found during the breeding season in several drainages in the Santa Rita Mountains, Patagonia Mountains, Canelo Hills, Huachuca Mountains, and Pajarito/Atascosa Mountains (Powell 2000; Krebbs and Moss 2009; WestLand Resources, Inc. 2013a, 2013b, 2015a, 2015b, 2015c; Tucson Audubon 2015a, 2015b; Cornell Lab of Ornithology 2016). Many drainages throughout Arizona have not been thoroughly surveyed and it is likely that additional yellow-billed cuckoo locations will be discovered. These include, but are not limited to the mountain ranges of southeastern Arizona, Eagle Creek, and along the Gila, San Francisco, and Blue Rivers.

Presence in Southeastern Arizona Mountain Ranges

In addition to gallery riparian forest and mesquite woodlands, yellow-billed cuckoos are also using more xeroriparian drainages in the foothills and mountains of southeastern Arizona. This kind of habitat is more typical of habitat where cuckoos are found in Sonora, Mexico. Cuckoos have been detected during the breeding season in Florida Canyon, Madera Canyon, Gardner

Canyon, Chino Canyon, Montosa Canyon, Box Canyon, Walker Canyon, Wasp Canyon, McCleary Canyon, and Barrel Canyons; and in Salero Ranch in the Santa Rita Mountains (WestLand Resources, Inc. 2013a, 2013b, 2015a, 2015b, 2015c; ; Tucson Audubon 2015a, 2015b; Cornell Lab of Ornithology 2016); Carr, Ash, Garden, Ramsey, and Miller canyons in the Huachuca Mountains; Turkey Creek, O'Donnell Creek, Collins Canyon, Lyle Canyon, Merritt Canyon, and Korn Canyon in Canelo Hills; Babocomari River; Arivaca Lake and tributaries, Rock Corral Canyon, Pena Blanca Lake and Canyon, Scotia Canyon, Sycamore Canyon, and California Gulch in the Atascosa/Pajarito Mountains; Kitt Peak on Baboquivari Mountain; Sycamore Canyon, Corral Canyon, Hermosa Creek, Harshaw Canyon, Goldbaum Canyon, Willow Springs Canyon, and Paymaster Spring in the Patagonia Mountains; and a few locations in the Chiricahua Mountains (WestLand Resources, Inc. 2013a, 2013b, 2015a, 2015b, 2015c ; Arizona Game and Fish Department 2015,; Tucson Audubon 2015a, 2015b; Cornell Laboratory of Ornithology 2016). In addition, cuckoos were documented during surveys for the first time at two locations in 2015 in the Whetstone Mountains (Tucson Audubon 2015b). Yellow-billed cuckoos are likely breeding in these locations, with nesting confirmed in Montosa Canyon, Sycamore Canyon in the Atascosa/Pajarito Mountains, Pena Blanca Lake, and Kitt Peak (American Birding Association 2014;, Tucson Audubon 2015a, 2015b; Cornell Lab of Ornithology 2016).

Threats

The primary threat to the western yellow-billed cuckoo is loss or fragmentation of high-quality riparian habitat suitable for nesting (Corman and Wise-Gervais 2005, FWS 2014a, 2014b). Habitat loss and degradation results from several interrelated factors, including alteration of flows in rivers and streams, mining, encroachment into suitable habitat from agricultural and other development activities on breeding and wintering grounds, stream channelization and stabilization, diversion of surface and ground water for agricultural and municipal purposes, livestock grazing, wildfire, establishment of nonnative vegetation, drought, and prey scarcity due to pesticides (Ehrlich *et al.* 1992, FWS 2014b). Pesticide use is widespread in agricultural areas in the western yellow-billed cuckoo breeding range in the United States and northern Mexico. Yellow-billed cuckoos have also been exposed to the effects of pesticides on their wintering grounds, as evidenced by DDT found in their eggs and eggshell thinning in the United States (Grocki and Johnston 1974, Laymon and Halterman 1987, Hughes 1999, Cantu-Soto *et al.* 2011). Because much of the species' habitat is in proximity to agriculture, the potential exists for direct and indirect effects to a large portion of the species in these areas through altered physiological functioning, prey availability, and, therefore, reproductive success, which ultimately results in lower population abundance and curtailment of the occupied range (Laymon 1980, Laymon 1998, Hughes 1999, Colyer 2001, Mineau and Whiteside 2013, Hopwood *et al.* 2013, Mineau and Palmer 2013, FWS 2014b).

The ongoing threats, including small isolated populations, cause the remaining populations to be increasingly susceptible to further declines and local extirpations through increased predation rates, barriers to dispersal by juvenile and adult yellow-billed cuckoos, chance weather events, fluctuating availability of prey populations, collisions with tall vertical structures during migration, defoliation of tamarisk by the introduced tamarisk leaf beetle (*Diorhabda* spp.), increased fire risk, and climate change events (Thompson 1961, McGill 1975, Wilcove *et al.*

1986). The warmer temperatures already occurring in the southwestern United States may alter the plant species composition of riparian forests over time. An altered climate may also disrupt and change food availability for the western yellow-billed cuckoo if the timing of peak insect emergence changes in relation to when the cuckoos arrive on their breeding grounds to feed on this critical food source.

Habitat for the western yellow-billed cuckoo has been modified and curtailed, resulting in only remnants of formerly large tracts of native riparian forests, many of which are no longer occupied by western yellow-billed cuckoos. Despite recent efforts to protect existing, and restore additional, riparian habitat in the Sacramento, Kern, and Colorado Rivers, and other rivers in the range of the western yellow-billed cuckoo, these efforts offset only a small fraction of historical habitat that has been lost. Therefore, we expect the threats resulting from the combined effects associated with small and widely separated habitat patches to continue to affect a large portion of the range of the western yellow-billed cuckoo.

Listing and Critical Habitat

The yellow-billed cuckoo was listed as a threatened species under the ESA on October 3, 2014 (79 FR 59992). Critical habitat for the yellow-billed cuckoo was proposed on August 15, 2014 (FWS 2014a). Proposed critical habitat encompasses 546,335 acres across the western United States.

Additional details on the status of this species and proposed critical habitat are found in our final rule to list the species as threatened (79 FR 59992) and our proposed rule to designate critical habitat (79 FR 48548). A revised proposed rule that may include additional proposed critical habitat is under development. The discussions of the status of this species in these documents are incorporated herein by reference.

Past Consultations

Because western yellow-billed cuckoos were only recently listed as threatened in 2014, no projects in the action area have undergone formal section 7 consultation for effects to the cuckoo. Ongoing grazing and travel management projects will undergo reinitiation of consultation.

Environmental Baseline

Status of the Yellow-billed Cuckoo in the Action Area

Although data are insufficient to determine population trends for this species within the action area, cuckoo survey and incidental detection data provide evidence of occupancy and likely breeding. Yellow-billed cuckoo numbers are difficult to determine without intensive surveying and monitoring. The yellow-billed cuckoo survey protocol is designed to document presence/absence during the breeding season, but is not designed to determine the number of breeding cuckoos (Halterman *et al.* 2011, 2015). Additional visits would be needed to determine cuckoo home ranges, occupancy throughout the breeding season, and to observe cuckoo nesting behavior. Because cuckoos have a very short nesting cycle, a pair may not remain in the area for the entire breeding season. However, we can infer breeding from behavioral cues observed. These include vocalizations between individuals, copulation, carrying food repeatedly to the

same location, and feeding fledglings. If cuckoos are detected on more than one of the four required surveys, breeding season occupancy is assumed (Halterman *et al.* 2015).

Within the Perimeter Fence (Project Area). Yellow-billed cuckoo protocol surveys (Halterman *et al.* 2011, 2015) were conducted during the breeding season in 2013, 2014, and 2015 in habitat within the Rosemont perimeter fence (project area) (WestLand Resources, Inc. 2015a, 2015b, 2015c). Surveys indicate likely breeding in upper and lower Barrel Canyon based on repeated cuckoo detections during the breeding season in two years as well as evidence of pairs (Table YBCU-1). Cuckoos are also using McCleary Canyon during the breeding season, based on detections during two surveys in 2015. Given that cuckoos have large home ranges, more than one canyon may occur within an individual's home range.

Vegetation associated with these detections was Emory oak (*Quercus emoryi*), Arizona white oak (*Q. arizonica*), velvet mesquite (*Prosopis velutina*), and desert willow (*Chilopsis linearis*), with an occasional Arizona sycamore (Platanus wrightii), Arizona walnut (*Juglans major*) and Goodding's willow (*Salix gooddingii*), and alligator juniper along sandy bottom drainages lacking perennial surface water. All transects were in habitat more typical of upland cuckoo habitat in southeastern Arizona and Sonora than the more typical mature cottonwood/willow/mesquite bosque/ash vegetation communities (Halterman *et al.* 2011; FWS 2013, 2014a, 2014b;WestLand Resources, Inc. 2015a, 2015b, 2015c).

In 2013, western yellow-billed cuckoos were detected along two transects at three separate locations (WestLand Resources Inc. 2015a). Two individuals were observed along lower Barrel Canyon transect, and one was observed along the Wasp Canyon transect.

In 2014, western yellow-billed cuckoos were observed along two transects at six separate locations. At two locations in Barrel Canyon, on the last survey, surveyors detected separate vocalizing pairs of cuckoos (WestLand Resources, Inc. 2015b). The presence of pairs is evidence of possible breeding (Halterman *et al.* 2015, FWS 2014a, 2014b).

In 2015, cuckoos were detected on all four surveys in lower Barrel Canyon, on two of four surveys in Upper Barrel Canyon, and on three of four surveys in McCleary Canyon (WestLand Resources, Inc. 2015c). Up to six cuckoos were detected during one survey in lower Barrel Canyon, with an exchange of vocalizations between two of the individuals that may indicate breeding. One cuckoo was detected on July 26, 2015 in Wasp Canyon, but this was the only detection for this canyon during the four surveys conducted between late June and August 2015.

Table YBCU-1. Yellow-billed cuckoo survey results from four canyons within the proposed Rosemont Copper Mine project area, 2013 - 2015, Santa Rita Mountains, Arizona (WestLand Resources, Inc. 2015a, 2015b, 2015c). Each canyon was surveyed four times annually during the breeding season according to the yellow-billed cuckoo survey protocol (Halterman *et al.* 2011, 2015).

Year	No. of Surveys Cuckoos Present	Possible Evidence of Breeding

Upper Barrel Canyon		
2013	0	
2014	2	vocalizations between a pair on 4th survey
2015	3	
Lower Barrel Canyon		
2013	1	
2014	2	vocalizations between a pair on 4th survey
2015	4	vocalizations between 2 cuckoos
McCleary Canyon		
2013	0	
2014	0	
2015	2	
Wasp Canyon		
2013	1	
2014	0	
2015	1	

Outside the Perimeter Fence. Other than at the confluence with Cienega Creek, cuckoo surveys in Davidson Canyon have not been conducted. One pair and two single cuckoos documented during a July 13 survey in Davidson Canyon, at the confluence of Cienega Creek in 1999 (Corman and Magill 2000) and a nest was found on July 25, 2008 (Kirkpatrick *et al.* 2010). Yellow-billed cuckoos have been incidentally observed in Las Cienegas NCA, along Cienega Creek Reaches 1 through 7, Empire Gulch Reach 1, and Mattie Canyon (Simms 2004, Bureau of Land Management 2013a), and observed through species-specific surveys from Cienega Creek Reaches 1 through 9 (Bureau of Land Management 2014a, USFS 2015a). In 2001, an estimated 23 mated pairs and 3 single birds occurred along surveyed portions of Cienega Creek; further, this species occurred more often in areas with vegetation more than 30 meters high and areas with greater cover in the 0.25- to 2-m range (BLM 2014). At least seven western yellow-billed cuckoos were documented in upper Cienega Creek (along the reach between Road 901A and the confluence with Gardner Canyon) on June 18, 2010 (M. Radke, pers. obs.). In addition, individuals were documented at Empire Gulch during the breeding season in 2010 and 2011, and one after-hatch-year individual was caught at the Empire Gulch Monitoring Avian Productivity and Survivorship station monitoring station in July 2011 (M. Radke, pers. obs.). A cuckoo was documented downstream of the Narrows on Cienega Creek while at an Arizona Bird Conservation Initiative riparian bird survey plot on August 8, 2011. Approximately 4.7 miles of the Pima County CCNP was surveyed on one day in 2013, with a total estimate of 11 separate cuckoos (Powell 2013a). The current drought is likely contributing to removing nesting habitat by causing cottonwood canopies to thin at the Pima County CCNP, though no data are available on the amount of nesting habitat removed or whether this loss is driving any population trends (Powell *et al.* 2014).

Yellow-billed cuckoos have been observed in Box Canyon during the breeding season in multiple years (Cornell Lab of Ornithology 2016, Tucson Audubon 2015b). Tucson Audubon detected cuckoos on 3 surveys in 2015, including the observation of a cuckoo carrying food (Tucson Audubon 2015b). Cuckoos were observed carrying food in 2013 and are often seen flying across Box Canyon Road (D. Sebesta, pers. comm. 2014). Other observations of cuckoos

in Box Canyon have been reported by birders during the breeding season in more than one year (Cornell Lab of Ornithology 2016).

Yellow-billed cuckoos have been detected during the breeding season in Gardner Canyon, south of the proposed Rosemont mine, but this area has never been surveyed (AGFD 2015, Cornell Lab of Ornithology 2016). Gardner Canyon is an intermittent reach that was analyzed for impacts in the FEIS, but no key reaches were identified during the multi-agency collaboration, and therefore none were explicitly analyzed in the SBA (USFS 2015a). Yellow-billed cuckoos have been reported by birders during the breeding season 2 miles upstream from the confluence with Cienega Creek near artificial ponds and near the confluence of Sawmill Canyon, approximately 9 miles from the confluence with Cienega Creek (Cornell Lab of Ornithology 2016). Habitat within Gardner Canyon is patchy, but suitable habitat exists.

Existing Habitat. Within the action area, riparian deciduous woodland vegetation extends downstream through Empire Gulch, Cienega Creek, Davidson Canyon, Box Canyon, and Gardner Canyon (USFS 2012). The vegetation in this area is a mix of riparian woodlands and shrublands, with a variety of vegetation associations. The dominant vegetation varies, depending on a suite of site-specific characteristics, including elevation, substrate, stream gradient, and depth to groundwater.

Riparian habitat by nature is dynamic and changes in location, size, and age over time. The degree of habitat turnover is dependent on the flood regime, amount of surface flow, and whether vegetation is xeric (such as mesquite or hackberry) or hydric (such as willow or cottonwood). Xeroriparian habitat exists in drainages that generally receive less surface flow than hydroriparian habitat. Although xeroriparian habitat is less sensitive to reduction in surface flow than hydroriparian habitat, it can experience reduced vigor, regeneration, and survival of young trees. Over time, a sustained reduction in surface flow will result in a decline in cuckoo habitat.

Davidson Canyon Habitat. Riparian vegetation in Davidson Canyon is xeroriparian and mesoriparian, ranging from sparsely vegetated habitat with few trees to patches of dense mesquite, hackberry, and junipers. Some walnut, ash, and Goodding's willows occur as single trees rather than well-developed riparian vegetation in part of Davidson Canyon (WestLand Resources, Inc. 2016). A more detailed description from Westland Resources, Inc. (2011) is excerpted below and is shown in Figure YBCU-2.

> In the lower Barrel Canyon reach, the riparian zone is much wider upstream of the intersection with state route 83, than portions of the reach immediately downstream. Upstream of 83 the riparian vegetation is more extensive, but mesquite and upland associated vegetation are dominant. The vegetation in the downstream section is also dominated by mesquite and other upland vegetation, but is particularly sparse and heavily damaged by grazing. In the areas around the confluence of Davidson and Barrel Canyons, the riparian zone narrows, but the vegetation present is relatively tall (6-8m). The species composition is mostly upland associated species, but pockets of a few walnut and ash trees do occur, including a considerable pocket of several large, mature Arizona walnut. Following this section, the canyon within Reach 1 broadens and the mesquite vegetation, while still dominant, becomes sparser. The more mesic riparian species that are present

occur as single individuals or in pockets of a few individuals. The species composition changes little throughout Reach 1, but vegetation characteristics do vary. Reach 2, the purported perennial section of Davidson Canyon, is associated with the further narrowing of the channel with bedrock slopes. Here the pockets of more mesic riparian wetland associated species are more frequent, but of limited extent due to channel morphology. Reach 3, [which occurs north and south of I-10] is associated with a widening of the channel to encompass dense mesquite thickets of moderate stature (5-9m) with an understory of mostly upland associated vegetation. Pockets of few to several individuals of more mesic riparian or wetland associated species, mostly Gooding's willow (*Salix gooddingii*), Arizona walnut (*Juglans major*) and velvet ash (*Fraxinus velutina*), are scattered throughout this segment of the canyon. In Reach 4, towards the confluence with Cienega Creek, Davidson Canyon is a relatively narrow, bedrock lined channel dominated by wetland-associated species, but upland species are still present.

Surface flow along Davidson Canyon does not originate from regional groundwater and based on groundwater use (TetraTech 2010a; ca 300 wells) does not appear to be permanently connected to the regional groundwater table (WestLand Resources, Inc. 2011). Surface flow is intermittent during wetter years and ephemeral during years of low precipitation. Geological evidence suggests that surface flow in Davidson Canyon is a result of bedrock constriction of narrow channels with limited alluvial depths, forcing upwelling of alluvial water to the surface (TetraTech 2010a). The water source in Davidson Canyon is seasonal precipitation (TetraTech 2010a). Data from a Pima County well downstream of Reach 2 indicate highly variable water depths, and an average water depth of more than 10 ft (TetraTech 2010a).

Disturbance from Livestock and Human Activity in lower Barrel and Davidson Canyons. WestLand Resources, Inc. (2011) observed disturbance to riparian vegetation due to livestock or recreational activities (mainly Off-Highway-Vehicle use) at 100 percent of the 70 sampling points in a study on riparian vegetation in lower Barrel and Davidson canyons. These impacts are independent of the proposed action and are not included in our analyses of effects of the action, but they raise concern about the future condition of cuckoo habitat within Davdison Canyon if disturbance from livestock and recreational activities are not controlled.

Cienenga Creek Habitat. The following habitat description of habitat in Cienega Creek is from WestLand Resources, Inc. (2012b) and follows Table YBCU-2. Please note WestLand's reach numbering system differs from the Key Reach numbering system used throughout the aquatic and riparian-related analyses in this BO.

WESTLAND REACH 3 [River Mile (RM) 17-27.5] This reach encompasses most of the hydroriparian vegetation and spatially intermittent surface flow within the BLM Las Cienegas NCA (RM 17-27.5). Downstream of the confluence of Cienega Creek and Gardner Canyon, a gallery forest of mature cottonwood and Goodding's willow (*Salix gooddingii*) becomes prevalent, marking the beginning of the hydroriparian stretch of Cienega Creek within the BLM Las Cienegas NCA. Mid-canopy cover is also relatively extensive near the confluence with Gardner Canyon. The riparian zone is relatively narrow here [~30-50meters (m)]. These conditions appear to persist for approximately 2 miles downstream. Much of this stretch of the creek consists of very dense understory and large pools of standing water (RM 19). The gallery

forest is bordered by dense 1-3m tall grasslands dominated by sacaton grass (*Sporobolus* spp.). Immediately downstream, the riparian vegetation is much less dense. A galley forest with mature cottonwood and Goodding's willow is present, but little to no understory exists. Surface water was not present downstream of RM 19 for approximately 3.5 miles until at around RM 22.5, where scour pools 0.5-1m deep occur, and become more prevalent and extensive further downstream. However, the mid and understory vegetation in this area remains sparse. These conditions transition into flowing surface water, often 0.5-1m deep at approximately RM 23. Understory vegetation becomes more prevalent at this point as well, but is still of relatively limited extent. The mid-canopy and understory vegetation becomes relatively denser downstream from RM 23, with young velvet ash (*Fraxinus velutina*) and cottonwood becoming prevalent. The gallery forest is interrupted by areas limited vegetation associated with exposed bedrock constraining the channel, creating large pools and waterfalls, such as the area near The Narrows (RM 25). Overall, the vegetation became denser, with more complex structure downstream. These conditions changed near the downstream (northern) extent of the BLM Las Cienegas NCA (RM 27.5). While gallery forest of cottonwood and willow still occur, the understory becomes much less extensive and surface water becomes restricted to remnant scour pools.

WESTLAND REACH 4 (RM 27.5-36) This is the reach of Cienega Creek between the BLM Las Cienegas NCA (RM 27.5) and approximately 0.25 miles upstream of I-10 (RM 36). This reach is largely xeroriparian in nature, consisting of mostly upland-associated species. The downstream extent of the BLM Preserve (RM 27.5) marks the transition between hydro/mesoriparian and xeroriparian vegetation. The vegetation characteristics likely reflect the changing hydrologic regime at this location from spatially intermittent to ephemeral. For approximately 9 miles downstream of the BLM Las Cienegas NCA, including Pima County's Empirita Ranch (RM 33), the riparian vegetation is largely xeroriparian, dominated by mesquite and limited amounts of netleaf hackberry (*Celtis reticulata*) with an understory of mostly desert broom (*Baccharis sarothroides*) and burrobush (*Hymenoclea monogyra*). The vegetation is likely supported by ephemeral surface flows and the alluvial channel is quite wide (>100m), particularly at Empirita Ranch. In places, the tall stature (~6-7m) of the mesquite and hackberry tree suggests that the vegetation is transitional between xeroriparian and mesoriparian. There are also a few Arizona walnuts (*Juglans major*) and ash along this reach, however, the tall mesquite, ash and walnut are widely scattered and mostly occur individually rather than as substantial pockets of vegetation. These conditions and riparian characteristics persist until the transition zone from xeroriparian to hydro/mesoriparian vegetation that occurs just south of I-10 (RM 36), near the upstream extent of the Pima County CCNP. Here, mature cottonwoods, ash and some young Goodding's willow occur along the channel, but mesquite continues to dominate the upper canopy and burrobush dominates the shrub layer.

WESTLAND REACH 5 (RM 36-46) This is the reach of Cienega Creek between the transition to hydro/mesoriparian vegetation near I-10 (RM 36) and the Pantano Dam (RM 46). Downstream of I-10, near the Pantano Jungle area (RM 38), cottonwood and willow gallery forest begins. The understory vegetation, however, is limited, and consists of a few young cottonwoods, Goodding's willows and seepwillows (*Baccharis salicifolia*). Cienega Creek throughout the Pima County Preserve is characterized by stretches of gallery forest with little understory interspersed with open areas of xeroriparian vegetation. These xeroriparian areas are dominated by mesquite with an understory of various grasses, desert broom and burrobush.

Similarly, surface flow along the stretch from Pantano Jungle (RM 38) to the USGS stream gauge at Pantano Wash (RM 46) is spatially intermittent, containing stretches of no surface flow. These conditions, characterized by hydro/mesoriparian gallery forest and perennial surface flow interspersed with areas of xeroriparian vegetation and no surface flow, persist until the Pantano dam (RM 46), just downstream of the confluence of Cienega Creek and Aqua Verde Creek (RM 45). Downstream of the dam, the sandy wash becomes increasingly wider and is dominated by xeroriparian vegetation, consisting of mostly mesquite, desert broom and burrobush that are likely supported by ephemeral flows.

Response to Removal of Cattle Grazing on Empire Cienega and Cienega Creek. Prior to the establishment of the Pima County CCNP there was extensive cattle grazing on the site, but once cattle were removed from the system, vegetation height and volume increased significantly and likely plateaued in the early 2000s (unpublished data). Vegetation often responds positively to removal of cattle (Krueper *et al.* 2003), but since 2005 there has only been a slight increase in the extent of cottonwood canopies in the Pima County CCNP, though this analysis does not address the density of vegetation within the canopy. The extent and vigor of mesquite trees has declined since 2005.

Removal of cattle grazing has resulted in increased vegetation in Empire Cienega and Upper Cienega Creek (M. Radke, pers. comm. January 27, 2016). Although effects of the drought are evident throughout Upper Cienega Creek, pockets of hydroriparian habitat continue to improve in suitability for both cuckoos and willow flycatchers.

Table YBCU-2. Summary of hydrologic regime and vegetation characteristics by reach of Cienega Creek, adapted from WestLand Resources, Inc. (2012b) and shown in Figure YBCU-2.

Reach	Reach surface water regime	River Miles	Vegetation Characteristics	Observations
Reach 3 Gardner Canyon to Apache Canyon	Spatially Intermittent	17.0-27.5 (10 miles)	Hydroriparian	Mostly cottonwood/willow gallery forest and perennial surface flow interrupted by a considerable section with no surface water (RM 19-22.5).
Reach 4 From the south end of BLM Las Cienegas NCA near Apache Canyon Preserve (RM 27.5) to approximately 0.25 miles upstream of I-10 (RM 36)	Ephemeral	27.5-36.0 (8.5 miles)	Xeroriparian; Transitional from Xeroriparian to Mesoriparian	Mostly xeroriparian vegetation, with limited pockets of mesoriparian vegetation, especially near the downstream end of the reach where the vegetation transitions to meso- and hydro-riparian vegetation.
Reach 5 Lower Cienega Creek 0.25 miles upstream of I-10 to del Lago Dam	Spatially Intermittent	36.0-46.0 (10 miles)	Hydroriparian; few stretches of Xeroriparian	Mostly cottonwood/willow gallery forest interrupted by stretches of mesquite-dominated xeroriparian vegetation. Surface flow is not continuous as there are several stretches of no surface flow.

Status of Yellow-billed Cuckoo Proposed Critical Habitat in the Action Area
Within Pima and Santa Cruz Counties, Arizona, critical habitat has been proposed along Cienega Creek and Empire Gulch, Florida Canyon, lower San Pedro River, Penitas Wash, Arivaca Wash and San Luis Wash, Santa Cruz River, and Sonoita Creek. Only Cienega Creek and Empire Gulch are within the action area. Proposed critical habitat is expected to be revised in 2016. Proposed critical habitat unit 33 (AZ–25, Upper Cienega Creek), is 2,106 hectare (5,204 ac) in extent and 23 km (14 mi) long and is comprised of 16 km (10 mi) of Cienega Creek and 7 km (4 mi) of Empire Gulch in Pima County (FWS 2014a) (Table YBCU 3). Proposed critical habitat unit 38 (AZ–30, Lower Cienega Creek), is 955 hectare (2,360 ac) in extent and is an 18-km (11-mi)-long segment of Cienega Creek in Pima County. The Upper Cienega Creek proposed critical habitat unit includes the Las Cienega NCA, including Empire Gulch, and the Lower Cienega Creek unit includes the Lower Cienega Creek Natural Preserve.

There are 7,284 acres of proposed critical habitat for the western yellow-billed cuckoo in the action area: 4,926.5 acres in unit 33 (AZ-25 Upper Cienega Creek) (68 percent of proposed critical habitat in the action area) and 2,357 acres in unit 38 (AZ-30 Lower Cienega Creek) (32 percent of proposed critical habitat in the action area) (FWS 2014a). The amount of proposed critical habitat in the action area is 1.3 percent of total proposed cuckoo critical habitat rangewide.

Within a 1,824,000 acre (2,850 square mile) area in southeastern Arizona, 7 proposed critical habitat units totaling 35,202 acres (55 square miles) exist along the upper and lower Cienega creeks, upper San Pedro River, Hooker Hot Springs, Santa Cruz River, Sonoita Creek, and Florida Wash in southeastern Pima, Santa Cruz, and western Cochise counties (Table YBCU-3). Distances from the Upper Cienega Creek and Lower Cienega Creek critical habitat units within the action area to units outside the action area are shown in Table YBCU-4. The distance from the eastern end of the Lower Cienega Creek unit to the Upper San Pedro River unit is 15 miles, the northeastern end of the Upper Cienega Creek unit to the Upper San Pedro River is 16 miles, the western end of Empire Gulch in the Upper Cienega Creek unit to the Florida Wash unit is 11 miles, the western end of Empire Gulch in the Upper Cienega Creek unit to the northern end of the Santa Cruz River unit is 24 miles, and the southern end of the Upper Cienega Creek unit to the Sonoita Creek Unit is 17 miles, and the eastern end of Lower Cienega Creek unit to the Hooker Hot Springs unit is 29 miles (Table YBCU-4).

Table YBCU-3. Seven proposed critical habitat units totaling 35,202 acres (55 square miles) within 1,824,000 acres (2,850 square miles) of southeastern Arizona in southeastern Pima, Santa Cruz, and western Cochise counties. The 1,824,000 acres includes the action area and nearest critical habitat units outside the action area.

Unit	Unit Name	Acres	County	Proposed Critical Habitat within Action Area to Nearest Proposed Critical Habitat Unit (miles) Outside Action Area to
26	AZ-18 Upper San Pedro River	21,786	Cochise	15
27	AZ-19 Hooker Hot Springs	375	Cochise	29
32	AZ-24 Sonoita Creek	1,610	Santa Cruz	17
33	AZ-25 Upper Cienega Creek	5,204	Pima	NA
34	AZ-26 Santa Cruz River	3,689	Santa Cruz	24
38	AZ-30 Lower Cienega Creek	2,360	Pima	NA
45	AZ-37 Florida Wash	188	Pima	11
Total		35,212		

Table YBCU-4. Distance between proposed yellow-billed cuckoo critical habitat segments within the action area to nearest critical habitat segment outside the action area.

From Critical Habitat Segment	To Critical Habitat Segment	Miles
AZ-25 Upper Cienega Creek	AZ-18 Upper San Pedro River	16
	AZ-37 Florida Wash	11
	AZ-26 Santa Cruz River	24
	AZ-24 Sonoita Creek	17
AZ-30 Lower Cienega Creek	AZ-18 Upper San Pedro River	15
	AZ-19 Hooker Hot Springs	29

Primary Constituent Elements for the Yellow-billed Cuckoo

The FWS has proposed to designate approximately 546,335 acres of critical habitat in Arizona, California, Colorado, Idaho, Nevada, New Mexico, Texas, Utah, and Wyoming (FWS 2014a). We note that the following PCEs in the proposed critical habitat rule are undergoing review and may be adjusted to better characterize Arizona habitat conditions in a future revised proposed rule:

(1) Riparian woodlands (willow-cottonwood, mesquite thornforest, or a combination of these) in contiguous or nearly contiguous patches of at least 200 acres in extent and at least 325 feet wide, with at least one nesting grove (often willow dominated with average canopy closure of more than 70 percent), and a cooler, more humid environment than surrounding areas;

(2) Adequate prey base, including a large insect fauna (e.g., cicadas, caterpillars, katydids,

grasshoppers, large beetles, and dragonflies) and treefrogs in breeding areas and postbreeding dispersal areas; and

(3) Dynamic riverine processes, especially including river system having hydrologic processes that promote regular habitat regeneration (sediment movement, seedling germination, plant vigor and growth), which leads to patches of old and new riparian vegetation.

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following yellow-billed cuckoo-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010b), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weaknesses of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the *other* possible hydrologic outcomes (using the same sensitivity analyses and assumptions) exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur. Thus, we have selected the precautionary approach.

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline against which mine-only effects are incrementally assessed.

The analysis of effects to the meso- and hydroriparian habitat for yellow-billed cuckoos diverges from this approach. While the hydrologic effects of climate change were modeled, we are unable to predict the full suite of effects of climate change on riparian ecosystems. While we do anticipate that reduced flows will adversely affect the extent and vigor of riparian vegetation, the hydrologic modeling contained in the SIR and May 2015 SBA do not address future temperatures, rainfall patterns, or other factors we anticipate would affect riparian vegetation. For this reason, the analyses of riparian-related effects to yellow-billed cuckoos are based largely on the mine-only drawdowns and their impact on hydroriparian vegetation.

Effects of the Action - Yellow-billed Cuckoo

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. In general, as a result of displacement by mine construction and mine-related groundwater drawdown, a decline in yellow-billed cuckoo numbers and habitat is expected to occur.

Direct Effects to Yellow-billed Cuckoos

Western yellow-billed cuckoos occur during the breeding season and likely breed within the perimeter fence where mine construction and operation will occur in Barrel, McCleary, and Wasp Canyons. The canyons within the perimeter fence and Davidson Canyon were included in the groundwater model, but the results did not appear in the 95th percentile analyses. Regardless, six miles of occupied yellow-billed cuckoo habitat in within the perimeter fence will be directly affected by mine construction and/or operations.

Direct impacts from the construction and operation of the mine and related facilities will harm cuckoos by removing suitable habitat and displacing breeding or foraging birds and or by disturbing cuckoos where suitable habitat is not displaced, but within the vicinity of mining activities. If there are resident birds present at the time of tree removal and site preparation, individuals could abandon their roosting and nesting sites. If present, nests and eggs would be lost, if ground disturbance occurred during the nesting season. Any individuals present in or adjacent to the project area could also experience impacts from decreased surface water flow in Barrel and Davidson Canyons, loss of prey availability, groundwater drawdown, noise, vibrations, and artificial night lighting (SWCA 2015). The effects could range from habitat use changes, activity pattern changes, increased stress responses, decreased foraging efficiency and success, reduced reproductive success, increased predation risk, intraspecific diminished communication, and hearing damage (NoiseQuest n.d. [2012]; Pater *et al.* 2009). These responses can vary, depending on the nature of the sound, including sound level, rate of onset, duration, number of events, spectral distribution of sound energy, and level of background noise (Pater *et al.* 2009). The magnitude of effects from noise, vibration, and light are uncertain, but these effects are expected to decrease as the distance from the mine increases.

Indirect Effects to Yellow-billed Cuckoos

The Effects to Aquatic Ecosystems, Effects to Riparian Ecosystems, and Effects of the Action - Gila Chub, in this BO apply to the analyses of yellow-billed cuckoos and are herein incorporated by reference. These sections discuss the proposed action's effect on regional groundwater and the volume and linear extent of surface flows in area streams; and the relationship between flood flow hydrology, depth to groundwater, and the recruitment, maturation, and retention of the riparian forests.

Light, Noise, and Vibration, Disturbance in McCleary Canyon

McCleary Canyon is immediately north of and adjacent to the proposed mine pit and perimeter

fence. Cuckoos remaining in McCleary Canyon will likely be adversely affected from artificial lighting, daily mine blasts, vibrations, and low frequency noise. Artificial lighting is anticipated to range from the equivalent of a quarter moon to full moon for much of the canyon. The extreme western portion of the canyon is anticipated to receive lighting brighter than a full moon (WestLand Resources, Inc. 2012a). The artificial lighting may disrupt or prevent cuckoos from successfully nesting in McCleary Canyon.

Blasting noise is expected to range from 70 to 90 dBA in McCleary Canyon, with no more than one blasting event per day (Tetra Tech 2009). The Occupational Safety and Health Administration noise standards are helpful in understanding the difference between different decibel levels. Noise from 70 to 90 dBA is described as noisy to very noisy (Tetra Tech 2009). Noise at 90 dBA is the equivalent of a leaf blower at five feet, jackhammer at 50 feet, or dog barking at five feet. Noise at 70 dBA is the equivalent of a leaf blower at 50 feet or 300 feet from busy six-lane freeway. Sudden blasts in the 70 to 90 dBA levels may flush birds from perches and nests, possibly causing abandonment.

In addition to noise, blasting generates low frequency airborne and ground vibrations that can induce vibrations in buildings or other structures. Peak airborne pressure levels occur at frequencies below the range of human hearing. Although not audible, these pressure waves can induce vibrations in buildings and other structures. The induced structural vibrations can rattle pictures, objects on wall-mounted shelves, or poorly fitted windows. Peak blast overpressure levels (air blast) at distances within one mile from the blast site may cause objects or windows to rattle. Modeling of blast-generated ground vibration levels indicates that locations less than 0.5 miles from the blast site may experience vibration intensities high enough to induce minor cosmetic damage to buildings (such as cracking paint or plaster) (Tetra Tech 2009). McCleary Canyon is within 0.5 miles of the blast site. Although the effects of blast vibrations on cuckoos or prey species are unknown, if buildings within 0.5 miles experience rattling or minor cosmetic damage, blast vibrations may flush cuckoos from tree perches and nests in McCleary Canyon (Tetra Tech 2009).

Highway 83 traffic and operational noise from haul trucks and other equipment working in the vicinity of McCleary Canyon is estimated to be 30 to 50 dBA (Tetra Tech 2009, 2010). The highway traffic and operational noise at 50 feet is less likely to disturb cuckoos than the higher decibel blast noise, being the equivalent of typical suburban daytime background conditions or an open field, summer night with numerous crickets.

Volume is just one measure of noise. Another measure is the frequency range of noise. Yellow-billed cuckoos vocalize within the same low frequency range of traffic noise (primarily ≤3 kHz) and may be affected by acoustic masking, whereby signals in the same frequency range as background noise are more difficult to detect (Klump 1996, Patricelli & Blickley 2006,Warren *et al.* 2006, Wood & Yezerinac 2006). Cuckoos were less likely to occur in noisy plots with traffic than in quiet plots in a Washington D.C. study, even when measures of vegetation were considered simultaneously (Goodwin and Shriver 2011). Results suggest that traffic noise influences the presence of bird species that vocalize in the frequency range generated by traffic noise. It is unknown whether the cuckoos may vacate areas along McCleary and Box canyons where they may be affected by acoustic masking from increased mine traffic noise.

Noise and Traffic Disturbance in Box Canyon

Increased vehicular traffic in the form of displaced recreation traffic is expected on Box Canyon Road during construction and mine operation (FEIS, Volume 3: 833-836), creating noise disturbance, and potential collisions with yellow-billed cuckoos flying across the road. The number of breeding cuckoos and offspring produced may decline. Approximately 3.5 miles of cuckoo habitat exists in the Box Canyon drainage.

Habitat Loss

Reduction in groundwater and related streamflow

As discussed in the Effects to Aquatic Ecosystems and Effects of the previous BO (FWS 2013) and this BO, the proposed action will adversely affect the subsurface and, eventually, the surface hydrology of Empire Gulch 1 and 2 (EG1, EG2 (Figure A-1). The modeled groundwater drawdowns at Cienega Creek and Davidson Canyon are of lesser magnitude than in Empire Gulch, but will likely result in reduced hydroriparian and xeroriparian habitat. Both lowered groundwater and reduction in streamflow affect hydroriparian and xeroriparian vegetation along drainages, although xeroriparian habitat can withstand greater water loss. The reduction in groundwater lowers the water table, while the reduction in streamflow reduces the length, width, and depth of wetted streambed. The net result is reduced plant regeneration, herbaceous and shrub growth, tree survival, foliar cover, woodland width, and prey abundance that coincides with the reduced length, width, and depth of wetted streambed and depth to groundwater.

In addition to reasons previously explained regarding model uncertainty, using the model to extrapolate effects on hydroriparian and xeroriparian habitat is all the more difficult because the model was not designed to predict changes in vegetation. The model does not account for varying vegetation depth to groundwater laterally from the streambed or the relationship between vegetation and stream flow depth, length, and lateral extent. Despite its limitations, we chose the loss of surface flow modeling as the basis for habitat loss because it can be measured across all affected drainages over time and is related to habitat health within and near the streambed.

We are assuming that there will be a 1:1 relationship between percent streamflow lost and percent habitat lost or degraded to the point of being incapable of supporting the occurrence of yellow-billed cuckoos. Based on a predicted average increase in depth to groundwater and associated loss of surface flow over the next 150 years (as presented in Table GC-3), we estimate a 10 percent loss of hydroriparian and xeroriparian breeding habitat, foraging habitat, and prey species in Empire Gulch and Cienega Creek (Table YBCU-5), with the exception of a 100 percent loss in EG1 and an 18 percent loss in EG2 (Table GC-3). Based on a predicted 4.3 percent reduction in surface flows from the placement of tailings in Barrel Canyon (a tributary) (SWCA 2012), we estimate a 4.3 percent loss of riparian and mesquite breeding habitat, foraging habitat, and prey species in Davidson Canyon.

We also anticipate that climate change will degrade habitat to the point of being incapable of supporting the occurrence of yellow-billed cuckoos. We reiterate that the modeled effect of climate change to streams is considered an effect relative to the present-day baseline, just as mine-driven drawdown's effects to streams are. In Table GC-3, the estimated percent losses of

the mine and climate change combined are 48 percent in Cienega Creek, 100 percent in EG-1, and 46 percent in EG-2. Subtracting the mine-driven drawdowns of 10 percent in Cienega Creek, 100 percent in EG-1, and 18 percent in EG-2, we anticipate climate change-only drawdowns of 38 percent in Cienega Creek, no measurable effect in EG-1 (which loses 100 percent of its flow to mine-driven drawdown)100 percent in EG-1, and 28 percent in EG-2.

The subsequent analyses, including the effects appearing in Table YBCU-5 will focus primarily on mine-driven drawdown, as this informs not only the effects solely attributable to the proposed action, but also the subsequent anticipated amount or extent of take for the species. Furthermore, the relationship between drawdowns and riparian vegetation is not as straightforward as the relationship between drawdowns and stream flow, permanence, and pool geometry. The modeled effects of climate change to stream flows are readily interpreted into effects to aquatic ecosystems and the species that occur in them (Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, northern Mexican gartersnake, and Huachuca water umbel). Stream flows and water availability are only one aspect of the ecology of riparian vegetation, which is also influenced by the increased air temperatures and altered flood-flow hydrology that may also accompany a changing climate (Lenart 2007). We will therefore include the anticipated effects of climate change on riparian vegetation in our effects analysis and conclusion, but we will not perform detailed calculations of mileage- and acreage-based losses of xero- and hydroriparian vegetation.

Habitat Measurements: Linear Miles. We measured straight-line distances between two points in the main channel. We did not measure meanders. Therefore, our measurements may differ from other measures. Cuckoo habitat is not uniformly distributed throughout the drainages within the action area, but exists as reaches or patches of suitable habitat interspersed with openings. We analyzed each drainage continuously from one end to the other rather than measuring each patch of cuckoo habitat separately. We chose this approach to encompass the changing vegetation over time and the ecosystem function of the drainages.

Habitat Measurements: Area. We used the area within cuckoo proposed critical habitat in estimates of cuckoo habitat acreage, but because we conducted our own measurements they may differ slightly from those in the critical habitat proposed rule (Table YBCU-5). Where critical habitat has not been proposed, we used the average width of riparian habitat: 0.1 mile for Cienega Creek, 0.09 mile for the Rosemont mine pit/infrastructure area, and 0.1 mile for Davidson Canyon. We measured only the habitat that grows along the drainage and did not include adjacent and less dense foraging habitat.

Riparian vegetation, whether woody species like mesquite, cottonwood, and willow or near-stream herbaceous vegetation, primarily obtains water from the shallow alluvial aquifer associated with Cienega Creek. This shallow alluvial aquifer likely is recharged by multiple sources of water, including a hydraulic connection with the regional aquifer and periodic recharge by storm flows (Garrett 2016).

The analysis assumes that drawdown in the regional aquifer caused by the mine would affect the shallow alluvial aquifer in multiple ways. Drawdown could lower the water table directly below riparian vegetation, increasing the depth that roots need to reach to obtain water, causing

reduction in streamflow, and causing pool levels to decline. Drawdown could also reduce the contribution of surface flow from upstream tributaries like Empire Gulch. These flow losses upstream would then propagate downstream through the alluvial system (Garrett 2016).
The riparian vegetation that lies away from the shallow alluvial aquifer along tributary drainage is more typically xeroriparian, subsisting on rainfall and the additional moisture concentrated along ephemeral stream channels. These areas are not likely to be impacted by drawdown in the regional aquifer. For this reason, for purposes of estimating impacts to habitat, impacts were not assumed to occur beyond the estimated boundary of the shallow alluvial aquifers along Cienega Creek and Empire Gulch, unless those areas are directly disturbed by the mine footprint (Garrett 2016).

Associated Effects of Loss of Surface Flow. Although we chose the loss of surface flow as the basis for habitat loss, additional associated effects that were not modeled contribute toward a reduction in suitable habitat and breeding cuckoos. We have no measures for these effects, but describe them qualitatively. They provide additional justification for our adverse effects determination. These associated effects include habitat fragmentation, increased loss of trees at outer periphery of habitat where depth to groundwater is the greatest, loss of trees where length of streamflow is reduced, increased headcutting where dead trees can no longer hold the stream bank intact, increased temperature, reduced humidity, reduced prey abundance, loss of nesting substrate, loss of cover, lack of regeneration and young trees to replace older trees, reduced length and width of riparian habitat reaches, reduced tree vigor, and reduced density of habitat. We provide the following summary of associated effects to yellow-billed cuckoos, based on the predicted percent loss of surface flow and associated increase in depth to groundwater over the next 150 years:

Narrowing of Habitat and Migration of Habitat Toward Center Channel. The inner perimeter of riparian habitat will gradually migrate toward the wetted stream channel center as the wetted channel width narrows. The periodic scouring floods in the narrowed low-flow channel will remove riparian seedlings and saplings, largely eliminating the youngest age class from developing into future riparian gallery forest. Where no replacement habitat is growing, suitable habitat will eventually die out.

Lack of Tree Regeneration and Survival. Riparian tree species and mesquite regeneration and seedling survival will decline as wetted streambed narrows and decreases in length and depth to groundwater increases. Where tree regeneration and survival are lacking in narrow reaches, suitable cuckoo habitat may cease to exist or may support fewer cuckoos when mature trees die.

Increasing Temperature and Evapotranspiration, Decreasing Humidity. Humidity, important for prey production and cuckoo nesting in southeastern Arizona, will decline and temperature and evapotranspiration will increase as habitat declines and fragmentation increases. These factors may reach a threshold in which cuckoos may no longer breed or may breed in reduced densities in some reaches.

Effects from Already Water-stressed Riparian System. Lower Cienega Creek continues to show the impacts of sustained drought on a shallow groundwater-dependent system (Pima Association of Governments 2015). Wet/dry surveys from June 2015 showed only 0.88 miles of flow, just

nine percent of the full 9.5 miles of flow extent observed in June of the mid-1980s. Surface flow is at its lowest during June, when yellow-billed cuckoos are searching for and selecting breeding habitat.

The slow desiccation of some areas of the Pima County CCNP in the last years has significantly impacted the gallery riparian forest on which the cuckoo depends for nesting, even as other forest patches continue to gain canopy volume and height (Powell *et al.* 2014). A photo taken on May 30, 2014 (Figure 12) in the Powell *et al.* (2014) report shows evidence of the water-stressed system on canopy cover. The canopy of healthy trees should be fully leafed-out, but the Pima County CCNP trees in the photo lack foliage and the dry streambed is covered with dried leaves. Cuckoos may not nest in an area with such open canopy. Future loss of groundwater and stream flow will exacerbate this problem.

Lateral Effects. The outer perimeter of hydroriparian and xeroriparian habitat farther from the channel center and at the greatest depth to groundwater will degrade at a greater rate than habitat closer to the channel center and groundwater. Lateral narrowing of habitat will likely reduce the density of breeding cuckoos and the habitat may eventually reach a threshold which is too narrow for breeding.

The drought has not only caused the thinning of cottonwood canopy at the Pima County CCNP (Powell 2013b: figure 40; Powell *et al.* 2014:figure 12) and death of cottonwoods at the Pima County CCNP (Pima Association of Governments 2014), it has caused the decline in the mesquite bosque vegetation community that borders the mesic riparian vegetation along the creek margins (Figure 34 in Powell *et al.* 2014). Between 2005 and 2011, most of the vegetation away from the active channel at the Pima County CCNP declined.

Although the SIR (USFS 2015b) predicts only small changes as a result of groundwater drawdown, these small changes occur within and, in some areas, immediately adjacent to the stream bed. The groundwater drawdown estimated to be less than 0.2 feet in most of Cienega Creek does not include the depth to groundwater change with lateral distance from the channel center. Expected changes in vegetation with increasing groundwater depth, per the literature, are described in Table 42 of the SIR (USFS 2015b). To apply and quantify expected changes to vegetation in affected reaches in the action area would require modeling and analyses across cross-sections of the drainages. Because this lateral modeling and analyses was not conducted, the effects to hydroriparian and xeroriparian habitat can only be described qualitatively.

The depth to groundwater increases with lateral distance from the stream center. That is, depth to groundwater is naturally most shallow within the stream bed but increases incrementally moving from the stream bed to the stream bank and adjacent uplands. We can expect the herbaceous, shrub, and tree diversity and cover to decline with lateral distance from the channel center. This change can be expected to occur first on the perimeter of the riparian or mesquite habitat adjacent to the more arid upland. Evidence of this can be found in the mesquite bosque vegetation community that borders the mesic riparian vegetation along the creek margins of the Pima County CCNP, where the drought has reduced the extent and vigor of this species (Powell *et al.* 2014). Mesquite trees have similarly declined in a number of areas (Figure 34; Powel *et al.* 2014). Although mesquite has a much greater tolerance for increased depth to groundwater than

riparian trees such as cottonwood and willow, it occurs away from the shallow groundwater aquifer of the Pima County CCNP, where well depths have declined (Figure 26, Powell *et al.* 2014). Mortality of mesquites is occurring, indicating the water table is likely to have declined beyond the considerable depth to which mesquite tap roots can reach. The current loss of cottonwoods and mesquite from the drought provides evidence that water stress from mine operation and drawdown is likely to cause further tree mortality.

Thinning Tree, Shrub, and Herbaceous Vegetation Density. Tree, shrub, and herbaceous vegetation density will decrease as stream flow and depth to groundwater decline. Vegetation thinning may reach a threshold at which vegetation is too open for breeding (Powell *et al.* 2014).

Loss of Habitat from Increased Erosion. Erosion along increasingly dry reaches will accelerate as roots from dead and dying trees fail to stabilize stream banks, further reducing suitable habitat. Erosion is likely to increase as less water flows through Empire Gulch, Cienega Creek, and Davidson Canyon, as is currently occurring with the drought. Headcutting has accelerated loss of riparian habitat in the Cienega Creek watershed. A major erosion head-cut in the streambed of lower Cienega Creek progressively erodes after major flood events when those floods are preceded by dry periods (Pima Association of Governments 2015). Erosion is also occurring in upper Cienega Creek. Head cutting in the Cienega Creek watershed demonstrates sediment fluctuation within the stream system. The head cut in lower Cienega Creek has changed from being a nick point with a steep drop in elevation within the three stream channels to a more gradual incline and a destabilized flood plain as it continues to move upstream (Pima Association of Governments 2015). The consequence of continued head cutting is an even greater loss of riparian habitat from bank collapse than from reduced flows alone.

Potential Loss of Permanent Cuckoo Recruitment. The number of cuckoos supported by riparian and mesquite habitat will permanently decline, along with the number of offspring produced. Where hydroriparian habitat converts to xeroriparian habitat and where general thinning or loss of habitat occurs, the density of cuckoos is expected to decline.

Decline in the Quantity and Quality of Yellow-billed Cuckoo Habitat and Prey Abundance. The combined result of the effects to regional groundwater, changes in the baseflow hydrology of streams, decreases in stream length, and increased temperature and riparian ET is a likely decline in the quantity and quality of yellow-billed cuckoo habitat along Empire Gulch, Cienega Creek, and Davidson Canyon. The reduced substrate for nest locations, prey species, and escape cover, in turn reduces reproductive success and increases the exposure to predation. Indirect effects to western yellow-billed cuckoo could also result from prey species experiencing the same indirect effects as the western yellow-billed cuckoo from groundwater drawdown, hence altering their predator-prey relationships. Aquatic, hydroriparian, and xeroriparian- dependent insect and amphibian prey abundance will decline as streamflow, width of wetted channel, pool volume, pool area, and habitat decrease. Reduced prey abundance will likely result in reduced density of breeding and foraging cuckoos. Changes to food sources could also result in changes in dispersal and hunting success (USFS 2015b).

Contaminants. 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), indirect

impacts to this species could occur from eating aquatic invertebrates originating from the mine pit lake.

Drainage-specific Effects:

Cienega Creek and Empire Gulch. Yellow-billed cuckoos in Cienega Creek and Empire Gulch are found in a portion of the riparian habitat that will be affected by mine drawdown and, to a small extent, reduced surface runoff resulting from the placement of tailings in Barrel Canyon. Cienega Creek is projected to experience an average of 10 percent loss of flow from mine-driven drawdown, a shift from perennial to intermittent flow in reaches CC7 and CC15, and an increase of depth to groundwater of up to 0.2 feet. Some hydroriparian habitat is likely to shift to xeroriparian habitat in Cienega Creek from mining. Lower Empire Gulch will experience an 18 percent loss of flow; this will also cause a shift from hydroriparian habitat to xeroriparian habitat. Upper Empire Gulch (EG1) will experience greater loss of cuckoo habitat due to the effects of the mine (100 percent), as it is expected to experience a greater increase in depth to groundwater and a shift to xeroriparian vegetation as the stream shifts away from perennial flow, beginning as early as 20 years post-mine closure.

We anticipate climate change-only drawdowns of 38 percent in upper and lower Cienega Creek, no additional effect in upper Empire Gulch (EG-1, which is anticipated to lose 100 percent of its flow to mine-driven drawdowns), and 28 percent in lower Empire Gulch (EG-2). The climate change-driven effects to hydroriparian vegetation in Cienega Creek and lower Empire Gulch will be relatively greater than mine-drawdowns alone. Upper Empire Gulch experiences no modeled climate change effects; its riparian habitat is affected solely by mine-related drawdowns.

Davidson Canyon. Patchy cuckoo habitat exists from the confluence of Barrel Canyon downstream to Cienega Creek. Davidson Canyon was not surveyed for yellow-billed cuckoos, but we assumed occupancy based on habitat similarity to occupied habitat and presence of cuckoos at the confluence of Davidson Canyon and Cienega Creek and within 2.5 miles of the confluence of Barrel and Davidson canyons (Corman and Magill 2000; WestLand Resources, Inc. 2015a, 2015b, 2015c; Cornell Lab of Ornithology 2016). The xeroriparian habitat in Davidson Canyon is similar to that of occupied cuckoo habitat within the perimeter fence at the proposed mine site, although it varies in plant species density and habitat width. The proposed action will adversely affect portions of the Davidson watershed and is predicted to reduce both storm-water runoff and regional groundwater levels (WestLand Resources, Inc. (2011). The pit lake will create a hydraulic sink that will divert regional ground water in the vicinity of the mine towards the pit and stormwater management practices proposed for the mine will retain surface water from precipitation events within the foot print of mine disturbance. Capture of runoff in the pit and placement of tailings is expected to reduce runoff (surface flows) 4.3 percent (see SIR and SWCA 2012), the wash contributes 8 to 24 percent of the baseflow in Lower Cienega Creek (Pima Association of Governments 2003), and the groundwater drawdown at Davidson Canyon/lower Cienega Creek Confluence is expected to be as much 0.35 feet by year 150 post-mine (Table GC-5 based on Tetra Tech (2010b), as referenced in SWCA 2012). Climate change modeling was not conducted for this site. The potential impacts of the mine-driven reduction in surface water discharges to Barrel and then Davidson Canyons and predicted groundwater decline are: (1) adverse effects on riparian vegetation in lower Barrel and Davidson Canyons;

and (2) a reduction in the length of reaches along lower Davidson Canyon that have perennial surface flow (WestLand Resources, Inc. 2011). We anticipate there will be some loss of cuckoo habitat in Davidson Canyon.

Conservation Measures Contribute toward Minimizing Adverse Effects of the Proposed Action

Sonoita Creek Ranch. Sonoita Creek Ranch, purchased by Rosemont, in two parcels is 5 miles in length and 1,580 acres (Table YBCU-7). No yellow-billed cuckoo surveys have been conducted on Sonoita Creek Ranch but some xeroriparian habitat appears to be suitable and cuckoos are regularly documented during the breeding season immediately south in similar habitat on Sonoita Creek and in the adjacent Patagonia Mountain drainages (WestLand Resources, Inc. 2013a, 2013b; Cornell Lab of Ornithology 2016). The property will be enhanced and managed to benefit cuckoos by retiring agriculture, fencing the perimeter to exclude grazing, enhancing floodplain channels, enhancing xeroriparian habitat, restoring natural drainage from the uplands. The approximately 5.7 miles of meandering channel will be enhanced and 3.8 miles of new ephemeral channel will be created. Approximately 730 acres of floodplain will be enhanced through native plant seeding and mesquite planting. Approximately 590 AF of certificated surface water rights from Monkey Spring will be available to flow through part of the property. Six acres of ponds and adjacent vegetation will be enhanced. Rosemont is funding the planning, implementation, management, and monitoring.

We are also aware of the concerns raised by Kondolf and Ashby (2015) regarding the purported hydrologic, hydraulic, and geomorphic design flaws for the Sonoita Creek restoration aspect of the Sonoita Creek Ranch conservation measure. Kondolf and Ashby's (2015) critique is primarily relevant to the ephemeral aquatic habitat in Sonoita Creek proper, though we anticipate that the authors ' concern over a lack of stream stability will mean that continual channel maintenance is required, else dynamic geomorphic process will result in continual erosional and deposition processes as the stream meanders. The xeroriparian vegetation enhancement proposed for the Sonoita Creek Ranch is likely to be concentrated away from the meander width of the active channel and will thus be less susceptible to being eroded away during high flow events.

Davidson Canyon Parcels. The Davidson and Barrel Canyon parcels, purchased by Rosemont, will be protected from development and damage (Table YBCU-7). No yellow-billed cuckoo surveys have been conducted in Davidson Canyon but some xeroriparian habitat appears to be suitable for the species. As mentioned above, the xeroriparian habitat in Davidson Canyon is similar to that of occupied cuckoo habitat within the perimeter fence at the proposed mine site, and, in the absence of cuckoo surveys, we assumed occupancy based on habitat similarity to occupied habitat and presence of breeding season cuckoos nearby (Corman and Magill 2000; WestLand Resources, Inc. 2015a, 2015b, 2015c; Cornell Lab of Ornithology 2016). Some xeroriparian habitat recovery is expected after fencing to exclude grazing and human recreation. The parcels include 1.8 miles of Davidson and Barrel canyons and 83 acres of xeroriparian habitat. Rosemont is funding management and monitoring for these parcels.

Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management (Revised Conservation Measure 3; $1.25 million Hydroriparian Conservation Fund). The hydroriparian habitat will be developed

specifically for willow flycatchers in a location yet to be determined, but it will also benefit cuckoos (Table YBCU-7). At least 0.5 miles and 31 acres of hydroriparian habitat to be enhanced11 with the $1.25 million will provide minimize the effect of the incidental take resulting from the loss of 3.3 miles and 860.5 acres of xero- and hydroriparian habitat (see Table YBCU-5). The proposed conservation measure is expected to fund planning, compliance and permitting, site preparation, implementation, monitoring, maintenance, and reporting. The expected number of miles and acres to be enhanced may be greater than the minimum estimated; costs for different enhancements vary widely.

Implementation of the conservation measure to fund enhancement of hydroriparian habitat will help minimize adverse effects (Table YBCU-7). Subtracting the minimum miles and acres to be enhanced from the miles and acres of acres adversely affected by the proposed action, as many as 2.8 hydroriparian miles and 829.5 hydroriparian acres will not be offset by conservation measures.

Calculation of the Mitigative Value of all Conservation Measures. The tables below contain calculations of the proposed action's net effects to the yellow-billed cuckoo. We differentiate between the number of hydroriparian and xeroriparian habitat miles and acres because hydroriparian habitat supports a greater density of cuckoos than xeroriparian habitat. Therefore, hydroriparian habitat is of greater value per acre. As stated above, subtracting the anticipated (and estimated) miles and acres of habitat to be restored via the Hydroriparian Conservation Fund yields the number of miles and acres of habitat that will not be offset by conservation measures. Subtracting 6.8 linear miles along major drainages and 730 acres of xeroriparian habitat to be protected or enhanced via the Sonoita Creek Ranch and Davidson Canyon Parcels conservation measures from the 7.3 miles and 428.7 acres of xeroriparian habitat adversely affected yields 0.5 fewer xeroriparian miles enhanced or protected than adversely affected but 301.3 more xeroriparian acres enhanced than adversely affected. Additional channels enhanced and created within Sonoita Creek Ranch will compensate for 0.5 fewer xeroriparian miles enhanced than adversely affected. Therefore, these conservation measures fully minimize the effects of the action on cuckoos in xeroriparian habitat. However, the conservation measures minimize the effects of the action on cuckoos in only a small proportion of hydroriparian habitat adversely affected. If the miles and acreage anticipated to be enhanced at Sonoita Creek Ranch and/or under the Hydroriparian Conservation Fund are not met, the adverse effects to xero- and hydroriparian vegetation will be greater than analyzed in this BO, thus necessitating consideration of reinitiation by the USFS and Corps.

11 Note that in the context of riparian vegetation, enhancement refers, at a minimum, to increases in the extent and/or vigor of riparian vegetation at a site where vegetation already exists in a reduced state. Should enhancement be implemented at a site devoid of riparian vegetation, it would amount to restoration of habitat. Protection of habitat refers to actions where existing riparian habitat is protected from threats, but no specific measures are implemented to increase the vigor and/or extent of the habitat.

Table YBCU-5. Expected adverse effects of the proposed Rosemont mine on yellow-billed cuckoos, without climate change. The anticipated percent of cuckoo breeding habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega, Cienega Creek, and Davidson Canyon at 150 years. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreages correspond to proposed critical habitat within a given reach or to the average width of riparian vegetation where critical habitat has not been proposed. Average width of riparian habitat where no critical habitat proposed: 0.1 mile for Cienega Creek, 0.09 mile for Rosemont mine area, 0.1 mile for Davidson Canyon. EG = Empire Gulch, CC = Cienega Creek

Reach	Within Critical Habitat?	Miles[12]	Acres[13]	Percent Habitat Affected without Climate Change[14]	Adversely Affected Miles	Adversely Affected Acres	Habitat along Drainage[15]
Upper Cienega Creek and Empire Gulch outside of EG1, EG2	Yes	15.2	4,554.0	10	1.5	455.4	Hydroriparian
EG1	Yes	0.7	124.8	100	0.7	124.8	Hydroriparian
EG2	Yes	0.9	247.7	18	0.2	44.5	Hydroriparian
Between Upper and Lower Cienega Creek	No	7.0	448.0	10	0.7	44.8	Xeroriparian
Lower Cienega Creek	Yes	9.4	2,357.8	10	0.9	235.8	Hydroriparian
Davidson Canyon	No	13.9	889.6	4.3	0.6	38.3	Xeroriparian
Mine pit/infrastructure area: Barrel, McCleary, and Wasp canyons[16]	No	6.0	345.6	100	6.0	345.6	Xeroriparian
Subtotal					3.3	860.5	Hydroriparian[17]
					7.3	428.7	Xeroriparian
Grand Total					**10.6**	**1,289.2**	Hydro-,xeroriparian.

12 Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.
13 205.4 acres of proposed critical habitat were subtracted from the total number of acres on upper Cienega Creek, where habitat receives flow from eastern tributaries. Flow from eastern tributaries will not be affected by the proposed mine activities.
14 The percent loss is based on loss of surface flow, but represents loss of cuckoo breeding and foraging habitat, reduction in the number of breeding cuckoos, loss of prey species, and contamination of breeding cuckoos eating contaminated prey species near the mine site. SWCA (2012) estimated that Davidson Canyon Wash will experience a 4.3 percent reduction in surface flows from the placement of tailings in Barrel Canyon (a tributary). Also note that climate change has greater effects (38 percent in upper and lower Cienega Creek, 100 percent in upper Empire Gulch, and 28 percent in lower Empire Gulch).
15 Habitat classified is the primary habitat type, but small patches of other habitat types occur within these reaches.
16 Loss of foraging habitat was not included in number of miles and acres of cuckoo habitat affected.
17 An unknown portion of the 3.3 miles and 860.5 acres is expected to transition from hydroriparian to xeroriparian habitat as streamflow declines, with a reduced density of cuckoos.

Table YBCU-6. Expected minimization of the effects of the proposed Rosemont mine on western yellow-billed cuckoos, without climate change, with offsetting habitat enhancement provided by the $1.25 million of funding in the Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management (Revised Conservation Measure 3). The anticipated percent of yellow-billed cuckoo breeding habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega and Cienega Creek at 150 years minus the number of miles and acres to be enhanced or protected from the $1.25million hydroriparian habitat fund and at Sonoita Creek Ranch and at Davidson Canyon. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreages correspond to critical habitat within a given reach or to the width of riparian vegetation where critical habitat has not been proposed.

Adversely Affected Miles	Adversely Affected Acres	Habitat Type Affected[18]	Miles to be Enhanced or Protected[19]	Acres to be Enhanced or Protected	Adversely Affected Miles minus Miles to be Enhanced or Protected	Adversely Affected Acres minus Acres to be Enhanced or Protected	Conservation Measure
3.3	860.5[20]	Hydro-riparian	≥0.5 mile (≥ 250 ft wide)	≥31	3.3 - ≥0.5 = ≤2.8	860.5 - ≥ 31 = ≤829.5	$1.25 million hydroriparian habitat enhancement
7.3	428.7	Xero-riparian	6.8 linear miles along major drainages including 9.5 miles of channels	730 acres enhanced 83 acres protected, totaling 813 acres enhanced or protected	7.3 - 6.8 = 0.5 but additional channels enhanced and created minimize adverse effects to no residual xeroriparian adversely affected miles	428.7 – 730 = - 301.3 No remaining xeroriparian habitat adversely affected acres; 301.3 more acres created than adversely affected	Sonoita Creek Ranch Davidson Canyon Parcels

18 Habitat classified is the primary habitat type, but small patches of other habitat types occur within these reaches.
19 Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.
20 An unknown portion of the 3.3 miles and 860.5 acres is expected to gradually convert from hydroriparian to xeroriparian habitat as streamflow declines, with a reduced density of cuckoos. Therefore, the remaining habitat is expected to have value to cuckoos as xeroriparian habitat. The 3.3 miles and 860.5 acres also corresponds to the number of acres of critical habitat adversely affected by the proposed action.

Table YBCU-7 Yellow-billed cuckoo habitat conservation measure summary

Reach	To be Enhanced or Protected	Miles to be Enhanced or Protected[21]	Acres to be Enhanced or Protected	Habitat Type to be Enhanced or Protected
Sonoita Creek Ranch (purchased, to be enhanced and excluded from grazing)	Enhanced	5 miles in length with 5.7 miles of meandering enhanced channel and 3.8 miles new ephemeral channel	730 floodplain acres enhanced Approx. 590 AF of certificated surface water rights from Monkey Spring Includes 6 acres of pond 850 upland acres protected	Xeroriparian
Davidson and Barrel Canyons Parcels (6 parcels purchased and excluded from grazing)[22]	Protected	1.8	83 xeroriparian acres protected Approx. 16 acres of potential waters of the U.S. and 3 springs (Barrel Spring, Questa Spring, and an unnamed spring), 446 acres of uplands protected	Xeroriparian
To be determined ($1.25 million for hydroriparian habitat enhancement)	Enhanced	≥0.5 mile (≥ 250 ft wide)	≥31 acres	Hydroriparian

21 Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.
22 Rosemont purchased six parcels, totaling 545 acres in Mulberry, Barrel, East Fork Davidson, and Davidson canyons (WestLand Resources, Inc. 2014). Of these acres, 83 are xeroriparian. Four parcels are within 2.5 miles of the proposed mine area and two parcels are five miles away. By protecting these parcels from development, they contribute toward additional conservation of Davidson Canyon. To be consistent with how adverse effects on habitat were calculated, tributaries to Davidson and Barrel canyons were not included in miles measured.

Effects to Yellow-billed Cuckoo Proposed 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 yellow-billed cuckoo inform the analysis of the effects to proposed critical habitat, and are incorporated herein by reference.

Mine construction, operation, and post-closure drawdown will affect proposed PCEs by (1) reducing depth to groundwater and wetted length and width of the stream that will result in reduced riparian and mesquite habitat quality and quantity, (2) reducing prey population, and (3) reducing flood flows that promote regeneration as well as scouring out any regeneration that grows in the narrowed stream channel. These effects would be in addition to relatively larger effects of natural variation (including drought and climate change). Overall, we expect mine construction, operation, and drawdown to adversely affect 10 percent of the habitat throughout units AZ-25, Empire Gulch and Upper Cienega Creek, and AZ-30, Lower Cienega Creek, with the exception of 100 percent in EG1 and 18 percent in EG2. That is, the proposed action is expected to adversely affect 860.5 acres of the 7,284.3 acres of proposed cuckoo critical habitat in the action area (Table YBCU-8). This amounts to 13 percent of proposed critical habitat miles and 12 percent of the critical habitat acres in AZ-25 (Empire Gulch and Upper Cienega Creek) and AZ-30 (Lower Cienega Creek). This loss of PCEs in Empire Gulch and Cienega Creek will occur within 0.02 percent of proposed critical habitat rangewide. We note that not all occupied cuckoo habitat is proposed as critical habitat; Barrel, McCleary and Wasp canyons; Davidson Canyon; and Gardner Canyon are examples of drainages with no proposed critical habitat. A 7-mile primarily xeroriparian reach between the Upper Cienega Creek and Lower Cienega Creek Units is also not proposed as critical habitat.

Table YBCU-8. Expected effects of the proposed Rosemont mine on yellow-billed cuckoo critical habitat, without climate change. The anticipated percent of yellow-billed cuckoo breeding habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega and Cienega Creek at 150 years. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreages correspond to proposed critical habitat within a given reach. EG = Empire Gulch, CC = Cienega Creek

Reach	Habitat along Drainage[23]	Miles[24]	Acres[25]	Percent Critical Habitat Affected without Climate Change[26]	Adversely Affected Critical Habitat Miles	Adversely Affected Critical Habitat Acres
Upper Cienega Creek and Empire Gulch outside of EG1, EG2	Hydroriparian	15.2	4,554.0	10	1.5	455.4
EG1	Hydroriparian	0.7	124.8	100	0.7	124.8
EG2	Hydroriparian	0.9	247.7	18	0.2	44.5
Subtotal	Hydroriparian	16.8	4,926.5		2.4	624.7
Lower Cienega Creek	Hydroriparian	9.4	2,357.8	10	0.9	235.8
Total	Hydroriparian	26.2	7,284.3	10-100	3.3	860.5[27]

23 Habitat classified is the primary habitat type, but small patches of other habitat types occur within these reaches.
24 Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.
25 205.4 acres of proposed critical habitat were subtracted from the total number of acres on upper Cienega Creek, where habitat receives flow from eastern tributaries. Flow from eastern tributaries will not be affected by the proposed mine activities.
26 The percent loss is based on loss of surface flow, but represents loss of cuckoo breeding and foraging habitat, reduction in the number of breeding cuckoos, loss of prey species, and contamination of breeding cuckoos eating contaminated prey species near the mine site. Climate change has greater effects (38 percent in upper and lower Cienega Creek, 100 percent in EG-1, and 28 percent in EG-2).
27 An unknown portion of the 3.3 miles and 860.5 acres is expected to gradually convert from hydroriparian to xeroriparian habitat as streamflow declines, with a reduced density of cuckoos.

Cumulative Effects – Yellow-billed Cuckoo

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.

The primary cumulative effects to the riparian vegetation (including within proposed critical habitat) and prey species where yellow-billed cuckoos occur are the stresses associated with decreases in water availability due to non-Federal actions. This suite of cumulative effects was described in detail in the sections containing descriptions of general effects to aquatic and riparian ecosystems and in the cumulative effects analysis for Gila chub in the 2013 Rosemont BO and is still accurate, thus incorporated by reference.

Conclusion – Yellow-billed Cuckoo

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted (using our model assumptions), the conclusion of non-jeopardy and no destruction or adverse modification, below, would remain valid.

After reviewing the current status of the yellow-billed cuckoo 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 yellow-billed cuckoo, and is not likely to destroy or adversely modify proposed yellow-billed cuckoo critical habitat. We present this conclusion for the following reasons:

- We anticipate 3.3 miles of hydroriparian habitat will be adversely affected due to mine-driven loss of surface flow in Empire Gulch and upper and lower Cienega Creek (Table YBCU-6), although an indeterminate portion of the hydroriparian habitat may transition to xeroriparian habitat as streamflow declines. The xeroriparian habitat that eventually replaces the hydroriparian habitat may support cuckoos, although in reduced density.

- Although the reduction of yellow-billed cuckoos and 3.3 miles of hydroriparian and 7.3 miles of xeroriparian breeding habitat in the action area represents a permanent loss, breeding cuckoos and suitable habitat not affected by climate change will continue to exist in the action area as well as within a 30-mile radius in the drainages and foothills of the Santa Rita Mountains, Canelo Hills, Patagonia Mountains, Whetstone Mountains, San Pedro River, and Sonoita Creek (Corman and Magill 2000,WestLand Resources, Inc.

2013a, 2013b; Arizona Game and Fish Department 2015; Cornell Lab of Ornithology 2016; Tucson Audubon 2015a and 2015b). Much of the nearby offsite breeding habitat is either on public land or conservation properties in the Coronado National Forest, San Pedro River National Conservation Area, Patagonia-Sonoita Creek Preserve, Patagonia State Park, and Canelo Hills Preserve.

- Proposed yellow-billed cuckoo critical habitat exists in Empire Gulch and along upper and lower Cienega Creek; effects to the proposed critical habitat parallel the effects to the species. Overall, we expect mine construction, operation, and drawdown to adversely affect 10 percent of the habitat throughout units AZ-25, Empire Gulch and Upper Cienega Creek, and AZ-30, Lower Cienega Creek, with the exception of 100 percent in EG1 and 18 percent in EG2. That is, the proposed action is expected to adversely affect 860.5 of the 7,284.3 acres of proposed cuckoo critical habitat in the action area. This amounts to 13 percent of critical habitat miles and 11 percent of the critical habitat acres in AZ-25, Empire Gulch and Upper Cienega Creek, and AZ-30, Lower Cienega Creek. This loss of proposed critical habitat in Empire Gulch and Cienega Creek is only 0.02 percent of proposed critical habitat rangewide. The anticipated climate change-driven drawdowns of 38 percent in upper and lower Cienega Creek and 28 percent in EG-2 will proposed critical habitat.

- The conservation measure to provide $1.25 million for riparian enhancement will help minimize adverse effects of the proposed action on hydroriparian habitat. Because the actual number of miles and acres of hydroriparian habitat to be enhanced depends on the cost and type of enhancement, we project that at least 0.5 miles and 31 acres of hydroriparian habitat will be enhanced with the funding to provide at least some offset to the 3.3 miles and 860.5 acres of hydroriparian habitat expected to be lost (Table YBCU-6) due to mining activities. The actual number of miles and acres of hydroriparian habitat to be enhanced may be greater.

- Rosemont Copper Mine's purchase, protection, and fencing of 1.8 miles of Barrel Canyon and Davidson Canyon xeroriparian habitat will help minimize adverse effects of the proposed action on xeroriparian habitat. Some additional cuckoo habitat may develop in conjunction with livestock exclusion (Table YBCU-7).

- Rosemont Copper Mine's purchase, enhancement, and management of 730 floodplain acres in Sonoita Creek Ranch will help minimize adverse effects of the proposed action (Table YBCU-7). See tables for miles and acres of habitat to be enhanced. Fencing to exclude grazing, enhancement of and creation of channels to direct flow, seeding and planting native trees, and restoring natural drainage from the uplands to the floodplain will increase the amount of xeroriparian habitat in Sonoita Creek Ranch.

- Conservation measures in the Davidson Canyon parcels and Sonoita Creek Ranch fully minimize effects of the action on cuckoos in xeroriparian habitat (but not in hydroriparian habitat). Although additional channels enhanced and created within Sonoita Creek Ranch will compensate for 0.5 fewer xeroriparian miles enhanced than adversely affected, the acreage protected and enhanced is greater by 301.3 acres than the number adversely

affected (83 acres + 730 acres = 813 acres protected or enhanced vs 428.7 affected).

Please note that in the Terms and Conditions, below, Rosemont will be required to monitor groundwater drawdown and the USFS (and Corps, as appropriate) will compare observed drawdown to modeled drawdown. Groundwater drawdown greater than modeled may require reinitiation of section 7 consultation.

This distinct population segment has only been listed since 2014 and we are still learning about its occurrence and habitat requirements in southeastern Arizona. Although cuckoos will be extirpated from the vicinity of the mine pit and will decline in Davidson Canyon, Empire Gulch, and Cienega Creek, they are expected to continue to breed in much of the action area.

Since the impacts of the proposed action affect a small portion of the yellow-billed cuckoo population and the action area is small compared to the range of the species, and cuckoos are expected to still be present in Empire Gulch, Cienega Creek and Davidson Canyon 150 years after mine closure, it is unlikely that a tipping point away from recovery would be reached. While the action area does include an important population of the species, effects will not cause the loss of the population. Suitable and occupied cuckoo habitat will remain in the action area and within a 30-mile radius in the drainages and foothills of the Santa Rita Mountains, Canelo Hills, Patagonia Mountains, Whetstone Mountains, San Pedro River, and Sonoita Creek. We expect 22.9 miles of cuckoo hydroriparian habitat to remain in Empire Gulch and upper and lower Cienega Creek, 6.3 miles of cuckoo xeroriparian habitat to remain between upper and lower Cienega Creek, and 13.3 miles of cuckoo xeroriparian habitat to remain in Davidson Canyon within the action area. We believe that cuckoos will still be present in Empire Gulch, Davidson Canyon and Cienega Creek 150 years after closure of the mine, although in reduced numbers as a result of reduced suitable habitat.

The adverse effects that occur in the action area do not reach the scale where recovery of the species would be precluded. Adverse effects are anticipated to be of a small scale in relation to the entire range of the cuckoo, and are unlikely to destroy or adversely modify the critical habitat in the action area to the extent that recovery would be precluded for many of the reasons found in the conclusion and discussion above.

Based on the above analyses and summary, it is the FWS's biological opinion that the proposed action will not alter the ability of this proposed critical habitat to retain its PCEs and to function properly. As such, yellow-billed cuckoo proposed critical habitat is anticipated to 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 yellow-billed cuckoo proposed critical habitat nor affect its role in recovery of the species.

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 – YELLOW-BILLED CUCKOO

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 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). "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 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, Corps, 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 – Yellow-billed Cuckoo

We anticipate that the proposed action will result in incidental take of yellow-billed cuckoos in the form of harm through permanent direct loss of occupied habitat from mine construction and placement of tailings. In addition, we anticipate indirect loss of occupied habitat from groundwater drawdown and related loss of surface flow in Barrel, McCleary, Wasp, and Davidson canyons; Barrel Canyon; Empire Gulch; upper and lower Cienega Creek; and the reach between upper and lower Cienega Creek.

We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take. However, we must use habitat as a surrogate for the amount or extent of take because the number of cuckoos in a given area cannot be determined with existing information and techniques. Counting yellow-billed cuckoos is difficult because males and females look and sound alike, they have large overlapping home ranges, they are behaviorally secretive, they have short breeding cycles, and they can move to different locations within and between breeding seasons (Halterman *et al.* 2015). These factors can lead to either underestimating or overestimating the number of cuckoos. Moreover, yellow-billed cuckoo surveys have been conducted only in a portion of suitable habitat to date; in Barrel, McCleary, and Wasp canyons; Empire Gulch; and parts of Cienega Creek. Protocol surveys (Halterman *et al.* 2015) are designed only to determine presence/absence in a given reach rather than an accurate count of

individual birds. Additional surveys and methods, including banding and possibly monitoring telemetered birds, would need to be employed to obtain an accurate count of individual birds and pairs throughout the breeding season.

It is reasonable to assume that the abundance of yellow-billed cuckoo is correlated with the extent of suitable riparian habitat. We therefore quantified the adverse effects of the proposed action as the number of stream miles and corresponding acres of xero- and hydroriparian habitat that we anticipate will be lost due to mine-driven groundwater drawdown. The estimated number of miles and acres anticipated to be adversely affected by construction and operation of the mine appears in Table YBCU-5, above and is summarized below.

We anticipate that 6 miles and 345.6 acres of occupied xeroriparian vegetation in Barrel, McCleary, and Wasp Canyons will be directly adversely affected as a result of construction and operation of the mine. We anticipate that 0.6 miles and 38.3 acres of xeroriparian habitat will be indirectly adversely affected due to mine-driven loss of surface flow in Davidson Canyon. Combined, the total xeroriparian habitat adversely affected is 7.3 miles and 428.7 acres. We anticipate that 0.7 miles and 44.8 acres of xeroriparian habitat will be indirectly adversely affected due to mine-driven loss of surface flow in the reach of Cienega Creek between upper and lower Cienega Creek. We also anticipate that 3.3 miles and 860.5 acres of hydroriparian habitat will be indirectly adversely affected due to loss of surface flow in Empire Gulch and upper and lower Cienega Creek.

While we anticipate that mine-driven groundwater drawdown will affect xero- and hydroriparian habitat to the extent described above, the habitat will also be affected by flow reductions attributable to climate change (see Tables A-1 through A-4 in the Effects to Aquatic Ecosystems section, incorporated herein by reference). Riparian vegetation in the Cienega Creek system is also successional in nature and variable in its extent (Powell 2013b). These aspects of the ecology render it difficult to determine what portion of future losses of xero- and hydroriparian riparian vegetation are attributable solely to mine-driven drawdown.

Hydroriparian vegetation is supported by the subsurface and surface flows of water in the affected streams. Xeroriparian vegetation also depends on groundwater, although at a somewhat greater depth than hydroriparian vegetation. Decreases in groundwater elevation within the shallow alluvium and decreases in stream baseflow therefore result in stress to both hydro- and xeroriparian ecosystems. Groundwater elevations, which can be readily measured, are consequently an effective surrogate measure of effects to xero- and hydroriparian habitat, which in turn, is an effective surrogate for yellow-billed cuckoo abundance. Therefore, for the purpose of determining take, we will employ groundwater drawdown as a surrogate measure of take for the yellow-billed cuckoo.

The specific levels of incidental take of yellow-billed cuckoo are expressed in terms of the groundwater drawdowns. anticipated (based on modeling) in the locations and time frames (0, 20, 50, 150 years) discussed above in the Gila chub analysis (see the Amount or Extent of Take subsection of the Gila Chub Incidental Take Statement, incorporated herein by reference and summarized in Table GC-4). We believe this surrogate measure is also appropriate for the yellow-billed cuckoo because the most significant effects to this species result from the anticipated loss of

riparian habitat, which is supported by shallow groundwater and surface water discharged from shallow groundwater sources.

A program of groundwater monitoring is the appropriate means to evaluate, over time, changes in groundwater elevation (again, as a surrogate for xero- and hydroriparian habitat and yellow-billed cuckoo abundance). An effective groundwater monitoring program was developed to monitor the groundwater elevation-based surrogate for the incidental take of Gila chub (see the Amount or Extent of Take subsection of the Gila chub Incidental Take Statement, incorporated herein by reference). The locations for the groundwater monitoring program and their justifications appear in Table GC-5, above.

In summary, and stated differently, the maximum allowable incidental take of yellow-billed cuckoo is represented by the surrogate measure of groundwater drawdowns at the sites and time intervals stated in Table GC-4, above. The to-be-modeled groundwater drawdowns at a suite of potential sites specified in Table GC-5, above, will serve as proxies for the incidental take at the sites in Table GC-4. The manner by which Rosemont and the USFS shall monitor compliance with the amount of incidental take is described further in the Terms and Conditions, below.

Effect of the Take – Yellow-billed Cuckoo

In this BO, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the yellow-billed cuckoo nor likely to result in destruction or adverse modification of proposed critical habitat for the reasons stated in the Conclusions section, above. Suitable and occupied yellow-billed cuckoo habitat will remain in the action area and within a 30 mile radius in the drainages and foothills of the Santa Rita Mountains, Canelo Hills, Patagonia Mountains, Whetstone Mountains, San Pedro River, and Sonoita Creek. We expect 22.9 miles of yellow-billed cuckoo hydroriparian habitat to remain in Empire Gulch and upper and lower Cienega Creek, 6.3 miles of yellow-billed cuckoo xeroriparian habitat to remain between upper and lower Cienega Creek, and 13.3 miles of yellow-billed cuckoo xeroriparian habitat to remain in Davidson Canyon within the action area.

Reasonable and Prudent Measures – Yellow-billed Cuckoo

In addition, the FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of yellow-billed cuckoos:

1. The USFS and Corps shall ensure that Rosemont monitor groundwater levels (as a proxy for the xero- and hydroriparian vegetation surrogate measure of take for yellow-billed cuckoo) at least annually (see also FEIS mitigation measure FS-BR-27);
2. The USFS and Corps shall ensure that Rosemont appropriately implements and monitors the hydroriparian habitat proposed to be created at a to-be-determined location, also as described in Revised Conservation Measure 3.
3. The USFS and Corps shall ensure that Rosemont monitors the xeroriparian habitat proposed to be created on the Sonoita Creek Ranch.

Terms and Conditions – Yellow-billed Cuckoo

In order to be exempt from the prohibitions of section 9 of the Act, Rosemont, the USFS, and Corps 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 USFS and Corps shall ensure that Gila chub Terms and Conditions 1.1, 1.2, 1.3, 1.4, and 1.5 are implemented. This Term and Condition implements the yellow-billed cuckoo Reasonable and Prudent Measure 1, above.
2. The USFS and Corps shall ensure that Rosemont's implementation and monitoring plans for xero- and hydroriparian habitat are submitted to the USFS, Corps, and FWS (in consultation with other wildlife agencies, as appropriate) in advance for review, comment, and approval. This Term and Condition implements yellow-billed cuckoo Reasonable and Prudent Measures 2 and 3, above.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effects of 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 and/or Corps must immediately provide an explanation of the causes.

Conservation Recommendations – Yellow-billed Cuckoo

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 critical habitat, to help implement recovery plans, or to develop information. The FWS recommends the following conservation activities:

1. We recommend that USFS and Corps ensure that Rosemont restores additional acreage of hydroriparian habitat, beyond what will be funded by Revised Conservation Measure 3.
2. We recommend that the USFS and Corps ensure that Rosemont researches techniques for reducing the use and loss of groundwater from the proposed action in the project area, considering any and all current and future techniques that may be technologically and economically feasible.
3. We recommend that the USFS implement Forest-specific actions to assist in recovery of the yellow-billed cuckoo.
4. We recommend the USFS continue conducting yellow-billed cuckoo surveys (per Halterman *et al.* 2015 or subsequent protocols) yellow-billed cuckoo surveys forest-wide to assess cuckoo habitat in the Sky Islands of Arizona.
5. We recommend the USFS and Corps ensure that Rosemont surveys for yellow-billed cuckoos (per Halterman *et al.* 2015 or subsequent protocols) in the adversely affected portion of the action area.

6. We recommend the USFS and Corps ensure that Rosemont surveys for yellow-billed cuckoos (per Halterman *et al.* 2015 or subsequent protocols) on Sonoita Creek Ranch and in suitable habitat on other conservation properties.
7. We recommend that USFS and Corps ensure that Rosemont incorporates the creation of suitable xeroriparian and upland yellow-billed cuckoo habitat in the to-be-reclaimed portions of the mine site.

In order 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.

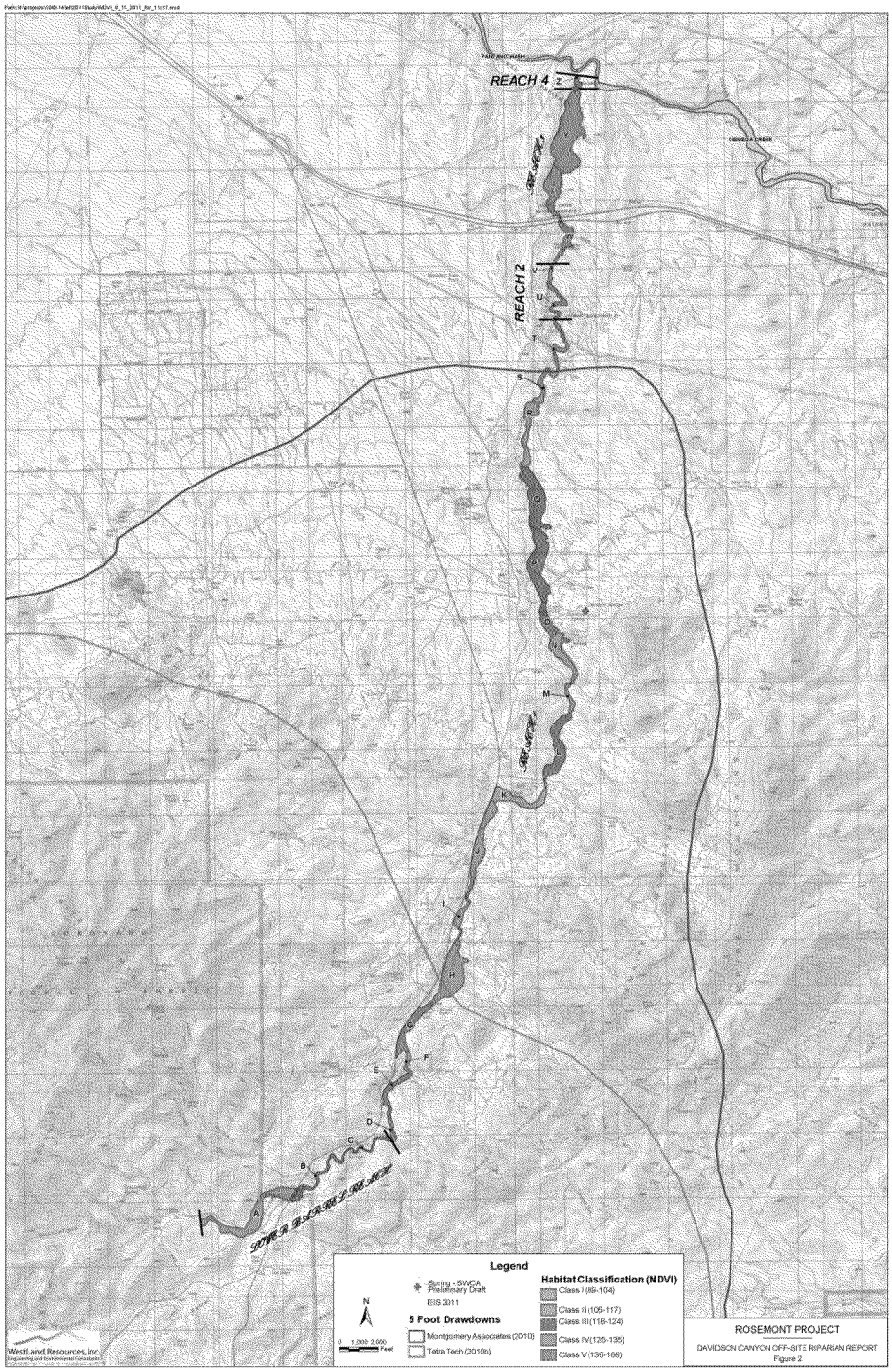


Figure YBCU-1

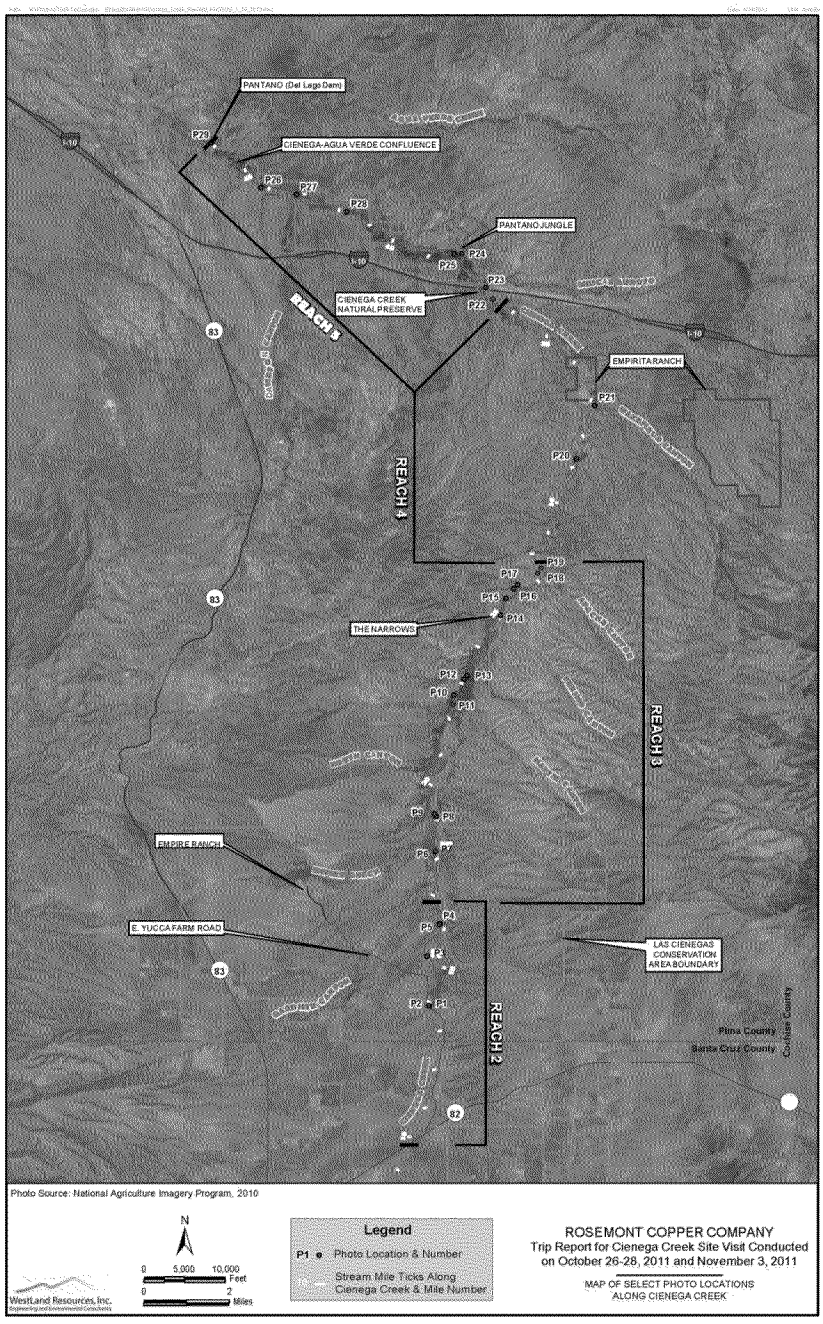


Figure YBCU-2

SOUTHWESTERN WILLOW FLYCATCHER

Status of the Species – Southwestern Willow Flycatcher

The rangewide status of the southwestern willow flycatcher remains substantively unchanged since we completed the October 30, 2013, BO. We reiterate that 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). The content of these respective documents is incorporated herein via reference.

Environmental Baseline – Southwestern Willow Flycatcher

Formal Consultations in the Empire Gulch/Cienega Creek Action Area and Broader Santa Cruz Management Area.

Few formal consultations from 1995 to 2012 addressed impacts to the flycatcher and its habitat within the Cienega Creek watershed in the Action Area and the Santa Cruz River in the Santa Cruz Management Area. Along Cienega Creek, the BLM evaluated grazing (FWS 1995; 2-21-95-F-177), stream restoration (FWS 1998b; 2-21-98-F-373), Management Plan implementation for the Phoenix Resource Management Area (FWS1998a; 2-21-88-F-167).and Management Plan implementation at Las Cienegas National Conservation Area (FWS 2002c; 02-21-02-F-162). Santa Cruz River (FWS 2001; 1999; 2-21-99-F-096) and the National Park Service at Tumacácori National Historic Park conducted tamarisk removal to reduce fire risk along the Santa Cruz River (FWS 2006; 02-21-05-F-0829). The Working Lands for Wildlife Program (FWS 2012; 02E0000-2012-F-0013) concluded that there may be short-term adverse effects to the flycatcher and its critical habitat across the bird's range when trying implement private land habitat improvement projects. These projects resulted in evaluations that concluded possible and likely short-term adverse impacts to the flycatcher from harassment and nest parasitism, minor habitat impacts, and also long-term flycatcher habitat improvement/protection from stream restoration, land management, and fire prevention.

Status of the Southwestern Willow Flycatcher in the Action Area

The 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 section, above. Southwestern willow flycatcher detections in the action area, informed by species-specific surveys and other avian monitoring projects, remain as described in the October 30, 2013, BO. It must be noted that surveys are conducted infrequently and only in portions of Empire Cienega and Cienega Creek. Therefore, the number of southwestern willow flycatchers detected during the breeding season is most certainly an underestimate. These prior data are summarized below:

- A southwestern willow flycatcher pair and nest were located in 2001 (within the critical habitat segment) in upper Cienega Creek.
- Two migrant flycatchers were documented in the same reach of upper Cienega Creek—one in 1999 and one in 2003.

- A single flycatcher territory was detected along Cienega Creek in 2001 (Smith *et al.* 2002). An individual flycatcher was documented on Cienega Creek during formal surveys in August 2003 (Keith Hughes, BLM files, as cited in BLM 2013).
- 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).
- A flycatcher (or flycatchers) was documented at the Empire Gulch Monitoring Avian Productivity and Survivorship (MAPS) station on June 8 and 17, 2011; the detection was listed as "probable breeder-song" for these dates (BLM 2013 and 2014, Paxton 2012). An after-hatch-year flycatcher was caught on June 17, 2011, and a hatch-year bird was caught on August 6, 2011, which provides evidence that willow flycatchers were likely breeding in Empire Gulch (M. Radke, pers. obs., as cited in BLM 2014).

From 2010 to 2012, an approximately 1-mile length of the so-called Claypit Reach of lower Cienega Creek was surveyed by Pima County in order to evaluate a potential Partners for Fish and Wildlife project that would remove tamarisk. The southwestern willow flycatcher has not been found during recent surveys at the CCNP in 2008, 2010, 2011, or 2012 (Rodden 2010, 2011, 2012). In 2014, surveys were not conducted but habitat appeared dry and unsuitable during an early season field trip (Brian Powell and Susan Sferra, unpublished data). Regular surveys have not been conducted at CCNP.

Status of the Southwestern Willow Flycatcher Critical Habitat in the Action Area

The southwestern willow flycatcher critical habitat within the action area remains much as it was described in the October 30, 2013 BO. The prior narrative is incorporated herein via reference, with the exception of the information found below.

We have refined our discussion regarding the southwestern willow flycatcher's occupancy of the critical habitat within the action area. The 6 detections on upper Cienega Creek occurred between Cinco Canyon south to Wood Canyon (Fig 10, USFS 2015a), a length of 5.3 miles within critical habitat. Four detections in Empire Cienega occurred within critical habitat in EG1, although the 0.68-mile reach includes habitat within and outside of critical habitat. The presence of a pair and nest in upper Cienega Creek confirms breeding in 2001 and the presence of territorial flycatchers and hatch year birds in Empire Gulch provides evidence of breeding in 2011.

The stream segments within the action area fall within the Santa Cruz Management Area, 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 species' Recovery Plan (FWS 2002a). The Santa Cruz Management Area is, in turn, a component of the larger 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, and/or the feeding and sheltering needs of migratory and dispersing flycatchers.

Given that the proposed action will affect southwestern willow flycatcher critical habitat, we

have restated the physical and biological features of critical habitat as well as the primary constituent elements (PCE). This will serve as a point of reference for our subsequent analyses and conclusions.

The physical and biological features of flycatcher critical habitat are the principal biological or physical elements essential to flycatcher conservation which may require special management considerations or protection (FWS 2013). We primarily identified the features and functions of rivers that generate flycatcher habitat and its food such as low gradient/broad floodplains, water, saturated soil, hydrologic regimes, elevated groundwater, and fine sediments, etc. (FWS 2013).

Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the southwestern willow flycatcher's life-history processes, we determined that the PCEs of its critical habitat 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 Goodding's 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).

We have also performed analyses to examine how the critical habitat present in the action area relates to critical habitat in nearby areas. This informs the understanding of how effects to

southwestern willow flycatcher habitat in the Santa Cruz Management Area can, or cannot, be considered offset by the presence of nearby, unaffected Management Units. It must be noted that Empire Gulch and Upper Cienega Creek are the only occupied reaches in the Santa Cruz Management Area.

The nearest southwestern willow flycatcher critical habitat outside of the action area is situated approximately 22 miles away on lower San Pedro River near the southern boundary of Middle Gila/San Pedro Unit. Further, with the exception of the occasionally-occupied Upper San Pedro River reach in the Middle Gila-San Pedro Management Unit, Empire Gulch and Upper Cienega Creek are the farthest south breeding locations in the U.S. The distance from the southwestern willow flycatcher critical habitat segments within the action areas to the nearest critical habitat segment outside the action area are shown in Table WIFL-1.

Relationship Between Flycatcher Critical Habitat and Recovery Plan Goals, and Habitat for Flycatcher Territories

For the 2013 flycatcher critical habitat designation, critical habitat was proposed (FWS 2011) in order to meet the numerical flycatcher territory and habitat-related goals established for Management and Recovery Units in the Flycatcher Recovery Plan (FWS 2002a) and to provide habitat for migrating flycatchers (FWS 2011, 2013). As a result, critical habitat segments were proposed for each of the 29 Management Units with numerical territory goals (FWS 2011). Within the Santa Cruz Management Area, a total of about 29 miles along Cienega Creek, Empire Gulch, and the Santa Cruz River were designated as flycatcher critical habitat (FWS 2013).

Critical habitat was designated within the Santa Cruz Management Area to meet the 25 flycatcher territory numerical goal, along with double the amount of habitat needed to help sustain those territories over time (and habitat for migratory flycatchers) (FWS 2001). Flexibility in the Recovery Plan exists so that not every Management Unit has to meet its targeted number as long as 80 percent of the minimum target is met in the Management Unit and the 20 percent is made up elsewhere within the Recovery Unit and the overall Recovery Units meets its goals (FWS 2002a). Based upon the most recent rangewide flycatcher territory estimate, the Gila Recovery Units has 659 flycatcher territories, for a goal of 650 (Durst *et al.* 2008). Three (Roosevelt, Upper Gila, and Gila/San Pedro) of the seven Management Units within the Gila Recovery Unit have surpassed their numerical goals, while four Management Units have not (Verde, Hassayampa/Agua Fria, San Francisco, and Santa Cruz).

Riparian habitat patches that southwestern willow flycatchers use to establish territories and nest in vary in size and shape, as do the size of flycatcher territories (FWS 2001). Along the Rio Grande in New Mexico, some habitat patches as small as 0.25 acres have been used, as well as larger 175 acre patches on the upper Gila River in New Mexico (FWS 2001). Some estimates have concluded that an average of 2.7 acres of dense riparian vegetation is needed for each territory in a patch (FWS 2001), where others have concluded that the overall amount of vegetation typically needed for adult and juvenile flycatchers to forage and nest is closer to 11 acres (FWS 2002).

Table WIFL-1. Distance from southwestern willow flycatcher critical habitat segments within the Santa Cruz Management Area to the nearest critical habitat segment outside the action area, but within the Gila Recovery Unit. The action area is within the Santa Cruz Management Area. Management Units are described in the Southwestern Willow Flycatcher Recovery Plan (FWS 2002a).

Management Unit	From Affected Critical Habitat Segment	To Unaffected Critical Habitat Segment	Miles
Within Santa Cruz Unit	Empire Gulch	Northern border of Santa Cruz River	26
	Southern border of Upper Cienega Creek	northern border of Santa Cruz River	28
From Santa Cruz Unit to Middle Gila/San Pedro Unit	Empire Gulch	Southern border of lower San Pedro River	31
	Northern border of Upper Cienega Creek	Southern border of lower San Pedro River	22

Background for Analyses and Definition of Baseline

The hydrologic data upon which a portion of the following southwestern willow flycatcher-specific analyses are based were described in both the Effects of the Proposed Action section (below) and Effects to Aquatic Ecosystems sections (above).

The hydrologic data are based on a 95th percentile analysis of the Tetra Tech (2010), Montgomery (2010), and Myers (2010) groundwater model best-fit and sensitivity analyses, as applicable. The 95th percentile analyses were developed for the SIR and were included in the May 2015 SBA to address FWS concerns with the use of multiple groundwater models with oftentimes divergent results. The 95th percentile analysis was described in detail in these prior documents, and was summarized in the Sources of Uncertainty subsection of the Effects of the Proposed Action section, above.

We are aware of the analytical strengths and weaknesses of this approach, but reiterate that our selection of the upper end of the 95th percentile values results in analyses in which 97.5 percent (which includes the 2.5 percent of the least well-represented values at the lower end of the distribution) of the other possible hydrologic outcomes (using our same assumptions and sensitivity analyses) exhibit lesser effects. The 95th percentile approach does not represent the most probable outcome (but it does provide reasonable certainty that the effects to this species given the same assumptions are unlikely to be greater than those described below). Due to the uncertainty inherent in these modeling efforts, there are no results that can be definitively said to be the most likely to occur (see the Effects to Aquatic Ecosystems section for additional detail).

Secondly, the following species-specific analysis considers the present-day state of the hydrology to represent the baseline condition. All streamflow-only effects, whether the result of anticipated climate change alone, mine drawdown alone, and/or climate change and mine drawdown combined, are described in terms of their divergence from present, pre-project conditions. Climate change is *not* viewed as an ongoing and evolving baseline condition of stream discharges against which mine-only effects are incrementally assessed.

The analysis of effects to the hydroriparian habitat for southwestern willow flycatchers diverges from this approach. While the hydrologic effects of climate change were modeled, we are unable

to predict the full suite of effects of climate change on riparian ecosystems. While we do anticipate that reduced flows will adversely affect the extent and vigor of riparian vegetation, the hydrologic modeling contained in the SIR and May 2015 SBA do not address future temperatures, rainfall patterns, or other factors we anticipate would affect riparian vegetation. For this reason, the analyses of riparian-related effects to southwestern willow flycatchers are based largely on the mine-only drawdowns and their impact on hydroriparian vegetation.

Effects of the Action - 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

We anticipate no direct effects to southwestern willow flycatcher territories because the footprint of the Rosemont Mine and associated ground-disturbing activities will occur where no breeding habitat exists or is likely to develop in the future. There are no known flycatcher territories or areas anticipated to have or to develop flycatcher breeding habitat within the mine site. The mine site also lacks the hydroriparian vegetation communities necessary for a riparian-obligate bird such as the southwestern willow flycatcher to use as stopover habitat during migration, nor do we expect such habitat to develop. As we concluded in our October 30, 2013 BO, we do not anticipate that any breeding or migrating flycatchers will be directly affected by the construction or operation of the mine.

Indirect Effects to Southwestern Willow Flycatchers

The Effects to Aquatic Ecosystems section discusses the proposed action's effect to surface flows and the extent of pools in Cienega Creek and Empire Gulch. The relationship between base- and flood-flow hydrology, depth to groundwater, and the recruitment, maturation, and retention of the riparian forests in which flycatchers occur was analyzed in the sections entitled Effects to Riparian Ecosystems and Effects of the Proposed Action and Western Yellow-Billed Cuckoo in this document. These prior narratives regarding effects to riparian vegetation are incorporated herein via reference. We note, however, that southwestern willow flycatcher's breeding activities are more closely tied to hydroriparian habitat (Goodding's willow and, to a lesser extent, Fremont cottonwood), a subset of the larger riparian plant community, than are yellow-billed cuckoos' breeding activities. The latter species occurs not only in hydroriparian sites, but also further landward into mesoriparian and xeroriparian sites dominated by velvet mesquite. The southwestern willow flycatcher analyses, therefore, will focus on effects to hydroriparian vegetation.

We anticipate that there will be losses of southwestern willow flycatcher hydroriparian habitat in parts of Empire Gulch (EG1, EG2) and upper Cienega Creek. A small number of southwestern willow flycatchers breeding in the to-be-affected reaches are likely be harmed by hydroriparian vegetation losses resulting from implementation of the proposed action. The species' occurrence in the action area during the breeding season is sporadic and in low numbers. Although only two

known nesting willow flycatchers were found, one in 2001 and one in 2011, additional willow flycatchers have been detected during surveys. Surveys have not been conducted regularly nor in all suitable habitats. Small patches of suitable habitat have developed in the past in the Gardner Canyon and Mattie Creek confluences with Cienega Creek, and may develop in the future in these and other areas prior to mine activity. Habitat has been gradually improving following removal of cattle (M. Radke pers. comm. December 9, 2015, Radke 2016).

The Effects to Riparian Ecosystems section discusses the potential for groundwater drawdowns to reduce the wetted length of the affected streams. The width of habitat (and critical habitat) was also taken into consideration for calculating take. The lateral extent of habitat is important for willow flycatcher occupancy. Changes in alluvial groundwater elevations can result in mortality of the shallow-rooted understory component of southwestern willow flycatcher habitat, thus causing a narrowing or contraction of the riparian corridor from the stream's banks landward. Declining alluvial groundwater can also cause stress and mortality of riparian trees situated up-gradient from the stream, thus causing a narrowing of the riparian corridor from the landward areas towards the channel. The combined result is a narrowing of the overall habitat currently available to flycatchers, with some areas potentially becoming too narrow to support the species.

We acknowledge that southwestern willow flycatcher habitat is dynamic and that any given site is likely to cycle in and out of suitability as succession, climatic, and environmental conditions change over time. The entire extent of critical habitat is unlikely to be suitable at one time but the entire reach is part of a functioning unit.

Habitat Loss

Reduction in groundwater and related streamflow

As discussed in the Effects to Aquatic Ecosystems and Effects of the previous BO (FWS 2013) and in this BO, and in the yellow-billed cuckoo section of this BO, the proposed action will adversely affect the subsurface and, eventually, the surface hydrology of Empire Gulch 1 and 2 (EG1, EG2 ;Figure A1). This information is incorporated by reference. EG1 is the stream segment where a flycatcher territory was most recently detected, and it is also expected to experience a greater increase in depth to groundwater and impacts to flycatcher habitat than EG2. As early as 20 years post-mine closure, the depth to groundwater is expected to increase, which will cause the loss of perennial surface flow. This change will shift the streamside vegetation from hydro-riparian habitat to xeroriparian vegetation. Because willow flycatchers do not breed in xeroriparian habitat, EG1 is not expected to support breeding willow flycatchers in the future.

Habitat Measurements: Linear Miles. We measured straight-line distances between two points in the main channel. We did not measure meanders. Therefore, our measurements may differ from other measures. Willow flycatcher habitat is not uniformly distributed throughout the drainages within the action area, but exists as reaches or patches of suitable habitat interspersed with openings. We analyzed each drainage continuously from one end to the other rather than measuring each patch of habitat separately. We chose this approach to encompass the changing vegetation over time and the ecosystem function of the drainages.

Habitat Measurements: Area. We used both southwestern willow flycatcher critical habitat and areas with hydroriparian vegetation outside of flycatcher critical habitat (but within the action area) to estimate the total area of flycatcher habitat affected by the proposed action (Table WIFL-5).

Riparian vegetation primarily obtains water from the shallow alluvial aquifer associated with Cienega Creek. This shallow alluvial aquifer likely is recharged by multiple sources of water, including a hydraulic connection with the regional aquifer and periodic recharge by storm flows (Garrett 2016).

The analysis assumes that drawdown in the regional aquifer caused by the mine would affect the shallow alluvial aquifer in multiple ways. Drawdown could lower the water table directly below riparian vegetation, increasing the depth that roots need to reach to obtain water, causing reduction in streamflow, and causing pool levels to decline. Drawdown could also reduce the contribution of surface flow from upstream tributaries like Empire Gulch. These flow losses upstream would then propagate downstream through the alluvial system (Garrett 2016).

The riparian vegetation that lies away from the shallow alluvial aquifer along tributary drainage is more typically xeroriparian, subsisting on rainfall and the additional moisture concentrated along ephemeral stream channels. These areas are not likely to be impacted by drawdown in the regional aquifer. For this reason, for purposes of estimating impacts to habitat, impacts were not assumed to occur beyond the estimated boundary of the shallow alluvial aquifers along Cienega Creek and Empire Gulch, unless those areas are directly disturbed by the mine footprint (Garrett 2016).

Associated Effects of Loss of Surface Flow. Although we chose the loss of surface flow as the basis for habitat loss, additional associated effects that were not modeled contribute toward a reduction in suitable habitat and breeding willow flycatchers. We have no measures for these effects, but describe them qualitatively. They provide additional justification for our adverse effects determination. These associated effects include habitat fragmentation, increased loss of trees at outer periphery of habitat where depth to groundwater is the greatest, loss of trees where length of streamflow is reduced, increased headcutting where dead trees can no longer hold the stream bank intact, increased temperature, reduced humidity, reduced prey abundance, loss of nesting substrate, loss of cover, lack of regeneration and young trees to replace older trees, reduced length and width of riparian habitat reaches, reduced tree vigor, and reduced density of habitat. We provide the following summary of associated effects to southwestern willow flycatchers, based on the predicted percent loss of surface flow and associated increase in depth to groundwater over the next 150 years:

Narrowing of Habitat and Migration of Habitat Toward Center Channel. The inner perimeter of hydroriparian habitat will gradually migrate toward the wetted stream channel center as the wetted channel width narrows. The periodic scouring floods in the narrowed low-flow channel will remove riparian seedlings and saplings, largely eliminating the youngest age class from developing into future riparian gallery forest. Where no replacement habitat is growing, suitable habitat will eventually die out. Willow flycatchers are most frequently found in association with

young willow, shrub, and herbaceous vegetation at the edge or understory of larger woody cottonwood and willow woodlands.

Lack of Tree Regeneration and Survival. Hydroriparian tree regeneration and seedling survival will decline as wetted streambed narrows and decreases in length and depth to groundwater increases. Where tree regeneration and survival are lacking in narrow reaches, suitable willow flycatcher habitat may cease to exist or may support fewer willow flycatchers when mature trees die.

Increasing Temperature and Evapotranspiration, Decreasing Humidity. Humidity, important for prey production and willow flycatcher nesting in southeastern Arizona, will decline and temperature and evapotranspiration will increase as habitat declines and fragmentation increases. These factors may reach a threshold in which willow flycatchers may no longer breed or may breed in reduced densities in some reaches.

Lateral Effects. The outer perimeter of hydroriparian and xeroriparian habitat farther from the channel center and at the greatest depth to groundwater will degrade at a greater rate than habitat closer to the channel center and groundwater. Lateral narrowing of habitat will likely reduce the density of breeding willow flycatchers and the habitat may eventually reach a threshold which is too narrow for breeding.

Although the SIR (USFS 2015b) predicts only small changes as a result of groundwater drawdown, these small changes occur within and, in some areas, immediately adjacent to the stream bed. The groundwater drawdown estimated to be less than 0.2 feet in most of Cienega Creek does not include the depth to groundwater change with lateral distance from the channel center. Expected changes in vegetation with increasing groundwater depth, per the literature, are described in Table 42 of the SIR (USFS 2015b). To apply and quantify expected changes to vegetation in affected reaches in the action area would require modeling and analyses across cross-sections of the drainages. Because this lateral modeling and analyses were not conducted, the effects to hydroriparian and xeroriparian habitat can only be described qualitatively. The depth to groundwater increases with lateral distance from the stream center. That is, depth to groundwater is naturally most shallow within the stream bed but increases incrementally moving from the stream bed to the stream bank and adjacent uplands. We can expect the herbaceous, shrub, and tree diversity and cover to decline with lateral distance from the channel center. This change can be expected to occur first on the perimeter of the riparian habitat adjacent to the more arid upland.

Reductions in Tree, Shrub, and Herbaceous Vegetation Density. Tree, shrub, and herbaceous vegetation density is anticipated to decrease as stream flow and depth to groundwater decline. Vegetation thinning may reach a threshold at which vegetation is too open for breeding (Powell *et al*. 2014).

Loss of Habitat from Increased Erosion. Erosion along increasingly dry reaches will accelerate as roots from dead and dying trees fail to stabilize stream banks, further reducing suitable habitat. Erosion is likely to increase as less water flows through Empire Gulch and Cienega Creek, as is currently occurring with the drought. Headcutting has accelerated loss of riparian habitat in the

Cienega Creek watershed. A major erosion head-cut in the streambed of lower Cienega Creek progressively erodes after major flood events when those floods are preceded by dry periods (Pima Association of Governments 2015). Erosion is also occurring in upper Cienega Creek. Head cutting in the Cienega Creek watershed demonstrates sediment fluctuation within the stream system. The head cut in lower Cienega Creek has changed from being a nick point with a steep drop in elevation within the three stream channels to a more gradual incline and a destabilized flood plain as it continues to move upstream (Pima Association of Governments 2015). The consequence of continued head cutting is an even greater loss of riparian habitat from bank collapse than from reduced flows alone.

Potential Loss of Permanent Willow Flycatcher Recruitment. The number of willow flycatchers supported by hydroriparian habitat will permanently decline, along with the number of offspring produced. Where hydroriparian habitat converts to xeroriparian habitat and where general thinning or loss of habitat occurs, willow flycatchers will no longer breed.

Decline in the Quantity and Quality of Willow Flycatcher Habitat and Prey Abundance. The combined result of the effects to regional groundwater, changes in the baseflow hydrology of streams, decreases in stream length, and increased temperature and riparian ET is a likely decline in the quantity and quality of willow flycatcher habitat along Empire Gulch and Cienega Creek. The reduced substrate for nest locations, prey species, and escape cover, in turn reduces reproductive success and increases the exposure to predation. Indirect effects to willow flycatchers could also result from prey species experiencing the same indirect effects as the willow flycatchers from groundwater drawdown, hence altering their predator-prey relationships. Aquatic and hydroriparian prey abundance will decline as streamflow, width of wetted channel, pool volume, pool area, and habitat decrease. Reduced prey abundance will likely result in reduced density of breeding and foraging willow flycatchers. Changes to food sources could also result in changes in dispersal and hunting success (USFS 2015a).

Quantification of Indirect Effects to Habitat and Critical Habitat

The suite of habitat loss-related impacts described in the preceding sections requires quantification in order to make an informed analysis of the effects of the proposed action. Subsequent sections will describe the manner by which these effects were quantified.

As stated above and in the Effects to Riparian Ecosystems section, diminished alluvial water levels and stream flow losses will result in adverse effects to riparian ecosystems. We employed the percent loss of stream flow from the present-day, baseline condition (see Table GC-3 for the calculations), to calculate the amount of habitat loss, expressed in terms of the length and width of riparian vegetation. The anticipated percent of flow loss will vary by reach: Cienega Creek (Key Reaches CC2, CC4, CC7, CC9, CC13, and CC15; averaging 10 percent), upper Empire Gulch (Key Reach EG1; 100 percent), and lower Empire Gulch (Key Reach EG 2; 18 percent). As stated in the effects analysis for the yellow-billed cuckoo, above, we are assuming that there will be a 1:1 relationship between percent streamflow lost and percent habitat lost or degraded to the point of being incapable of supporting the occurrence of southwestern willow flycatchers.

Effects to the length and width of habitat are straightforward calculations (percent flow loss

multiplied by habitat patch length). The effect to riparian habitat width was expressed similarly, but multiplied by the overall acreage rather than contemplating a reach-by-reach change in the width of riparian forest. We felt this approach better accommodated the dynamic, successional nature of riparian habitat. The results of our calculations appear in Table WIFL-2, below.

We also anticipate that climate change will degrade hydroriparian habitat to the point of being incapable of supporting the occurrence of southwestern willow flycatchers. We reiterate that the modeled effect of climate change to streams is considered an effect relative to the present-day baseline, just as mine-driven drawdown's effects to streams are. In Table GC-3, the estimated percent losses of the mine and climate change combined are 48 percent in Cienega Creek, 100 percent in EG-1, and 46 percent in EG-2. Subtracting the mine-driven drawdowns of 10 percent in Cienega Creek, 100 percent in EG-1, and 18 percent in EG-2, we anticipate climate change-only drawdowns of 38 percent in Cienega Creek, no measurable effect in EG-1 (which loses 100 percent of its flow to mine-driven drawdown), and 28 percent in EG-2.

The subsequent analyses, including the effects appearing in Table WIFL-2, will focus primarily on mine-driven drawdown, as this informs not only the effects solely attributable to the proposed action, but also the subsequent anticipated amount or extent of take for the species. Furthermore, the relationship between drawdowns and riparian vegetation is not as straightforward as the relationship between drawdowns and stream flow, permanence, and pool geometry. The modeled effects of climate change to stream flows are readily interpreted into effects to aquatic ecosystems and the species that occur in them (Gila chub, Gila topminnow, desert pupfish, Chiricahua leopard frog, northern Mexican gartersnake, and Huachuca water umbel). Stream flows and water availability are only one aspect of the ecology of riparian vegetation, which is also influenced by the increased air temperatures and altered flood-flow hydrology that may also accompany a changing climate (Lenart 2007). We will therefore include the anticipated effects of climate change on riparian vegetation in our effects analysis and conclusion, but we will not perform detailed calculations of mileage- and acreage-based losses of hydroriparian vegetation.

Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management (Revised Conservation Measure 3). The hydroriparian habitat will be developed specifically for willow flycatchers (although it will also benefit yellow-billed cuckoos; see above). We have calculated that at least 0.5 miles and 31 acres of hydroriparian habitat would be enhanced with the $1.25 million in this fund and that this activity will provide some offset for the 1.64 miles and 303.77 acres of hydroriparian habitat expected to be lost. The proposed conservation measure is expected to fund planning, compliance and permitting, site preparation, implementation, monitoring, maintenance, and reporting. The expected number of miles and acres to be enhanced may be greater than the minimum estimated; costs for different enhancements vary widely.

Implementation of the conservation measure to fund enhancement of hydroriparian habitat will help minimize adverse effects (Table WIFL-4). Subtracting the minimum miles and acres to be enhanced from the miles and acres of acres adversely affected by the proposed action results in minimized adverse effects; the minimized adverse effects are ≤1.14 miles and ≤273 acres of hydroriparian habitat.

Calculation of the Mitigative Value of all Conservation Measures. The tables below contain calculations of the proposed action's net effects to southwestern willow flycatchers. As stated above, subtracting the anticipated (and estimated) miles and acres of habitat to be restored via the $1.25 million enhancement fund from the adversely affected acres yields the minimized adversely affected miles and acres of habitat. If the miles and acreage anticipated to be enhanced under the Hydroriparian Conservation Fund are not met, the adverse effects to xero- and hydroriparian vegetation will be greater than analyzed in this BO, thus necessitating consideration of reinitiation by the USFS and Corps.

Table WIFL-2. Expected effects of the proposed Rosemont mine on southwestern willow flycatcher breeding habitat, without climate change, and without any offsetting habitat enhancement. The anticipated percent southwestern willow flycatcher breeding habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega and Cienega Creek at 150 years. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreages correspond to critical habitat within a given reach or to the width of riparian vegetation where critical habitat is not designated. EG = Empire Gulch, CC = Cienega Creek

Reach	Within Critical Habitat?	Total Habitat Miles*	Total Habitat Acres**	Percent Habitat Affected (without Climate Change) ***	Adversely Affected Miles	Adversely Affected Acres	Habitat along Drainage
Total EG1	Yes, No	0.68	87.96	100	0.68	87.96	Hydroriparian
within EG1 W of critical habitat	No	0.26	41.64				
EG1 critical habitat	Yes	0.25	32.20				
within EG1 E of critical habitat	No	0.17	14.12				
Cienega Creek N of Hilton Wash (near S border of CC2) N to S border of EG2	Yes	1.29	501.31	10	0.13	50.13	Hydroriparian
EG2 (includes part of Cienega Creek)	Yes	0.94	280.3	18	0.17	50.45	Hydroriparian
Cienega Creek from S border of EG2 N to N border of Las Cienegas NCA	Yes	6.57	1152.33	10	0.66	115.23	Hydroriparian
Cienega Creek critical habitat	Yes	8.8	1933.94	Varies	0.96	215.81	Hydroriparian
Grand Total	**Yes, No**	**9.48**	**2021.9**		**1.64**	**303.77**	**Hydroriparian**

* Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.

**10.4 acres of critical habitat were subtracted from the total number of acres on upper Cienega Creek, where habitat receives flow from eastern tributaries. Flow from these eastern tributaries will not be affected by the proposed mine activities.

*** Climate change has greater effects (38 percent in upper and lower Cienega Creek and 28 percent in lower Empire Gulch) and no additional effect in upper Empire Gulch, which is anticipated to be dewatered by mine-related drawdowns alone.

As shown in Table WIFL-2, above, we anticipate that approximately 1.6 miles and 304 acres of flycatcher habitat are expected to be adversely affected by the proposed action (Table WIFL-2). We further anticipate that implementation of Revised Conservation Measure 3 (Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management; see the Description of the Proposed Conservation Measures section, above), will partially minimize the adverse effects of the proposed action.

Conservation Measure 3 includes a commitment to expend $1,250,000 on habitat enhancements for southwestern willow flycatchers, but no specific projects or further details were provided. We therefore investigated the potential costs of habitat enhancement, eventually employing costs estimates based on Stillwater Sciences (2015); the results of these efforts are detailed in Table WIFL-3, below. In brief, we anticipate that implementation of Revised Conservation Measure 3 – $1.25 million of funding – will result in approximately ≥0.5 mile and ≥31 acres of hydroriparian enhancements. The proposed conservation measure is expected to fund planning, compliance and permitting, site preparation, implementation, monitoring, maintenance, and reporting. The expected number of miles and acres to be enhanced may be greater than the minimum estimated; costs for different enhancements vary widely.

Table WIFL-3. Potential implementation of the $1,250,000 hydroriparian habitat enhancement fund for southwestern willow flycatchers. The costs in this table represent the possible use of the fund. The actual costs and on-the-ground activities to enhance willow flycatcher habitat will depend on the specific needs of the selected site, but the length and acres to be enhanced will be ≥ 0.5 miles and ≥ 31 acres. The hydroriparian enhancement project will replace the same type of habitat that will be lost as a result of the proposed action. Cost per acre estimates based on those summarized in Stillwater Sciences (2015). Costs do not account for inflation.

Activity	Frequency	Cost
Start-up and oversight costs (planning, compliance[28] documents, permits)	Ongoing	$1,250,000 x 33 % = $412,500
Minor site grading[1]	One time	$15,000 x 10 acres = $150,000
Subtotal		$412,500 + $150,000 = $562,500
Remaining implementation funds		$1250000 – 562,500 = $687,500
		Cost/Acre
Site preparation; clearing and grubbing, biomass left on-site	One time	$3,967
Hydroseeding	One time	$3,461
Herbicide application/ maintenance	Every other year for 20 years	$1,444 x 10 yrs = $14,440
Site and success monitoring	Every other year for 20 years	$25 x 10 yrs = $250
Subtotal		*$22,118/acre*
Minimum # of acres to be enhanced		$687,500 ÷ $22,118/acre = **31acres** (≥ 1 mile, ≥ 250 ft wide)

[1] Our assumption is that grading will be required only for 10 acres of a 31 acre site.

Given our anticipated adverse effects as well as the anticipated magnitude of minimization

associated with Conservation Measure 3 (in stream miles and acres of habitat), we were able to determine the minimized adverse effects of the proposed action to the southwestern willow flycatcher. Our analysis of these minimized adverse effects appears in Table WIFL-4, below.

Table WIFL-4. Expected minimization of the adverse effects of the proposed Rosemont mine on southwestern willow flycatcher breeding habitat, without climate change, with offsetting habitat enhancement. The anticipated percent of willow flycatcher breeding habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega and Cienega Creek at 150 years minus the number of miles and acres to be enhanced by implementation of Revised Conservation Measure 3 – Western Yellow-Billed Cuckoo and Southwestern Willow Flycatcher Habitat Enhancement and Monitoring, Surveying, and Conservation Property Management. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreage by reach is shown in Table WIFL-1.

Adversely Affected Miles*	Adversely Affected Acres**	Habitat Type Affected	Miles to be Enhanced	Acres to be Enhanced	Adversely Affected Miles minus Miles to be Enhanced	Adversely Affected Acres minus Acres to be Enhanced	Habitat Type to be Enhanced or Protected
1.64	303.77	Hydroriparian	≥0.5	≥31	≤1.14	≤273	Hydro-riparian

* Our measurements may differ from other measurements. We measured straight-line distances between two points in the main channel. We did not measure meanders.
**10.4 acres of critical habitat were subtracted from the total number of acres on upper Cienega Creek, where habitat receives flow from eastern tributaries. Flow from these eastern tributaries will not be affected by the proposed mine activities.

Lastly, we were also able to determine the proposed action's minimized adverse effects to southwestern willow flycatcher *critical* habitat, a subset of the effects to flycatcher habitat in general. These minimized effects are shown in Table WIFL-5, below, and amount to ≤0.71 mile and ≤217 acres of critical habitat. It is important to note that these anticipated minimized effects to flycatcher critical habitat are valid only if the to-be enhanced sites are situated entirely within areas already designated as critical habitat. We anticipate that the presence of critical habitat will be an important site selection criterion when habitat enhancement areas are pursued.

Table WIFL-5. Expected minimization of adverse effects of the proposed Rosemont mine on southwestern willow flycatcher critical habitat, without climate change, with offsetting habitat enhancement. The anticipated percent of willow flycatcher breeding critical habitat affected is based on Table GC-3 overall percent loss of surface flow for Empire Cienega and Cienega Creek at 150 years minus the number of miles and acres to be enhanced. Percent flow loss is derived from one value for each reach, as displayed in Table GC-3. Acreage is based on critical habitat as shown in Table WIFL-1. It was assumed that enhancement sites will also be within critical habitat.

Adversely Affected Critical Habitat Miles*	Adversely Affected Critical Habitat Acres **	Habitat Type Affected	Miles to be Enhanced	Acres to be Enhanced	Adversely Affected Miles minus Miles to be Enhanced	Adversely Affected Acres minus Acres to be Enhanced
1.21	248	Hydro-riparian	≥0.5	≥31	≤0.71	≤217

* Our measures may differ from other measures. We measured straight-line distances between two points in the main channel. We did not measure meanders.
From Table WIFL-2: 0.25 + 0.96 miles of critical habitat (EG1 + CC) = 1.21 miles; 32.2 acres + 215.81 acres of critical habitat (EG1 + CC) = 248 acres
**10.4 acres of critical habitat were subtracted from the total number of acres on upper Cienega Creek, where habitat receives flow from eastern tributaries. Flow from these eastern tributaries will not be affected by the proposed mine activities.

Discussion of Effects

The quantification of adverse effects to southwestern willow flycatcher habitat discussed above must be evaluated in terms of the species' ecology, specifically the manner in which it is distributed within available habitat. The greater the distance between small populations, the greater the extirpation risk due to the reduced likelihood of immigration from other populations to offset impacts from catastrophic dynamic habitat events (e.g. drought, flooding) and demographic-related issues (e.g. birth/death rates and sex ratios) (Finch and Stoleson 2000). The discovery of flycatcher fidelity to breeding sites, year-to-year movement of adult and young-of-the-year flycatchers, and the interconnected nature of breeding sites during a 10-year flycatcher banding and re-sighting study in AZ (Paxton *et al.* 2007, Ellis *et al.* 2008) improved our understanding about how territory distribution and abundance may affect population persistence and flycatcher recovery (FWS 2014). The estimated 1,299 rangewide flycatcher territories are distributed in a large number of small breeding groups and a small number of relatively large breeding groups (Durst *et al.* 2008). The current widespread distribution of the flycatcher territories (Durst *et al.* 2008) and the bird's ability to move long distances and quickly colonize habitat help to prevent the threat of small populations from having a greater impact rangewide. When we apply the improved understanding of flycatcher movement to the varied rangewide configuration of flycatcher territories, we reach complex conclusions about the vulnerability of the flycatcher breeding population. Although willow flycatchers move between sites and larger flycatcher population centers benefit other nearby populations, the rarity and limitation of long-distance flycatcher movements causes concern for the persistence of territories that are the most isolated from population centers (FWS 2014).

The relatively isolated Empire Gulch and Cienega Creek sites are known to be occupied by a breeding pair willow flycatchers in some years. Both sites are vulnerable to extirpation considering there was only a single pair detected at each location and the long distance these sites are from other occupied flycatcher sites outside the action area. The added effects of groundwater drawdown and related reduced stream flow from the proposed action will likely result in extirpation at the Empire Cienega site and will increase the likelihood of extirpation at the locations within the Cienega Creek site.

Effects to Critical Habitat for Southwestern Willow Flycatchers

All habitat adversely affected is within southwestern willow flycatcher critical habitat, with the exception of approximately 56 acres of additional hydroriparian habitat surrounding EG1 (Table WIFL-2).

Southwestern willow flycatcher critical habitat exists in Empire Gulch and along Cienega Creek. The mine drawdown-driven flow losses in Cienega Creek are likely to cause mortality of hydroriparian habitat in 0.96 mile and 215.81 acres (see the Cienega Creek critical habitat row in Table WIFL-2, above) of hydroriparian vegetation (PCE 1), in addition to the effects of climate change. Together, the proposed action and climate change are anticipated to result in adverse effects; the proposed action's incremental effect is that critical habitat units on the mainstem of Cienega Creek will experience a small loss in ability to function in the recovery of the southwestern willow flycatcher.

Flow losses in upper Empire Gulch due solely to the proposed action - independent of the effects of climate change - are anticipated to be more severe, and reach magnitudes capable of causing the woody riparian community to transition to a more xeric species composition. The anticipated dewatering of upper Empire Gulch (Key Reach EG1) would likely result in losses (0.25 mile, 32.2 acres) of riparian vegetation (PCE 1). The dewatering will also halt the export of aquatic macro-invertebrates upon which southwestern willow flycatchers feed (PCE2). In the future, this may prevent this small critical habitat segment of upper Empire Gulch from contributing to southwestern willow flycatcher recovery.

We cannot determine in advance if any of the proposed conservation measures will result in enhanced habitat within the critical habitat boundaries. If the to-be-enhanced areas lie entirely within critical habitat, then they may minimize the propose action's effects to critical habitat. In this scenario, the anticipated, minimized effects of the proposed action appearing in Table WIFL-5 are valid. If to-be-enhanced areas are not entirely within critical habitat, we would anticipate that the effects to critical habitat would be minimized to a lesser extent.

Cumulative Effects – Southwestern Willow Flycatcher

The cumulative effects were described in detail in the October 30, 2013 BO, remain unchanged and are incorporated herein via reference, with the exception that we consider the effects described in the prior document to apply to both southwestern willow flycatcher habitat as well as the species' critical habitat. Effects to critical habitat are a subset of effects to riparian vegetation throughout the range of the flycatcher.

Conclusion

As discussed in full in the Sources of Uncertainty section, above, we have chosen to base our effects analysis on the upper end of the 95th percentile analysis. Given the long time frames involved, long distances involved, and small amounts of drawdown in the aquifer, there is a high degree of uncertainty associated with groundwater predictions. The scenario represented by the upper end of the 95th percentile analysis is not the scenario most probable to occur. Rather, by selecting it we are analyzing a conservative position that ensures almost all of potential and reasonable outcomes disclosed by the models (using our assumptions) would be encompassed by this BO analysis. This conservative approach ensures that under almost all potential outcomes that can be reasonably predicted (using our assumptions), the conclusions of non-jeopardy and no destruction or adverse modification, below, would remain valid.

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:

- Previous formal flycatcher consultations within the Action Area and Santa Cruz Management Area have not reached adverse effect determinations for critical habitat, older formal consultations prior to designation of critical habitat were minor in impact, and some proposed actions were anticipated to conserve/improve flycatcher habitat. Therefore, the environmental baseline within the Santa Cruz Management Area has not been markedly degraded from past projects evaluated under section 7 of the ESA.
- While survey effort has not been comprehensive or regular since listing, only a few (three or fewer) flycatcher territories have been detected in any one season along upper Cienega Creek, Empire Gulch, and in the action area. The most recent record within the Santa Cruz Management Area was the flycatcher territory detected in 2011 along Empire Gulch. Although flycatchers are important within the Santa Cruz Management Area given so few occur there, they are more numerous in other management units within the Gila Recovery Unit (of which the Santa Cruz Management Area is a subdivision). A single flycatcher territory represents only 0.15% of the flycatcher territories found across the greater Gila Recovery Unit and 0.07 % of all the territories across its breeding range. A total of 659 territories were estimated for the Recovery Unit in 2007 and 1299 territories across its range (the last year for which a comprehensive, area-wide estimate/analysis was conducted) (Durst *et al.* 2008).
- We anticipate that the proposed action will result in losses of hydroriparian vegetation in Cienega Creek and lower Empire Gulch. We anticipate the complete loss of EG1 (0.68 miles, 87.96 acres) and degradation of habitat throughout Empire Gulch and upper Cienega Creek from the conclusion of

mining through the modeled 150-year duration of the May 2015 SBA's analysis and onward from that point.

- The proposed conservation measure of $1.25 million for hydroriparian habitat enhancements is expected to fund planning, compliance and permitting, site preparation, implementation, monitoring, maintenance, and reporting. We expect funding to cover at least 0.5 miles and at least 31 acres of hydroriparian enhancement in a location yet to be determined. The expected number of miles and acres to be enhanced may be greater than the minimum estimated; costs for different enhancements vary widely. Implementation of the conservation measure to fund enhancement of hydroriparian habitat will help minimize adverse effects. Subtracting the minimum miles and acres to be enhanced from the miles and acres of adverse effects, the minimized adverse effects are ≤1.1 miles and ≤273 acres of southwestern willow flycatcher habitat.
- The proposed action is expected to affect 1.6 miles and 304 acres of flycatcher habitat in the Cienega Creek watershed, which includes permanently altering the physical and biological features and primary constituent elements of a 1.21 mile and 248 acre subset of designated flycatcher critical habitat. The permanent impacts to 1.21 miles of affected flycatcher critical habitat represent 4.2 percent (1.21 miles divided by 28.8 total miles x 100) of the designated flycatcher critical habitat within the broader Santa Cruz Management Area. About 95 percent of the area (about 27 miles) designated as flycatcher critical habitat on the landscape within the Santa Cruz Management Area is expected to be unaffected by the proposed Rosemont Mine project and available to reach flycatcher numerical and habitat-related recovery goals.
- We expect the 27 stream miles of flycatcher critical habitat unaffected by the proposed project will provide sufficient area to meet the 25-territory flycatcher recovery goal (and double the habitat). This conclusion is based upon estimates of the amount of flycatcher habitat found in the Action Area (about 200 acres/mile) and a conservative amount of vegetation estimated needed for each flycatcher territory (11 acres).
- The aforementioned effects to critical habitat in the action area relative to elsewhere in the Santa Cruz Management Area, Gila Recovery Unit, and rangewide designation are of a magnitude too small to diminish the value of critical habitat for the conservation of southwestern willow flycatchers; critical habitat will therefore not be adversely modified nor destroyed.
- We understand that riparian habitat (including southwestern willow flycatcher critical habitat) is dynamic and its quality and availability are not uniform through time. However, the use of riparian vegetation measurements from this opinion can broadly illustrate why we anticipate that adequate area exists on the landscape in the Santa Cruz Management Area to reach flycatcher recovery goals. Twenty-seven stream miles are estimated to possess approximately 5,400 acres of riparian vegetation for flycatcher habitat (27 miles x 200 acres). At a conservative estimate of 11 acres per flycatcher territory, 25 territories would need about 275 acres (11 acres x 25 territories). If we double the habitat needed to maintain these territories through time as described in the Recovery Plan (FWS 2002a), it increases the flycatcher's recovery requirement to 550 acres. As a rough estimate, there are about 5,400 acres available across 27 miles of critical habitat in the Santa Cruz Management Area to meet the 550 acres needed for flycatchers (after the impacts from the proposed project). This exercise and rough estimate illustrates the broad area remaining in the Santa Cruz Management Area for flycatcher recovery and why the proposed project is not anticipated to appreciably diminish the conservation value of designated critical habitat.
- The analyses contained in this BO support the conclusion that the magnitude of the proposed action's effects to hydroriparian vegetation occupied or likely to be occupied by southwestern willow flycatchers is small relative to the amount of southwestern willow flycatcher critical habitat present in

the action area. The proposed action therefore will not destroy nor adversely modify southwestern willow flycatcher critical habitat.

- In combination, the permanent degradation/alteration of 1.6 miles of flycatcher habitat (representing 304 Empire Gulch/Cienega Creek acres), the loss of habitat for a few (three or fewer) known flycatcher territories, and the counterbalancing potential flycatcher territories that could occur within this affected habitat, are not anticipated to result in jeopardy for the continued existence of the flycatcher because of the small number of flycatchers, territories, and habitat this unit represents and contributes to the subspecies locally and across its range. Based upon the most recent rangewide estimate (Durst *et al.* 2008), a single flycatcher territory represents 0.15% of the flycatcher territories found across the greater Gila Recovery Unit (n=659) and 0.07 % (n=1299) of all the territories across its breeding range. While a few flycatcher territories within the Santa Cruz Management Area have been erratically detected since listing, the estimated rangewide flycatcher population has grown from fewer than 400 territories to nearly 1,300 territories in 2008. And similarly, the Gila Recovery Unit has grown from 454 territories in 2001 to 659 in 2007. In other words, the local recovery unit with its rangewide population has persisted and increased its distribution since listing, and there is no expectation that the erratic persistence of the few territories has been essential to the continued growth of the Gila Recovery Unit or rangewide population.
- There are 12.2 miles of critical habitat in the Cienega Creek watershed, 28.8 miles in the Santa Cruz Management Area, 473.9 miles in the Gila Recovery Unit (of which the Santa Cruz Management Area is a subdivision), and 1,227 miles rangewide. The loss of habitat within Empire Gulch and a portion of Cienega Creek represents a small fraction of critical habitat in the Santa Cruz Management Area (4.2 percent), in the Gila Recovery Unit (of which the Santa Cruz Management Area is a subdivision) (0.25 percent) and in the rangewide critical habitat designation (0.1 percent). The proposed action's effects are small in magnitude and are thus unlikely to 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 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). "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

We anticipate that the proposed action will result in incidental take of southwestern willow flycatchers in the form of harm through indirect permanent loss of habitat occupied by nesting flycatchers in Empire Gulch and Cienega Creek. We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take. However, we must use habitat as a surrogate for the amount or extent of take because thorough southwestern willow flycatcher surveys are conducted too infrequently to determine the number territories in the action area. In addition, the survey protocol (Sogge *et al.* 2010) is designed only to determine presence/absence in a given reach rather than an accurate count of individual birds. Additional surveys and methods, including banding and possibly monitoring telemetered birds, would need to be employed to obtain an accurate count of individual birds and pairs throughout the breeding season.

It is reasonable to assume that the abundance of southwestern willow flycatchers is correlated with the extent of suitable riparian habitat. We therefore quantified the adverse effects of the proposed action as the number of stream miles and corresponding acres of hydroriparian habitat that we anticipate will be lost due to mine-driven groundwater drawdown. The estimated number of miles and acres anticipated to be adversely affected by construction and operation of the mine appears in Table WIFL-2, above and is summarized below.

Nesting flycatchers have high site fidelity to nesting areas that possess the qualities to generate preferable habitat conditions (FWS 2002). We anticipate that 1.6 miles (approximately 304 acres) of hydroriparian habitat relied upon by nesting flycatchers (including areas that could be used for flycatcher recovery) will be indirectly adversely affected due to loss of surface flow in Empire Gulch and upper Cienega Creek. Nesting habitat is expected to be made permanently unusable due to mine-related actions that cause groundwater and stream flow reductions. Riparian vegetation and habitat patches are expected to gradually narrow, become thinner, and subsequently die. As habitat quality begins to decline, we can initially expect flycatchers to attempt to nest, resulting in reduced reproductive performance, nest failure, and/or increased predation or nest parasitism of eggs, nestlings, and adults. The elimination of suitable habitat is expected to eventually prevent flycatchers from establishing territories, building nests, laying and incubating eggs, and fledging nestlings.

Because the number of flycatchers that can use an area, nest, and reproduce is not predictable from one year to the next and also due to an incomplete survey history through time for the action area preventing us from having a comprehensive understanding of how the area has been used by flycatchers over time, we must use habitat as a surrogate for the amount or extent of incidental take. Given that southwestern willow flycatcher habitat within the action area occurs along the stream channels, the estimated number of acres anticipated to be adversely affected is meaningful only when used in conjunction with length of stream miles lost. We use the number of stream miles and corresponding width of hydroriparian habitat to determine acres.

Empire Gulch (near EG1 and 2), and upper Cienega Creek have been the occupied reaches within the Santa Cruz Management Area. Both are within the action area and will be adversely affected by the proposed action. We estimate effects to 1.64 miles and 304 acres of the 9.48 miles and 2021.9 acres of southwestern willow flycatcher habitat in Empire Gulch and Cienega Creek. Habitat occupied by flycatchers is dynamic and can vary widely in suitability, location, and occupancy over relatively short

periods of time. Successional changes cycle through suitability, senescence or scouring, regeneration, and growth. Therefore, suitable habitat within Empire Gulch and Cienega Creek may not be present all at one time.

Depending on the reach, 10 to 100 percent of the habitat is expected to be adversely affected by groundwater drawdown and associated stream flow reduction within 150 years. Calculating the habitat loss expected for each corresponding reach, 1.6 miles and 304 acres in Empire Gulch and Cienega Creek are expected to be adversely affected by the proposed action. As a result, 1.6 miles and 304 acres will be used as a surrogate for incidental take and is the amount or extent of incidental take allowed. Because this habitat is expected to become permanently unusable, we anticipate that all flycatchers will be incidentally taken within these acres.

While we anticipate that mine-driven groundwater drawdown will affect hydroriparian habitat to the extent described above, the habitat will also be affected by flow reductions attributable to climate change (see Tables A-1 through A-4 in the Effects to Aquatic Ecosystems section, incorporated herein by reference). Riparian vegetation in the Cienega Creek system is also successional in nature and variable in its extent (Powell 2013). These aspects of the ecology render it difficult to determine what portion of future losses of hydroriparian riparian vegetation are attributable solely to mine-driven drawdown.

Hydroriparian vegetation is supported by the subsurface and surface flows of water in the affected streams. Decreases in groundwater elevation within the shallow alluvium and decreases in stream baseflow therefore result in stress to hydroriparian ecosystems. Groundwater elevations, which can be readily measured, are consequently an effective proxy for effects to hydroriparian habitat, which in turn, is an effective surrogate for southwestern willow flycatcher abundance. Therefore, for the purpose of determining take, we will employ groundwater drawdown as a surrogate measure of take for the southwestern willow flycatcher.

The specific levels of incidental take of southwestern willow flycatcher are expressed in terms of the groundwater drawdowns anticipated (based on modeling) in the locations and time frames (0, 20, 50, 150 years) discussed above in the Gila chub analysis (see the Amount or Extent of Take subsection of the Gila Chub Incidental Take Statement, incorporated herein by reference and summarized in Table GC-4). We believe this surrogate measure is also appropriate for southwestern willow flycatcher because the most significant effects to this species result from the anticipated loss of hydroriparian habitat, which is supported by shallow groundwater and surface water discharged from shallow groundwater sources.

A program of groundwater monitoring is the appropriate means to evaluate, over time, changes in groundwater elevation (again, as a surrogate for hydroriparian habitat and southwestern willow flycatcher abundance). An effective groundwater monitoring program was developed to monitor the groundwater elevation-based surrogate for the incidental take of Gila chub (see the Amount or Extent of Take subsection of the Gila chub Incidental Take Statement, incorporated herein by reference). The locations for the groundwater monitoring program and their justifications appear in Table GC-5, above.

In summary, and stated differently, the maximum allowable incidental take of southwestern willow flycatcher is represented by the groundwater drawdowns at the sites and time intervals stated in Table GC-4, above. The to-be-modeled groundwater drawdowns at a suite of potential sites specified in Table GC-5, above, will serve as proxies for the surrogate measure of incidental take in miles and acres of

hydroriparian habitat appearing in Table WIFL-4, above. The manner by which Rosemont and the USFS shall monitor compliance with the amount of incidental take is described further in the Terms and Conditions, below.

Effect of the Take – Southwestern Willow Flycatcher

In this BO, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the southwestern willow flycatcher, nor likely to result in destruction or adverse modification of southwestern willow flycatcher critical habitat. The loss occurs within a part of the only known southwestern willow flycatcher breeding area within the Santa Cruz Management Area, but the lost habitat is not essential to the recovery of this management area nor to the Gila Recovery Unit. At least 659 territories occur within the Gila Recovery Unit, of which the Santa Cruz Management Area is a subset.

Reasonable and Prudent Measures – Southwestern Willow Flycatcher

In addition, the FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of southwestern willow flycatchers:

1. The USFS and Corps shall ensure that Rosemont monitor groundwater levels (as a proxy for the hydroriparian vegetation surrogate measure of take for southwestern willow flycatcher) at least annually (see also FEIS mitigation measure FS-BR-27);

2. The USFS and Corps shall ensure that Rosemont appropriately implements restoration and monitors the hydroriparian habitat proposed to be created at a to-be-determined location, also as described in Revised Conservation Measure 3.

Terms and Conditions – Southwestern Willow Flycatcher

In order to be exempt from the prohibitions of section 9 of the Act, Rosemont, the USFS, and the Corps 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 USFS and Corps shall ensure that Gila chub Terms and Conditions 1.1, 1.2, 1.3, 1.4, and 1.5 are implemented. This Term and Condition implements the southwestern willow flycatcher Reasonable and Prudent Measure 1, above.

2. The USFS and Corps shall ensure that Rosemont's implementation and monitoring plans for hydroriparian habitat are submitted to the USFS, Corps, and FWS (in consultation with other wildlife agencies, as appropriate) in advance for review, comment, and approval. This Term and Condition implements southwestern willow flycatcher Reasonable and Prudent Measure 2, above.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effect of incidental take that is anticipated to 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 and/or Corps must immediately provide an explanation of the causes and discuss with the FWS whether reinitiation of consultation is required.

Conservation Recommendations – Southwestern Willow Flycatcher

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 USFS and Corps ensure that Rosemont restores additional acreage of hydroriparian habitat, beyond what will be funded by Revised Conservation Measure 3.

2. We recommend that the USFS and Corps ensure that Rosemont researches techniques for reducing the use and loss of groundwater from the proposed action in the project area, considering any and all current and future techniques that may be technologically and economically feasible.

3. We recommend that the USFS, Corps, and Rosemont Copper Company facilitate implementation of more consistent flycatcher presence/absence surveys (per Sogge *et al*. 2010 or subsequent protocols), including nest searching and monitoring along Empire Gulch, upper Cienega Creek, and the Santa Cruz Management Area to better understand the status of the flycatcher within the overall action area and the Management Area.

4. We recommend that the USFS, Corps, and Rosemont Copper Company implement long-term monitoring of groundwater resources in the Action Area, especially in 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, and one that 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. This information should be used to track the Rosemont Copper Mine's use of water and its comparative impact to the watershed.

In order 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.

JAGUAR

Status of the Species - Jaguar

Legal Status

There have been no changes to the legal status of the jaguar since the October 30, 2013 BO; the prior narrative is incorporated herein via reference.

Life History

There have been no updates to the jaguar's life history information since the October 30, 2013 BO; the prior narrative is incorporated herein via reference.

Prey

There is no new information regarding jaguar prey. The narrative from the October 30, 2013 BO is incorporated herein via reference.

Home Range and Movement

The home range information contained in the October 30, 2013, BO remains current and is incorporated herein via reference, except for the updated information in the following paragraphs:

A small number of home range studies have been conducted in the NRU. 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) (Nuñez Perez 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). Using camera traps and the 24-hour Mean Maximum Distance Moved (MMDM) method, Culver *et al.* (2016) estimated the home range for one adult male in the Santa Rita Mountains in Arizona was 90 km^2. However, this number should be cited with caution, as the study was not designed to determine home range size, and the 24-hour MMDM is a conservative estimate of this jaguar's home range, as it is known to have traveled from the Whetstone Mountains to the Santa Rita Mountains, a distance of at least 35.5 km.

Jaguars move regularly throughout their home ranges, with mean daily movements ranging from 1.8 ± 2.5 km (1.1 ± 1.6 mi) to 8.17 ± 7.26 km (5.08 ± 4.51 mi) using a variety of methods. 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 males moving significantly larger distances (3.3 ± 1.8 km (2.0 ± 1.1 mi)) than females (1.8 ± 2.5 km (1.1 ± 1.6 mi)) (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 the forests of Jalisco, jaguars can move up to 20 km (12 mi) in a single night, frequently finishing very close to where they started (Nuñez Perez 2006). Hernandez-Santin (2007) found the mean daily movement of female jaguars in Paraguay ranged from 2.68 ± 2.20 to 3.82 ± 3.14 km (1.67 ± 1.37 to 2.37 ± 1.95 mi) and of males from 3.37 ± 2.69 to 8.17 ± 7.26 km (2.09 ± 1.67 to 5.08 ± 4.51 mi). Hernandez-Santin (2007) states the maximum distance traveled in one day by a male jaguar was 39 km (24 mi) and 30 km (19 mi) by a female. According to Rabinowitz and Zeller (2010), de Almeida (1990) cites jaguars moving 15 km or more in a single night on hunting patrols in the Brazilian Pantanal. In Nacori Chico, Sonora, female jaguars returned to a given location approximately every 20 days and males every 30 days (Rosas-Rosas and Bender 2012). Figueroa (2013) found, on average, jaguars moved 2.56 km (0.99 mi) per day in Belize, with the mean daily distance traveled during the dry season significantly larger than the distance traveled during the wet season or the average distance traveled for the duration of the study. The maximum daily distance traveled by jaguars during the study was 9.19 ± 3.78 km (3.55 ± 1.46 mi).

Habitat

There is no new information regarding jaguar habitat. The narrative from the October 30, 2013 BO is incorporated herein via reference.

Distribution, Abundance, Population Trends

The distribution, abundance, and population trend information contained in the October 30, 2013, BO remains current and is incorporated herein via reference, except for the updated information in the following paragraphs:

From 1996 through 2015, 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. This same jaguar, named *El Jefe* by Tucson-area school children in late 2015, has been repeatedly photographed (2012 to 2015) in the Santa Rita Mountains, within and near the proposed action area, as recently as September 2015 (https://www.flickr.com/photos/usfws_southwest/sets/72157632294203147/; 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); however, considering this jaguar has been regularly detected in the Santa Rita Mountains since 2012, we hypothesize he has established a home range in these mountains.

Threats

There is no new information regarding threats to the jaguar beyond what is contained in the October 30, 2013 BO; the prior narrative is incorporated herein via reference.

Jaguar Recovery Planning

The description of the state of jaguar recovery planning remains substantively as described in the October 30, 2013 BO. The prior narrative is incorporated herein via reference with the following updates.

Northwestern Recovery Unit (NRU)

This section is updated as follows:

The Northwestern Recovery Unit (NRU) extends from south-central Arizona and extreme southwestern New Mexico, United States south to Colima, Mexico (Figure J-1), and is approximately 226,826 km^2 (87,578 mi2); with 29,021 km^2 (11,205 mi2) in the U.S. and 197,805 km^2 (76,373 mi2) in Mexico (Table J-1). The estimated area of jaguar habitat within the NRU is 170,854 km^2 (65,967 mi2; Table J-1). Table J-1, below, describes the subdivisions within the NRU.

Table J-1: Northwestern Recovery Unit Area size and estimate of jaguar habitat within each Area (Sanderson and Fisher 2013).

NRU Area	**Area Size**		**Estimate of Jaguar Habitat within Area**	
	km^2	**mi2**	**km^2**	**mi2**
Jalisco Core Area	54,949	21,216	44,460	17,166
Sinaloa Secondary Area	31,191	12,043	28,723	11,090
Sonora Core Area	77,710	30,004	67,931	26,228
Borderlands Secondary Area – Mexico portion	33,955	13,110	22,901	8,842
Borderlands Secondary Area – U.S. portion	29,021	11,205	6,839	2,641
Total	226,826	87,578	170,854	65,967

The remainder of this section remains unchanged, with the exception that the Northwestern Management Unit designation has been removed - this area is now the Borderlands Secondary Area.

Critical Habitat

The critical habitat narrative in the October 30, 2013 BO is incorporated herein via reference, but is updated as follows:

Critical habitat (as defined under the ESA) for the jaguar is designated in the United States for approximately 309,263 ha (764,207 ac) in Pima, Santa Cruz, and Cochise counties, Arizona, and Hidalgo County, New Mexico in six critical habitat units (79 FR 12571; Figure J-2): (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, Empire, and Huachuca Mountains, and the Canelo and Grosvenor 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 147,248 ha (351,501 ac) in the Patagonia, Santa Rita, Empire, and Huachuca Mountains, as well as the Canelo and Grosvenor Hills, in Pima, Santa Cruz, and Cochise counties, Arizona. Unit 3 is generally bounded by a line running roughly 3 km (1.9 mi) east of Interstate 19 to the west; a line running roughly 6 km (3.7 mi) south of Interstate 10 to the north; Cienega Creek and Highways 83, 90, and 92 to the east, including the eastern slopes of the Empire Mountains; and the U.S.-Mexico border to the south. Land ownership within the unit includes approximately 101,354 ha (250,452 ac) of Federal lands; 11,847 ha (29,274 ac) of Arizona State lands; and 29,046 ha (71,775 ac) of private lands. The Federal land is administered by the Coronado National Forest, Bureau of Land Management, and National Park Service. 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 2012 through August 2015 (https://www.flickr.com/photos/usfws_southwest/sets/72157632294203147/). 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 compatible with jaguar use.

Subunit 4a: Whetstone Subunit

Subunit 4a consists of 25,284 ha (62,478 ac) in the Whetstone Mountains in Pima, Santa Cruz, and Cochise Counties, Arizona. Subunit 4a is generally bounded by a line running roughly 4 km (2.5 mi) east

of Cienega Creek to the west, a line running roughly 6 km (3.7 mi) south of Interstate 10 to the north, Highway 90 to the east, and Highway 82 to the south. Land ownership within the subunit includes approximately 16,066 ha (39,699 ac) of Federal lands; 5,445 ha (13,455 ac) of Arizona State lands; and 3,774 ha (9,325 ac) of private lands. The Federal land is administered primarily by the Coronado National Forest and Bureau of Land Management. 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 elements essential 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 address human disturbances through development activities, and widening or construction of roadways, power lines, or pipelines to ensure all PCEs remain compatible with jaguar use.

Subunit 4b: Whetstone-Santa Rita Subunit

Subunit 4b consists of 5,143 ha (12,710 ac) between the Empire Mountains and northern extent of the Whetstone Mountains in Pima County, Arizona. Subunit 4b is generally bounded by (but does not include) the eastern slopes of the Empire Mountains to the west, a line running roughly 6 km (3.7 mi) south of Interstate 10 to the north, the western slopes of the Whetstone Mountains to the east, and Stevenson Canyon to the south. Land ownership within the subunit includes approximately 532 ha (1,313 ac) of Federal lands and 4,612 ha (11,396 ac) of Arizona State lands. According to the final 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 2012, 2014).

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 7,722 ha (19,081 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, Elgin-Canelo Road, and Upper Elgin Road to the west; Highway 82 to the north; a line running roughly 4 km (2.5 mi) west of Highway 90 to the east; and up to but not including the Huachuca Mountains to the south. Land ownership within the subunit includes approximately 1,350 ha (3,336 ac) of Federal lands; 2,981 ha (7,366 ac) of Arizona State lands; and 3,391 ha (8,379 ac) of private lands. The Federal land is administered by the Coronado National Forest and Bureau of Land Management. According to the final 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 2012).

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 Designating Critical Habitat

The description of the models used to designate critical habitat remain as stated in the October 30, 2013, BO and are incorporated herein via reference.

Primary Constituent Elements for Jaguar Critical Habitat

The primary constituent element subsection in the October 30, 2013, BO is incorporated herein via reference, but is updated as follows:

The primary constituent elements of critical habitat essential to the conservation of the jaguar within areas of expansive open spaces in the southwestern United States at least 100 km^2 (37 mi2) in size 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 greater than 1 to 50 percent 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, 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;

6. Are below 2,000 m (6,562 ft) in elevation; and

7. 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 (expressed as an HII of less than 20).

Jaguar Recovery Planning in Relation to Critical Habitat

This section remains as written in the October 30, 2013, BO, except we remove the reference to the Northwestern Management Unit.

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 designated critical habitat with respect to the conservation of the jaguar.

Action Area

The action area remains as described in the October 30, 2013 BO except as described in the Description of the Proposed Action section (see Table 1) and in the following text:

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 (the Borderlands Secondary Area) of the NRU, and at least one jaguar has recently occurred in and near the project area. For the purposes of the jaguar analysis, we use the Forest Service Action Area definition (i.e., defined by hydrology).

Terrain, Vegetation Communities, and Climate in the Action Area

The description of the action area's terrain, vegetation communities, and climate data remain as described in the October 30, 2013, BO, and are incorporated herein via reference.

Status of the Species within the Action Area

Life History and Habitat

The description of the jaguar's life history and habitat in the action area remains as it was described in the October 30, 2013, BO, and is incorporated herein via reference.

Distribution and Abundance

The distribution and abundance of jaguars in the action area is largely the same as it was described in the October 30, 2013, BO and is incorporated herein via reference. The subsection is updated as follows:

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, were located on lands administered by the Coronado National Forest within designated 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 critical habitat Subunit 4 – Whetstone Unit) in November 2011 is the same jaguar later detected in the Santa Rita Mountains (within 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 September 2015 (https://www.flickr.com/photos/usfws_southwest/sets/72157632294203147/).

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).
This hypothesis is supported by Culver *et al.*'s (2016) study. They presume this jaguar, which was detected in 118 photographs/videos and 13 scats, is a resident because he was photographed by their cameras every month of the year from November 2012 to February 2015.

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

The threats to jaguars remain as they were described in the October 30, 2013, BO and are incorporated herein via reference. The only change is that we refer to the former Northwestern Management Unit as the Borderlands Secondary Area.

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

This section is updated as follows:

Current Condition of Critical Habitat - The action area as defined by the Forest Service occurs within the Patagonia Unit (Unit 3) (Figure J-2), which consists of 147,248 ha (351,501 ac) in the Patagonia, Santa Rita, Empire, and Huachuca Mountains, as well as the Canelo and Grosvenor 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.

The action area is situated west of the Whetstone-Santa Rita Unit (Subunit 4b) (Figure 2) which consists of 5,143 ha (12,710 ac) between the Empire Mountains and northern extent of the Whetstone Mountains in Pima County, Arizona. The Whetstone-Santa Rita Subunit, which may provide connectivity from the Whetstone Mountains to Mexico through Unit 3, was not known to be occupied at the time of listing (FWS 2012, FWS 2013), and is not known to have ever been used by jaguars.

Factors Responsible for the Current Condition of Critical Habitat - The Patagonia Unit is designated 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, 2013) 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 less than 20 was the parameter identified as an essential component for the conservation of the jaguar in the United States (FWS 2014).

According to the final rule, connectivity between the United States and Mexico is necessary if viable habitat for the jaguar is to be maintained (FWS 2014). The intent of Subunit 4b is to connect Subunit 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 2012, FWS 2013). In the final critical habitat rule for the jaguar, we noted the existence of the Rosemont Mine project, and stated that we had evaluated the project through the section 7 consultation process (FWS 2013). As a result, we determined that the project would not constitute destruction or adverse modification of jaguar critical habitat at that time (FWS 2014). We also found that the impacts of the critical designation on the Rosemont Project would be minimal (FWS 2014).

Conservation Role of the Designated 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 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 designated critical habitat rule as essential for the conservation of jaguars. Therefore, the intent of the final rule is to provide connectivity of Subunit 4a to Mexico through Unit 3 via Subunits 4b and 4c, although there are no records indicating that either of these subunits has been used by jaguars.

Past and Ongoing Federal Actions in the Action Area

No change to this section, except that four (not three) projects have undergone formal section 7 consultation for effects to the jaguar in southern Arizona. A summary of the fourth consultation is described below:

4. *Biological Opinion on Ongoing and Future Military Operations and Activities at Fort Huachuca, Arizona* (Consultation number 22410-2013-F-0247 issued May 16, 2014)

This consultation addressed the effects of operations and activities to meet mission objectives of Fort Huachuca, including tenant-specific activities within Fort Huachuca training areas, air operations associated with Libby Army Air Field, recreational opportunities, resource management, realty actions, and programmed facilities development projects both on post and off post that are master planned.

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 designated 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

This section is updated as follows:

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. As of April 2016, we are aware of a single male resident jaguar in the Santa Rita Mountains. This jaguar will likely be subject to the effects analyzed in this section; however, other jaguars potentially occurring in the area in the future would also be affected.

Effects to jaguars and their habitat are categorized into permanent and long-term (30 years) effects. Permanent effects can be classified as both in perpetuity (e.g., the mine pit) and as very long term effects (e.g., impacted areas between the mine pit and the security fence) for which we cannot predict the overall outcome of revegetation and restoration activities. We do not know if the restored areas will become suitable habitat for jaguars, and it is possible that some areas may be converted from their current native vegetation state (Madrean evergreen woodland, semidesert grassland, etc.) and may not return to the previous condition, thus they are lost for certain plant and animal species (FEIS 2015, p. 1139). Therefore, for the purposes of our analysis, we are considering effects within the security fence to be permanent. Long-term (30 years) effects are those that are in place during mining operations and restoration activities (dust, increased lighting, disturbance, etc.), but that are expected to decrease quickly once these operations and activities cease. We expect these effects within the action area, including between the security fence and perimeter fence. See Table J-2 for acreages of permanent effects, long-term (30 years) effects, and conservation lands.

Table J-2: Acreages of permanent effects and long-term (30 years) effects, as well as conservation lands in southeastern Arizona (and within jaguar critical habitat) related to the construction of the proposed Rosemont Mine (U.S. Forest Service Process Memorandum to File, June 15, 2015).

Impact	Acres	Acres within jaguar critical habitat
Permanent effects* (total)	5,411	4,013

Security fence	*4,228*	*3,514*
New roads	*265*	*210*
Utility right-of-way	*899*	*280*
Trails	*19*	*9*
Long-term (30 years) effects** (total)	8,006	6,139
Permanent effects (total), above*	*5,411*	*4,013*
*Additional area within perimeter fence***	*2,595*	*2,126*
Conservation lands (total)	3,064	1,857
Sonoita Creek Ranch	*1,580*	*1,328*
Davidson Canyon Watershed Parcels	*545*	*527*
Helvetia Ranch North Parcels	*939*	*21*

* 20 acres of decommissioned roads are omitted from the calculation of permanent effects.
** Long-term effects include permanent effects plus an additional 2,595 acres encompassed by the perimeter fence, which surrounds the security fence and portions of the primary access road and utility right-of-way (note that these portions of the primary access road and utility right-of-way are considered part of the 5,411 acres of permanent effects). The perimeter fence will be removed at the end of the project. Long-term effects of noise, increased lighting, etc. (discussed below) will also impact areas outside of the perimeter fence; however, those areas are not quantified in this table.

1. Project Construction

The June 2012 BA defined the project area (BA 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 June 2012 BA indicated that 7,016 acres of land would be directly disturbed. The acreage of direct disturbance was refined in the May 2015 SBA to 5,431 acres, which includes areas within the security fence (4,228 acres), the primary access road (226 acres), the utility line corridor (899 acres), decommissioned or new forest roads (59 acres), and the rerouted Arizona National Scenic Trail and trailheads (19 acres). The total area excluded from public access (within the perimeter fence) would be 6,990 acres. The affected area appears in Figure J-2.

Vegetation types within this area are Madrean evergreen woodland and semidesert grassland, both important vegetation types for jaguars in the Borderlands Secondary Area of the NRU; and both xero- and hydroriparian. Therefore, the project will result in long term (30 years, after which the perimeter fence will be removed), direct effects to 8,006 acres (perimeter fence, roads, trails, and ROW) and the permanent removal of about 5,411 acres of jaguar habitat (security fence, new roads, and ROW; 20 acres of decommissioned roads are omitted from the calculation of permanent effects).

Although we do not know the average home range size of jaguars in Arizona, home ranges in Sonora range from 84 to 200 km^2 (20,757 to 49,421 acres). Note that the 24-hour MMDM home range estimate of the male jaguar in the Santa Rita Mountains (90 km^2) falls within this range, although this estimate should be used with caution. There will be a 6,990-acre temporal loss of up to approximately 14.1 to 33.7 percent of a jaguar home range. In the future, once the perimeter fence has been removed, the 5,411 acres within the security fence will be approximately 10.9 to 26.0 percent of a jaguar home range, with slightly

lesser percentages of affected acreage if reclamation succeeds in reestablishing sufficient permanent canopy cover. It is also likely that the effects are slightly overestimated due to the fact that not all of the 899 acres of utility ROW are within the Madrean evergreen woodland or semidesert grassland vegetation types; the far westernmost portion is within the Arizona upland subdivision vegetation type, if not within human-disturbed habitats such as other, existing ROWs and similar features. Again, these are direct effects associated with the footprint of various mine features; indirect effects (light, noise, traffic, etc.) are discussed in subsequent sections. Regardless of the exact, directly-affected acreage, the jaguar known to be in the northern Santa Rita Mountains recently will most likely lose some portion of its home range. The extent of that loss is unknown because the animal's home range has not been determined.

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 Burt (1943, as cited by Powell and Mitchell 2012) defined home range as ''that area traversed by an individual in its normal activities of food gathering, mating, and caring 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. Culver *et al.*'s (2016) study supports our hypothesis. Due to loss of habitat and additional human disturbance near the project area (e.g., lights, noises, traffic - see below for further discussion), the male jaguar detected in the Santa Rita Mountains will most likely adjust its home range southward.

As explained by Powell and Mitchell (2012), a home range provides information on the locations of resources (Folse *et al.* 1989; Saarenmaa *et al.* 1988; South 1999; Spencer 2012; Stillman *et al.* 2000; Turner *et al.* 1994; With and Crist 1996; all as cited by Powell and Mitchell 2012) and such knowledge affects an animal's fitness. Dispersing mammals often have higher mortality or lower reproduction than conspecifics in familiar territory (Blanco and Cort´es 2007; Gosselink *et al.* 2007; Soulsbury *et al.* 2008; all as cited by Powell and Mitchell (2012) (Powell and Mitchell 2012). Learning a home range requires time, leading to site fidelity, and site fidelity has been used to define whether an animal has established a home range (e.g., Spencer *et al.* 1990, as cited by Powell and Mitchell 2012) (Powell and Mitchell 2012).

There are no changes (relative to the October 30, 2013, BO) to the remainder of this subsection.

2. Lighting

There are no changes (relative to the October 30, 2013, BO) to the remainder of this subsection.

3. Noise

There are no changes (relative to the October 30, 2013, BO) to the remainder of this subsection.

4. Roads and Utility Maintenance Corridor

There are no changes (relative to the October 30, 2013, BO) to the remainder of this subsection.

5. Increase in Human Disturbance

There are no changes (relative to the October 30, 2013, BO) to the remainder of this subsection.

Effects of the Action on Critical Habitat

The Effects of the Action section from the October 30, 2013, BO is incorporated via reference, but is updates as follows:

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

According to the final 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 NRU (FWS 2014). As explained in the final rule (FWS 2014), 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 a unit not known to have been occupied at the time of listing. Per the final 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 designated 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 100 square kilometers (37 square miles; 24,710 acres)</u>

The proposed action will permanently affect open spaces because the security fence will encircle and directly affect 3,514 acres of designated critical habitat in Unit 3; new roads, trails, and the utility ROW will directly affect an additional 499 acres (17 acres of decommissioned roads are not permanent effects). These 4,013 acres of effects represent 1.1 percent of the 351,501-acre designated critical habitat Unit 3 and 0.53 percent of all designated critical habitat rangewide (764,207 acres).

Outside of the security fence, a perimeter barbed-wire fence will be constructed to AGFD wildlife-compliant standards, but the area between it and the security fence will be subject to road, powerline, and water line construction and use (note that some of this construction is considered a permanent effect), light, noise, and prey base effects. The perimeter fence will enclose an additional 2,126 acres beyond the security fence, thus affecting a total of 6,139 acres of jaguar designated critical habitat for up to 30 years (4,013 acres of permanent effects plus 2,126 acres of temporal effects; Table J-2), with some areas potentially becoming more suitable if vegetation reclamation is successful over the long term. The area of designated critical habitat permanently affected by roads and trails remains at 499-acres (17 acres of to-

be-decommissioned roads are not a permanent effect). These 6,139 acres of combined long-term and permanent effects from both fences and the associated roads, trails, and rights-of-way represent 1.75 percent of the 351,501-acre critical habitat Unit 3, and 0.80 percent of all designated critical habitat rangewide (764,207 acres).

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 100 km^2).

Primary Constituent Elements

PCE 1: Connectivity to Mexico

Connectivity to Mexico is a trait of the designated critical habitat and exists throughout each unit. Should a project be constructed such that it directly excludes any of the designated critical habitat from access by jaguars moving to or from Mexico, the areal extent of the PCE is reduced. The proposed action will permanently remove connectivity to Mexico on 3,514 acres of land that will be encircled by the security fence, which will not be permeable to large, terrestrial animals such as jaguars. The perimeter fence and the section of access road between it and the security fence will likely remove or appreciably reduce connectivity to Mexico on 2,126 additional acres for 25 to 30 years. If connectivity to Mexico is to be stated in terms of width, rather than area, the mine (measured from the edge of the perimeter fence) will narrow the northern portion of Unit 3 from its present width of 3.6 km (2.2 mi) to approximately 1.5 km (0.93 mi) (see analysis in subsequent paragraph and Figure J-8, below). Designated critical habitat will remain in place outside of the perimeter fence, north of the proposed mine, south of the Imerys Quarry, and thus our analysis must consider if connectivity to Mexico is retained in that largely indirectly-affected area.

The location of the proposed project in the northern portion of Patagonia Unit 3 would constrict the width of the northeastern portion of the unit which, in turn, could restrict the connection between Unit 3 and the Whetstone-Santa Rita Subunit 4b to the east which, as stated in the final critical habitat rule (FWS 2014), may provide connectivity from the Whetstone Mountains to Mexico via the western portion of Unit 3 (see Figure J-2). 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 northern portion of Unit 3 to a strip approximately 1.5 km (0.93 mi) in width from its present minimum width of 3.6 km (2.2 mi) (see Figure J-8 below).

There are no changes to the remainder of this subsection as it appeared in the October 30, 2013, BO.

PCE 2: Adequate levels of prey species

There are no changes to this subsection as it appeared in the October 30, 2013, BO.

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

There are no changes to this subsection as it appeared in the October 30, 2013, BO.

PCE 4: Madrean evergreen woodland or semidesert grassland vegetation community between greater than 1 to 50 percent canopy cover

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 1% 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) 3,514 acres of designated critical habitat in Unit 3; roads and trails will directly and permanently affect an additional 499 acres.

PCE 5: Moderate to highly rugged terrain

There are no changes to the PCE 5 subsection as it appeared in the October 30, 2013, BO. The subsection regarding PCE 6, below, has been added.

PCE 6: Are below 2,000 m (6,562 ft) in elevation

The entire project area is below 2,000 m (6,562 ft) in elevation. Effects to this PCE are not anticipated, as areas will not be created that exceed 2,000 m (6,562 ft) in elevation.

PCE 7: Little human influence or disturbance

This subsection is updated from the October 30, 2013, BO as follows:

This PCE was developed using research that highlights the fact that jaguars generally avoid areas of human activity. Pursuant to the final rule, an HII of less than 20 is an essential element of PCE 7. 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 2014). 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 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 7 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 (e.g., the current Sycamore Canyon access road), 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 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, and possible upgrades to SR 83 (as described above) and 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 northeastern portion of Unit 3. 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 from 2012 through 2015 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. Once mine operations cease, human activity and disturbance will decrease dramatically. Operating facilities and some fencing will be removed and the waste and tailings landform will be revegetated. This will reduce many of the effects described above, including nighttime lighting, noise and traffic associated with the mine.

Summary of Effects to PCEs

This subsection has been updated from the October 30, 2013, BO as follows:

In summary, the mine's project footprint will adversely affect all PCEs except PCE 6 (i.e., connectivity to Mexico, prey, surface water, canopy cover, rugged terrain, and little human influence, but not elevation) to some degree in the northern portion of Unit 3 for 25 to 30 years, although some of the effects will be offset to varying degrees by the proposed conservation measures. 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 portion of Unit 3 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 the constricted area of Unit 3, then the role of Subunit 4b to the east, as defined in the final critical habitat rule (i.e., to connect Subunit 4a to Mexico via Unit 3) would be lost. That said, connectivity of Subunit 4a to Mexico would still exist via Subunit 4c. Additionally, if the constricted corridor creates a barrier to jaguar movement, the function of the northeastern portion of Unit 3 could be diminished, primarily during mining operations but less so after operations have ceased. 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 Unit 3) and possible indirect loss of critical habitat (in Unit 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

There are no changes to this subsection as it appeared in the October 30, 2013, BO.

Effects of the Action on Critical Habitat in Relation to Recovery

There are no changes to this subsection as it appeared in the October 30, 2013, BO.

Proposed Conservation Measures and Their Effects

There are no changes to this subsection as it appeared in the October 30, 2013, BO with the exception of Conservation Measure 7, below:

7. Rosemont will acquire or record restrictive covenants or conservation easements on the following parcels of land (3,064 acres total within the NRU, including 1,857 acres of jaguar critical habitat; Table J-2):

a. Sonoita Creek Ranch: This land will be conserved (see details in the description of the proposed action) and will provide wildlife conservation benefits as described in the conservation measures. It contains a total of approximately 1,580 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. A total of 1,328 acres of the Ranch occur within 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. We assume in our analysis that managing for connectivity between the Canelo Hills/Patagonia Mountains and the Santa Rita Mountains as stated above includes ensuring that jaguars can safely cross Highway 82, which runs between these mountain ranges, using crossings (e.g., underpasses or overpasses and associated fencing) appropriate for large cats. If this is not the case, connectivity between Canelo Hills/Patagonia Mountains and the Santa Rita Mountains will not be achieved. We provided suggested conservation measures to address connectivity between the Santa Rita and Patagonia Mountains; however, these measures were not incorporated into the Rosemont Mine proposed action.

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 545 acres of semidesert grassland and associated xero- or mesoriparian habitat. All but one of these parcels are within jaguar critical 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 939 acres of semidesert grassland on the west side of the northern Santa Rita Mountains near the proposed project's infrastructure corridor. There are approximately 21 acres of jaguar critical habitat on the far southeastern portion of these parcels. These will be included as available land for the establishment of water features beneficial to listed species such as jaguars.

Summary of Effects of the Action

Jaguar

The proposed project will directly and indirectly affect jaguars and jaguar habitat within the Borderlands Secondary Area of the NRU. The proposed action will result in an up to 30-year temporal loss of up to approximately 16.2 to 38.6 percent of a jaguar home range. The proposed action will result in a permanent loss of up to approximately 10.9 to 26.0 percent of a jaguar home range. Lesser effects may be anticipated as reclamation activities proceed and successfully reestablish sufficient permanent canopy cover; permanent habitat losses will then be largely due to the security-fenced area and pit.

The mine will also permanently reduce the abundance of jaguar prey, estimated by AGFD (2012) to amount to 14 white-tailed deer and 56 collared peccary (javelina), both key prey species for jaguar. However, this habitat loss will be partially offset by Rosemont's conservation commitment to protect 3,064 acres of land within the NRU (including 1,857 acres of jaguar critical habitat) in perpetuity.

There are no changes to the remainder of this subsection as it appeared in the October 30, 2013, BO.

Designated Jaguar Critical Habitat

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

The security fence will encircle and directly affect 3,514 acres of designated critical habitat in Unit 3; the direct effects of new roads, trails, and the utility ROW bring the total affected area to 4,013 acres. These 4,013 acres of effects represent 1.1 percent of the 351,501-acre designated critical habitat Unit 3 and 0.53 percent of all designated critical habitat rangewide (764,207 acres).

The perimeter fence will enclose an additional 2,126 acres beyond the security fence, thus affecting a total of 5,640 acres of jaguar critical habitat for up to 30 years, with some areas potentially becoming more suitable if vegetation reclamation is successful over the long term. The addition of road, trail, and utility ROW effects brings the affected area to 6,139 acres of combined long-term and permanent effects, which represents 1.75 percent of critical habitat Unit 3, and 0.80 percent of all critical habitat rangewide. Conservation lands (totaling 3,064 acres), however, will be protected and managed in perpetuity within the NRU, including 1,857 acres of jaguar critical habitat, and therefore will offset some of this habitat loss.

2. Indirect effects to critical habitat and reduced connectivity due to the proposed project:

As described above, the location of the proposed project in the northern portion of Patagonia Unit 3 will likely restrict connectivity between Patagonia Critical Habitat Unit 3 and the Whetstone-Santa Rita Subunit 4b to some unknown extent, particularly during mining operations but less so after these operations have ceased. The latter unit, according to the final rule, provides connectivity from the Whetstone Mountains to Mexico through Unit 3 (see Figures J-2 and J-3). 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 portion of northeastern Unit 3, then the

functional role of Subunit 4b, as defined in the final critical habitat rule (i.e., to connect Subunit 4a to Mexico via Unit 3), would be removed. That said, connectivity of Subunit 4a to Mexico would still exist via Subunit 4c. Additionally, if the constricted corridor area creates a barrier to jaguar movement, the function of the northeastern portion of Unit 3 (i.e., the portion of Unit 3 from the constricted corridor to the western boundary of Subunit 4b) would also be diminished. Again, however, the remaining portion of Unit 3 (i.e., south of the mine) would still remain functional. Further, Rosemont's permanent protection of 1,857 acres of private lands within critical habitat will further protect connectivity within critical habitat.

3. Effects to recovery:

By definition, critical habitat is habitat determined to be essential for the conservation (i.e., recovery) of the species. Adverse effects to some of these limited critical habitat areas and to one potential pathway from the Whetstones to Mexico, as may occur during mining operations as described above, but less so after these operations have ceased, somewhat reduces the ability of critical habitat and the northernmost secondary area (i.e., the Borderlands Secondary Area) to contribute to the recovery of jaguars in the NRU. That said, the majority (758,068 acres or 99.2 percent of all critical habitat rangewide, taking only into consideration the direct impacts to critical habitat) of designated 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 NRU because the majority of the jaguar population, including two important Core Areas, in the NRU occurs outside of the United States and will not be directly affected by the proposed project.

4. Effects to conservation:

This partial loss of function of Unit 3 and possible reduction in function of Subunit 4b will somewhat diminish the conservation value of designated critical habitat as a whole during mining operations, but less so after these operations have ceased. 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. Adverse effects to portions of these areas (i.e., designated critical habitat areas), as are likely to occur as a result of the proposed action, reduce the ability of jaguar critical habitat to function as intended by the final rule. That said, the vast majority of designated critical habitat will be unaffected by the proposed action and will therefore retain its function and conservation value. Further, the effects of the proposed action on the designated critical habitat will not considerably reduce the capability of jaguar 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. On the eastern flank of the Whetstone Mountains near Benson is the proposed development of Las Villages de Vignetto, which may house 80,000 people in 24,000 homes. 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. The proposed Villages at Vignetto near Benson could result in approximately 8,000 to 15,000 acres of suburban development east of the Whetstone Mountains. 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). Permanent habitat loss (assuming a 5,411-acre (8.5-mi^2) area) from the proposed action will affect a miniscule amount of habitat from this global perspective. The proposed action's effect to the 15.1 million km^2 (5.8 million mi^2) combined NRU and Pan-American Recovery Units, which encompass the entire range of the jaguar, is small, at 1.4×10^{-6} percent. The effects of habitat loss are also small at the recovery unit scale. According to Table J-1, the proposed action will permanently affect approximately 0.01 percent of the 65,967 mi^2 of jaguar habitat within the NRU, approximately 0.07 percent of the 11,483 mi^2 of jaguar habitat within the Borderlands Secondary Area, and 0.3 percent of the 2,641 mi^2 of jaguar habitat within the in the U.S. portion of the Borderlands Secondary Area.

2. Only one jaguar will likely be incidentally taken via harassment 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 6 jaguars in the U.S. portion of the Borderlands Secondary Area, 43 jaguars in the entire Borderlands Secondary Area, and 3,414 jaguars within the NRU; actual population numbers are unknown.

3. Although abundance and population trends for the jaguar rangewide are not well known and populations throughout the species' range continue to be at risk, the Rosemont Copper mine will not have an appreciable impact on the population at the rangewide, NRU-specific, or Borderlands Secondary Area-specific scales. 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.

Critical Habitat

Legal Standards and Definitions

As stated in the introductory paragraphs of this BO, we published a final rule on February 11. 2016 (81 FR 7214), revising the definition for destruction or adverse modification of critical habitat the Act's implementing regulations at 50 CFR 402.02. Specifically, we finalized the following regulatory definition: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." This revised definition has been applied to the jaguar critical habitat analysis in this consultation. The revised definition also supersedes the October 30, 2013, Final BO's and November 30, 2015, Draft BO's reliance 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), which we used, at those times, to complete our analyses with respect to critical habitat.

There are otherwise no changes to this subsection as it appeared in the October 30, 2013, BO.

Therefore, following guidance from each of these four sources and considering the effects noted above, it is our opinion that implementation of the proposed action will not likely destroy or adversely modify designated 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 in Unit 3, the majority of Unit 3 will retain its PCEs and function. The security fence and roads will permanently remove 4,013 acres of critical habitat in Unit 3. These 4,013 acres of permanent effects represent 1.1 percent of critical habitat Unit 3 and 0.53 percent of all critical habitat rangewide. The additional 2,126 acres surrounded by the perimeter fence brings the long-term (25-30 years) effects to 6,139 acres, which represents 1.75 percent of critical habitat Unit 3, and 0.80 percent of all critical habitat rangewide. Further, proposed conservation measures will permanently protect 1,857 acres within designated critical habitat that could otherwise be subject to development or other adverse

effects. This provides an offset of 30 to 46 percent to the critical habitat expected to be lost.

2. If the constriction of the designated critical habitat between the proposed Rosemont Mine and Imerys Quarry render the northeastern portion of Unit 3 inaccessible (but see discussion below), an additional 32,992 acres of Unit 3 would be removed from its function in jaguar conservation. The perimeter fence, roads, and utility ROW will affect 6,139 acres of critical habitat for the long term (25 to 30 years). Adding this acreage to that of the inaccessible portion of Unit 3, the areal extent of the long-term loss of designated critical habitat containing all the PCEs to support jaguars would be 36,131 acres. This would constitute approximately 11.1 percent of Unit 3 and 5.1 percent of all critical habitat rangewide. Adding the acreage of the inaccessible portion of Unit 3 to the 4,013 acres of designated critical habitat in which all PCEs are permanently affected by the security fence and roads brings the total impact to 37,005 acres. This would constitute a permanent loss of 10.5 percent of Unit 3 and 4.8 percent of all critical habitat rangewide. Both the long-term and permanent hypothetical losses are partially offset by the aforementioned permanent protection of 1,857 acres of conservation lands within jaguar critical habitat. Although the proposed action could potentially cause long-term and permanent, direct and indirect losses of function in Unit 3, function would be retained in 88.9 (long-term) to 89.5 (permanent) percent of Unit 3 and in 94.9 (long-term) to 95.2 (permanent) percent of all designated critical habitat.

3. If the lost function of northeastern Unit 3 analyzed in Item 2, above, removed the connectivity-to-Mexico role of the 12,710-acre Subunit 4b and also rendered the 62,479-acre Subunit 4a inaccessible via northeast Unit 3, the resulting 75,189-acre loss of function would represent an additional 9.8 percent of the overall designated critical habitat (8.2 percent in Subunit 4a, 1.7 percent in Subunit 4b). We note, however, that connectivity to Mexico for Subunit 4a exists through Subunit 4c and the southeastern portion of Unit 3 in the Huachuca Mountains, regardless of the potential functional loss of Subunit 4b.

4. When the 6,139 acres occupied by the perimeter fence, roads, trails, and utility ROW are added to the potential for a functional losses of 32,992 acres of northeastern Unit 3 and all of the 12,710-acre Subunit 4b (as in Items 2 and 3, above), there would be a 51,841-acre long-term loss of function within the 364,211-acre combined area of Unit 3 and Subunit 4b. Considering the 4,013-acre security-fenced area and roads, there would be a 49,715-acre permanent loss of function to the combined area of Unit 3 and Subunit 4b. Under these hypothetical scenarios, function would be retained in 85.8 to 86.3 percent of the combined acreage of Unit 3 and Subunit 4b and in 93.2 to 93.5 percent of all designated critical habitat. We reiterate that connectivity to Mexico for Subunit 4a exists through Subunit 4c and the southeastern portion of Unit 3 in the Huachuca Mountains, regardless of the potential functional loss of Subunit 4b. We again note that both the long-term and permanent potential losses would be partially offset by the aforementioned permanent protection of 1,857 acres of conservation lands.

5. When the 6,139 acres occupied by the perimeter fence, roads, trails, and utility ROW are added to the potential for a functional losses of 32,992 acres of northeastern Unit 3, the 62,479-acre Subunit 4a, and the 12,710-acre Subunit 4b (as in Items 2 and 3, above), there would be a 114,320-acre long-term loss of function within the 426,690-acre combined area of Unit 3 and Subunits 4a and 4b. Considering the 4,013-acre security-fenced area and roads, there would be a 112,194-acre permanent loss of function to the combined area of Unit 3 and Subunits 4a and 4b. Under these

hypothetical, worst-case scenarios, function would be retained in 73.2 to 73.7 percent of the combined acreage of Unit 3 and Subunits 4a and 4b and in 85.0 to 85.3 percent of all designated critical habitat. We reiterate that connectivity to Mexico for Subunit 4a exists through Subunit 4c and the southeastern portion of Unit 3 in the Huachuca Mountains, regardless of the potential functional loss of Subunit 4b, and that both the long-term and permanent potential losses would be partially offset by the aforementioned permanent protection of 1,857 acres of conservation lands.

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 in Unit 3 and access Subunit 4b; (2) that such a preclusion would render Subunits 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 designated critical habitat for jaguar recovery. It is our opinion that the standard of "highly probable" is not met for any of these arguments singly, l*et al*one 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 array of designated 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 9.8 percent of critical habitat (8.2 percent in 4a, 1.7 percent in 4b) (see Item 3 in Habitat Loss analysis, above); 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. Further, we have analyzed three other hypothetical combinations, including: (1) the loss of function in Subunits 4a and 4b (see Item 3 under Habitat Loss section, above); (2) the effects of the action, the loss of function in Unit 3 and Subunit 4b (see Item 4, above); and (3) the effects of the action, the loss of function in Unit 3 and Subunits 4a and 4b (see Item 5, above). These hypothetical, and increasingly worst-case effects, are similarly unsupported by the best available information.

No change to the remainder of this subsection.

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 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). 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 detections of the presence of one jaguar have occurred within the action area as recently as August 2015. The most recent detections were from trail cameras placed by researchers from the University of Arizona, originally as part of a jaguar and ocelot survey and monitoring project funded by the FWS and the Department of Homeland Security, but now as part of a citizen science initiative. All detections were located on lands administered by the Coronado National Forest and are of a single male jaguar. One of the earlier detections (from a resident hunter) was from a trail camera located to the west of and adjacent to the proposed project area. Thus, incidental take in the form of harassment of a jaguar is likely to occur because trail cameras have detected a male jaguar within the area subject to direct and/or indirect effects of the proposed project (the action area).

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 on jaguars. 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 jaguar(s) are documented in the action area and those jaguar(s) are reasonably certain to be taken by the proposed action. Presence of additional jaguar(s) in the action area will not necessarily result in take being exceeded; however, if additional jaguar(s) are detected in the action area, the Forest Service and FWS will immediately discuss the situation and determine if reinitiation is required.

In summary, and stated differently, the maximum allowable incidental take of jaguar is the harassment of one individual.

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. The jaguar's range consists of about 11.7 million km^2 from southern United States all the way to Argentina. Also, there are about 30,000 jaguars in the wild. Therefore, take of one jaguar in the form of harassment in the U.S. will not jeopardize the species.

REASONABLE AND PRUDENT MEASURES - JAGUAR

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

1. Minimize the effects of disturbance from noise and roads to the jaguar.
2. Monitor jaguars in the area of the Santa Rita Mountains described in Term and Condition Number 2.
3. Monitor incidental take resulting from the proposed action and report to the FWS the findings of that monitoring.

TERMS AND CONDITIONS - JAGUAR

To be exempt from the prohibitions of section 9 of the Act, the Forest Service shall ensure that Rosemont complies 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 Terms and Conditions implement Reasonable and Prudent Measure Number 1:

a. The USFS and Corps shall ensure that Rosemont Copper Company minimizes road-related noise, especially at night, through the use of techniques such as avoiding, to the extent practicable (i.e., that allows for safe driving conditions), horn use and "Jake-braking" (the use of an engine's compression combined with downshifting the transmission to slow a vehicle). Compliance with this Term and Condition may be demonstrated by placing signs advising vehicle operators to not

employ "Jake-brakes" at both ends and the midpoint of the primary access road.

b. The USFS and Corps shall ensure that Rosemont Copper Company limits speeds on the primary and secondary access roads and the Sycamore connector road to no more than 25 miles per hour 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. Compliance with this term and condition may be demonstrated by placing speed limit signs in appropriate locations. Compliance may also be demonstrated by placing signs cautioning vehicle operators of the presence of wildlife both at ends and the midpoint of the primary access road and at any other locations determined necessary by the USFS Biological Monitor (while implementing the wildlife movement-related Conservation Measure).

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

The USFS and Corps shall ensure that Rosemont conduct (or provide funding to conduct) jaguar surveys and monitoring for the life of the proposed mine and for 5-years post-closure. Jaguar surveys and monitoring shall be conducted by a contractor with expertise in large felid survey and monitoring, sampling design, GIS, and data analysis. Objectives of the survey and monitoring project include, but are not limited to the following: (1) determine if the male jaguar previously detected near the proposed mine continues to use the area; (2) determine if additional jaguars are present in the vicinity of the mine; (3) gather basic information on jaguar movement and habitat use patterns in the vicinity of the mine, including, if possible, determining travel routes; and (4) enable operations to take into account the presence of jaguars in the immediate vicinity. The exact design, scope, and location of the survey and monitoring project will be determined in the survey and monitoring plan and updated as needed to gather the best possible information on jaguars.

Unless another survey and monitoring design of equal or lesser effort is determined to be potentially more scientifically effective (i.e., to allow for the best scientific information possible to be obtained), surveys and monitoring will be conducted for the first five years in a 200 km^2 area of jaguar proposed critical habitat roughly centered on the perimeter fence of the mine. Jaguars detected in this area will then be subject to focused monitoring. We note that 200km^2 is the largest home range (obtained via radio-telemetry) documented from the northern portion of the species range by Rosas-Rosas and Bender (2012) (see Home Range and Movement section, above). After five years, FWS (in coordination with AGFD), USFS, and Rosemont will meet to discuss and determine if the existing survey and monitoring design should be continued with the same level of effort, or if a new design with a similar level of effort should be employed; the goal of either effort will be to continue to obtain the best information possible on jaguars in the action area. Rosemont shall implement the new survey and monitoring design, if warranted, for the life of project plus 5-years post-closure, unless another design of equal or lesser effort is determined to be more effective.

All jaguar detections will be reported to FWS and AGFD within 24 hours.

Jaguar survey and monitoring must commence prior to significant surface disturbance. Jaguar survey and monitoring will be conducted through non-invasive means, including, but not limited to the use of trail cameras, and/or scat-detection dogs. Prior to the commencement of any field

work: (1) a survey and monitoring plan (draft and final) will be submitted to and approved by the FWS and other entities (AGFD in particular); and (2) all necessary permits will be obtained, copies of which must be sent to FWS and other entities as applicable.

The survey and monitoring plan will include, among other information: (1) the objectives; (2) a detailed description of survey and monitoring methods and analysis techniques to be employed, including the location and spatial array of paired cameras, track plots, or scat-detection dog transects, and frequency with which photos will be downloaded and viewed (at least monthly), track plots read, or scat-detection transects run; (3) a communications plan that explains, among other things, how jaguar detections will be relayed to the FWS, AGFD, and the general public; and how media requests will be handled; (4) reporting format and schedule (reporting will include draft and final reports, as well as monthly updates); and (5) qualifications of the survey and monitoring team. All aspects of the plan and implementation of the plan (including, but not limited to, who will conduct the survey and monitoring, how the survey and monitoring will be conducted, and when reports will be due) must be coordinated with FWS (in coordination with AGFD) and approved by FWS. Additionally, all survey and monitoring efforts must be coordinated with the FWS (in coordination with AGFD), USFS, other entities, affected land owners and managers, and other parties determined to be appropriate by the FWS.

The aforementioned survey and monitoring effort expands on the Conservation Measure in the Description of the Proposed Action of the BA which states "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." Please note that AGFD has requested that the agency not be referred to within task-oriented conservation measures; it only appears here due to the agency name appearing in quoted text. Reasonable and Prudent Measure Number 2 is required because the $50,000 camera study identified in the Conservation Measures is a small fraction of funding needed to conduct jaguar surveys and monitoring for the life of the proposed mine, and 5-years post-closure. To reduce survey and monitoring redundancy and possible disturbance to jaguars in the area, this Conservation Measure and the aforementioned survey and monitoring effort should be conducted by the same entity.

3. The following Term and Condition implements Reasonable and Prudent Measure Number 3:

To monitor incidental take resulting from the proposed action, the USFS and Corps shall ensure that Rosemont monitors the impacts of the action as they relate to jaguar and that Rosemont reports these to the FWS for the life of the project. A report will be due to the FWS annually on December 31. The 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.

In summary, 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 the impact of 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 reinitiation of consultation and review of the reasonable and prudent measures provided. USFS 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

1. 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. Coordinating the aforementioned Conservation Recommendations with FWS and other entities before the measures are employed.

2. Support jaguar recovery through implementing and/or funding priority recovery actions for the jaguar as determined by the Jaguar Recovery Team.

3. Provide funding to contribute toward the conservation and management of unprotected/undeveloped lands for wildlife connectivity in the wildlife corridor referred to as Strand B in the Patagonia-Santa Rita Linkage Design (Beier *et al.* 2008) or the wildlife corridor determined by the USFWS to be the best biological corridor for wildlife connecting the Santa Rita and Patagonia Mountains.

4. Provide funding to contribute toward the conservation and management of unprotected/undeveloped lands for wildlife connectivity in the best biological corridor for wildlife connecting the Santa Rita and Whetstone Mountains.

5. Provide funding to contribute to researchers' efforts to evaluate and enhance existing and/or construct new wildlife crossings (e.g., wildlife overpasses or underpasses and associated fencing) along and across Highways 82 and 83. These crossings would improve connectivity between the Santa Rita and Patagonia Mountains and the Santa Rita and Whetstone Mountains, respectively. To be effective, at least four wildlife crossings should be located along Highways 82 and 83 based on studies of carnivore movement in the area.

6. Provide funding to FWS for a full-time Fish and Wildlife Biologist for the life of the project to assist in study design, and to track the implementation of all conservation measures and adherence to all terms and conditions of this Final BO.

7. Protect jaguar habitat and corridors in the NRU in Sonora to allow for expansion of jaguars from the nearest core area into the U.S. and help offset the partial loss of function of Jaguar Critical Habitat Units 3 and 4a.

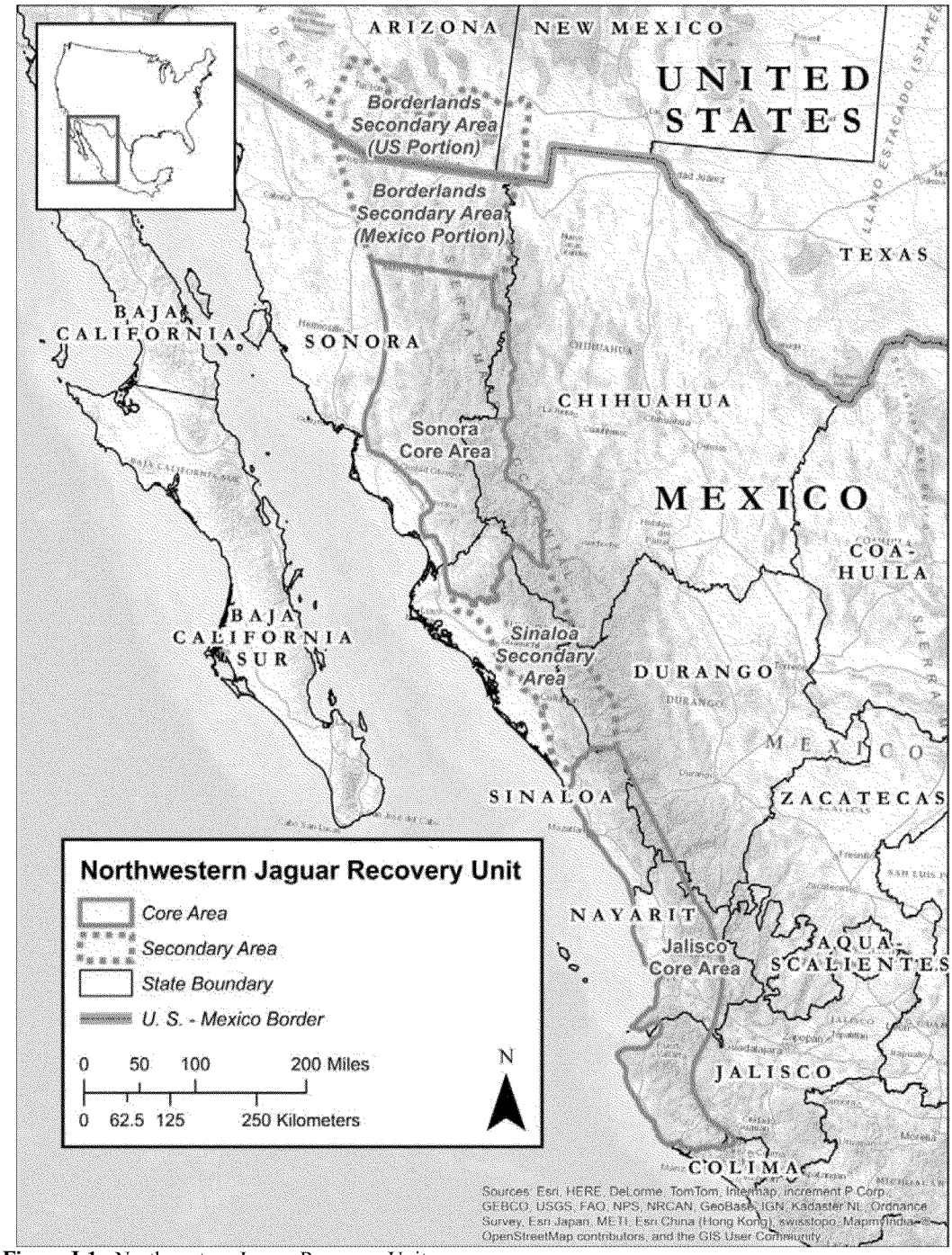
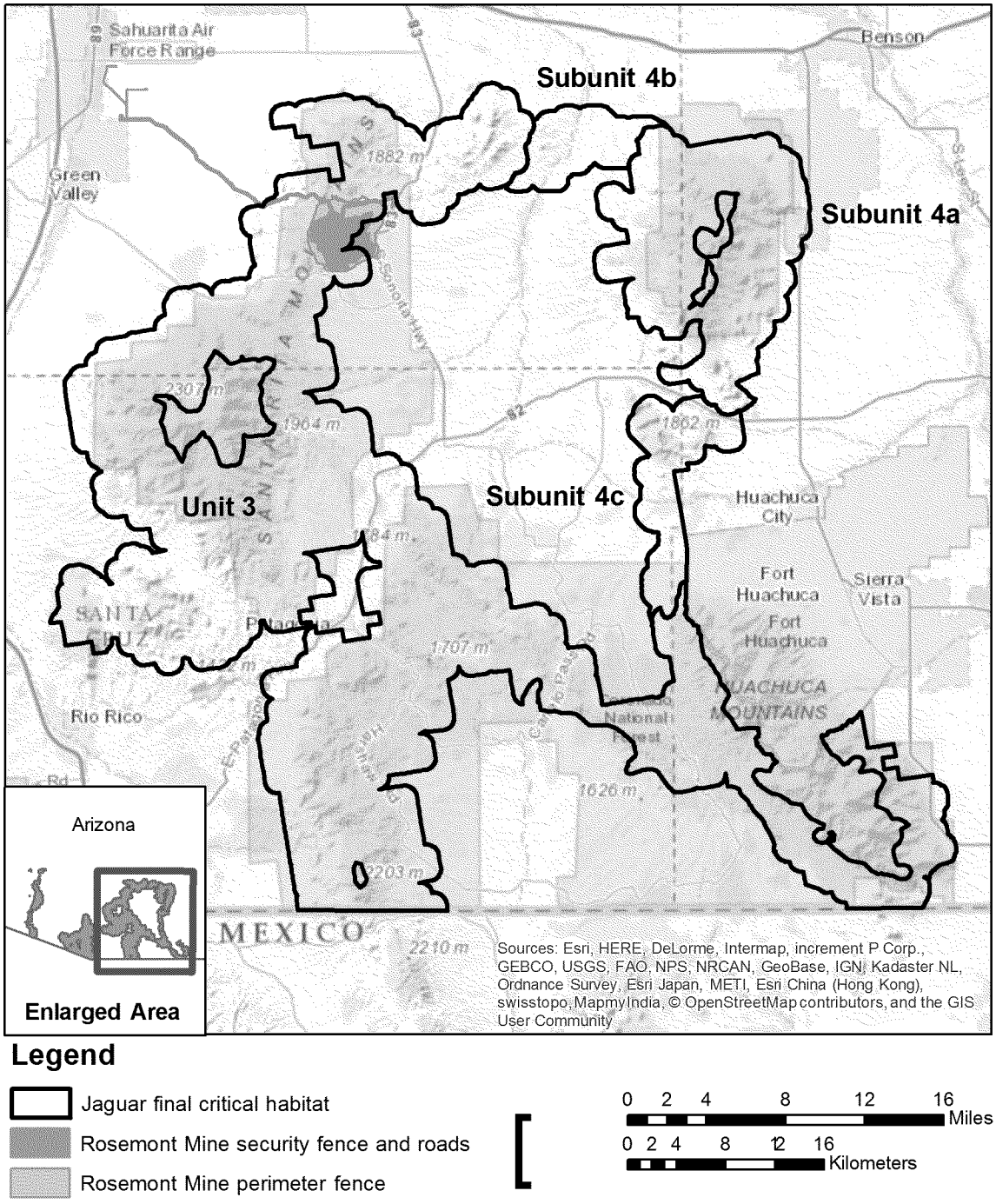


Figure J-1: Northwestern Jaguar Recovery Unit.



Legend

- Jaguar final critical habitat
- Rosemont Mine security fence and roads
- Rosemont Mine perimeter fence

0 2 4 8 12 16 Miles

0 2 4 8 12 16 Kilometers

Figure J-2: Map showing the proposed action within designated jaguar critical habitat Unit 3 in relation to Critical Habitat Unit 4 (Subunits a, b, and c).

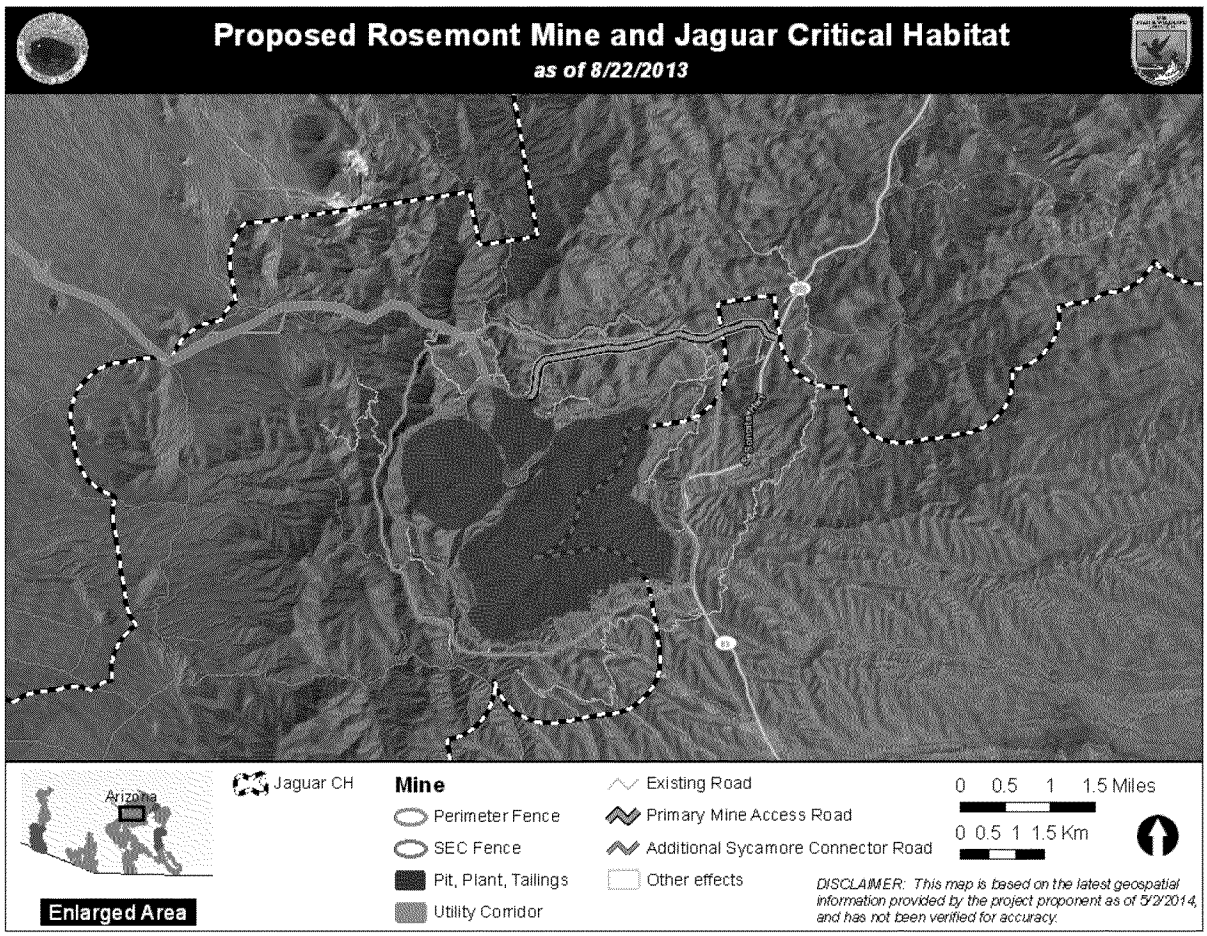


Figure J-3: Proposed Rosemont Mine Project and Jaguar Critical Habitat. Note the "Enlarged Area" shows revised proposed critical habitat for the jaguar, which is identical to final designated critical habitat in this area.

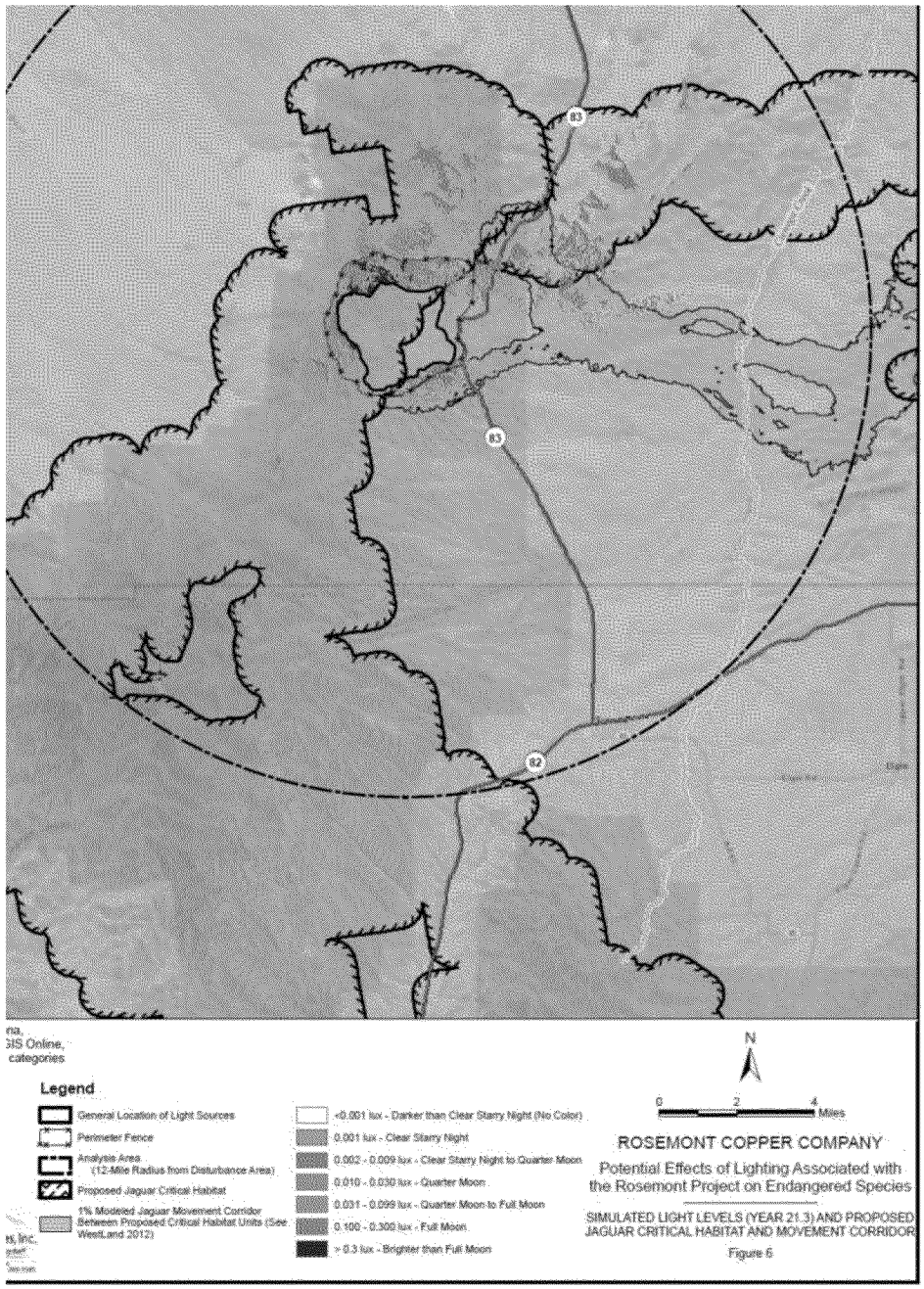


Figure J-4: Simulated light (horizontal) levels as a result of the proposed Rosemont Mine project in relation to jaguar critical habitat (Figure 6 of WestLand Resources Inc, 2012). Please note that this map uses a version of the proposed critical habitat boundaries superseded by the March 5, 2014, final rule (79 FR 12572).

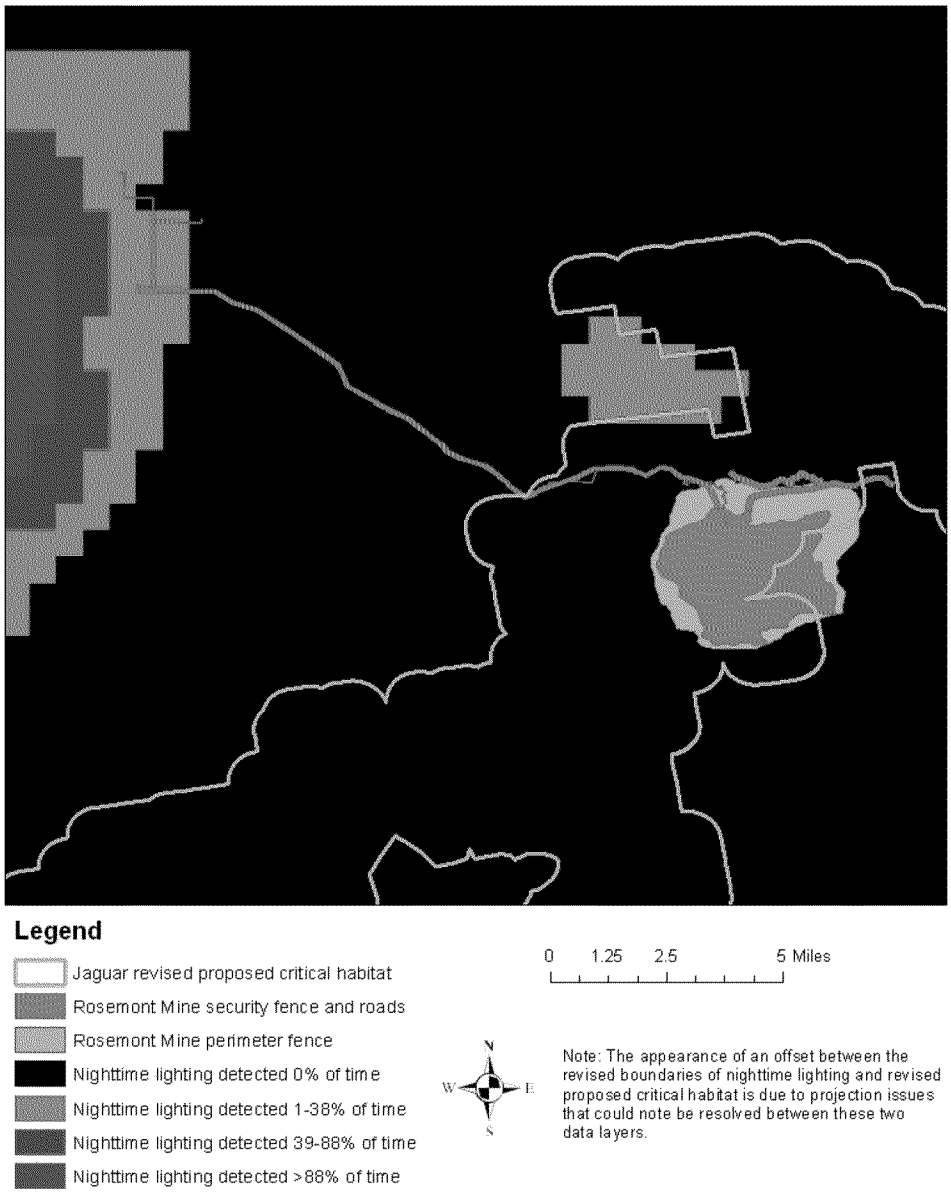


Figure J-5: Map showing nighttime lighting (based on data provided to FWS by the Wildlife Conservation Society) from the current Imerys Quarry (purple area) in relation to the proposed Rosemont mine and designated jaguar critical habitat. Note that Figures J-6 and J-7 appear only in the October 30, 2013, Final BO.

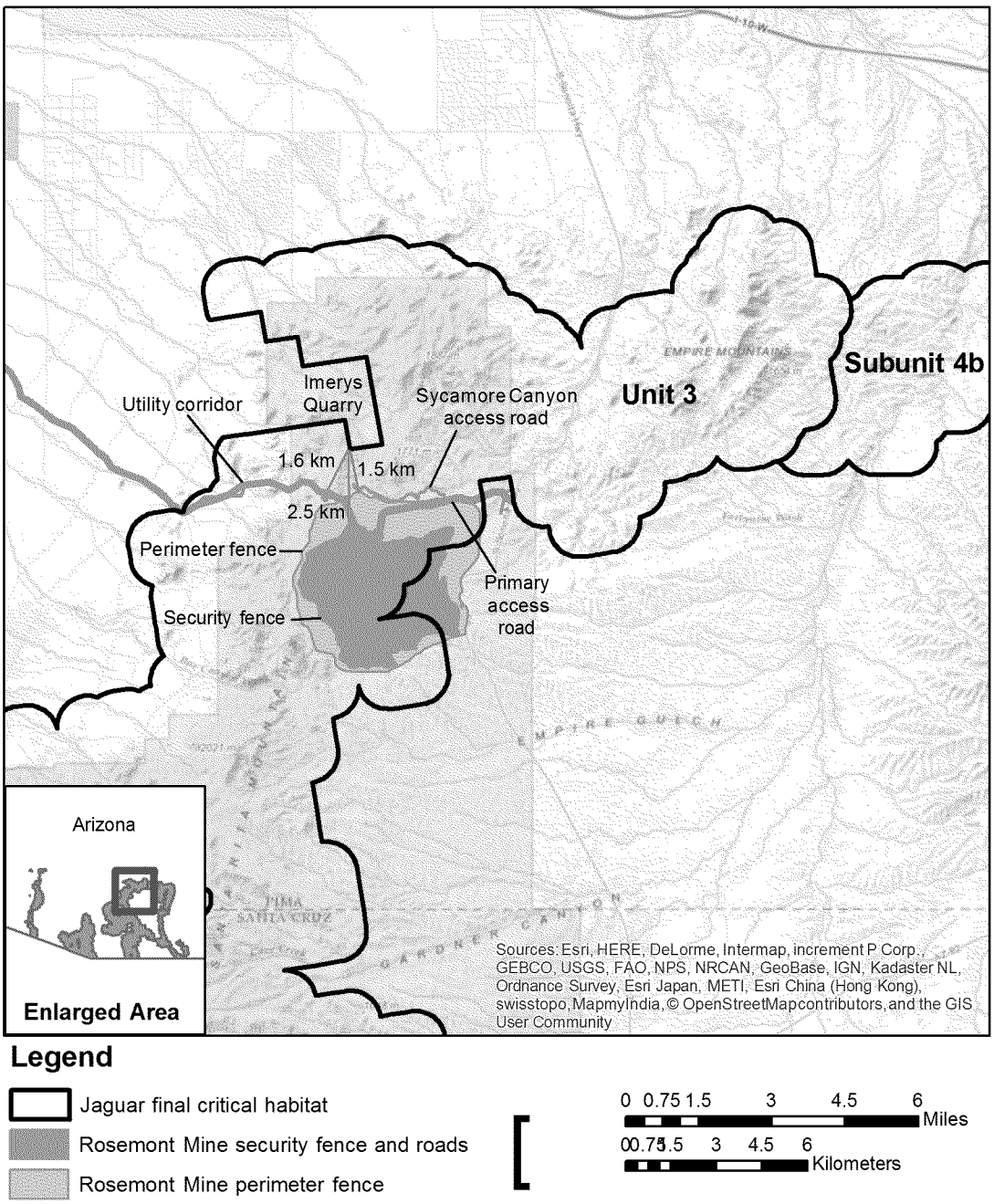


Figure J-8: The proposed action within jaguar critical habitat Unit 3 and the narrowest distances between the perimeter fence (1.5 km), security fence (2.5 km), and utility corridor (1.6 km) of the proposed action and the edge of critical habitat. Note that the area of the northeastern portion of Unit 3 between the 1.5-km line and the western boundary of Subunit 4b is 32,992 acres (13,351 hectares). Note that Figures J-6 and J-7 appear only in the October 30, 2013, Final BO.

OCELOT

Status of the Species - Ocelot

Description, Legal Status, and Recovery Planning

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

Life History and Habitat

As stated in our last biological opinion, no home range studies have been done for ocelots in Arizona or northwestern Mexico. Recently, however, Culver *et al.* (2015) estimated minimum observed ranges for ocelots in Arizona and Sonora. The average minimum observed range of three Arizona ocelots was 30.09 km^2 (11.62 mi^2), with minimum observed ranges ranging from 7.76 to 63.40 km^2 (3.00 to 24.48 mi^2). The average minimum observed range of 9 Sonora ocelots was 11.75 km^2 (4.54 mi^2) (< 1.97 km^2 - 0.76 mi^2) to (> 31.49 km^2 - 12.16 mi^2) (Culver *et al.* 2015).

The following are additions to information on ocelot habitat in Arizona. A male ocelot that was killed by a vehicle west of Globe, Arizona, in 2010 (Holbrook *et al.* 2011) was in the interior chaparral vegetation community, at an elevation of 1,334 m within the Greater Oak Flat Watershed (AGFD as cited by Featherstone *et al.* 2013). Recent detections of three other ocelots in Arizona were located in the semidesert grassland (46%), Madrean evergreen woodland (46%), and Great Basin grassland (8%) biotic communities (Culver *et al.* 2015). On average, all ocelot locations had 23% tree cover and were found at an elevation of 1,832 m. Additionally, on average, they were 2,335 m from perennial water sites and 6,337 m from major roads (Culver *et al.* 2015).

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). We are not aware of any range-wide estimates of suitable ocelot habitat.

Estimating population sizes of secretive nocturnal carnivores, especially species that inhabit dense vegetative cover, such as the ocelot, is difficult. We are not aware of any range-wide estimates for ocelots; however, population size has been estimated in a number of countries. An effective population size of 10,000 to 528,732 individuals was estimated for Brazil (Oliveira 2013). A total population of 1,500 to 8,000 individuals was estimated for Argentina (Aprile *et al.* 2012). 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. Gómez-Ramírez (2015) estimated a population of 1,421 ocelots in Sonora. 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). Stasey (2012) reported a population estimate of 371 ocelots in a 1,560 km^2 patch of habitat in the Sierra of Tamaulipas.

Since 2009, a total of five ocelots have been detected in Arizona, including four detected by trail cameras and hunting dogs, and one dead ocelot that had been struck by a vehicle. A description of these detections follows. In November 2009, a live ocelot (sex unknown) was documented in the Whetstone Mountains in Cochise County, Arizona, with the use of camera-traps (Avila-Villegas and Lamberton-Moreno 2013). In April 2010, a second ocelot was found dead on a road near Globe, Arizona. A genetic analysis was conducted and all data indicated the young male ocelot was not of captive but wild origin (Holbrook *et al.* 2011). Origin of the ocelot recovered in Globe is still unclear due to a lack of comparative samples from Arizona or Sonora although in the DNA analysis, it clustered with samples from Mexico. A two-year camera-trap study in the area near Globe, Arizona, did not photograph any additional ocelots (Featherstone *et al.* 2013).

In February 2011, a third male ocelot was treed by a hunting dog and photographed in the Huachuca Mountains. He was subsequently detected multiple times by trail cameras, including once in the Patagonia Mountains in May 2012 (Culver *et al.* 2015), and was also treed by hunting dogs again (in the Huachuca Mountains). After being detected in the Patagonia Mountains he returned to the Huachuca Mountains, meaning that he traveled an approximate round trip distance of 84 km (Culver *et al.* 2015). He was most recently detected in May 2013. In May 2012, a fourth male ocelot was detected in the Huachuca Mountains via trail camera. He has been detected many times via trail cameras, most recently in October 2015, and treed by hunting dogs once. In April 2014, a fifth male ocelot was detected in the Santa Rita Mountains via trail camera. He was photographed several times over a two-month period and has not been detected since. Additionally, an ocelot was detected in December 2013 in the Santa Rita Mountains; however it is unknown if this was the same as the fifth ocelot described above or a different ocelot.

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. Out of the 36 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

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

Planning and Conservation Efforts

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

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). Ocelots have recently been documented in the Santa Rita Mountains. For the purposes of the ocelot analysis, we use the Forest Service Action Area definition (i.e., defined by hydrology).

Terrain, Vegetation Communities, and Climate in the Action Area

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

Status of the Ocelot in the Action Area

Life History and Habitat

As stated in our last biological opinion, no home range studies have been done for ocelots in Arizona. Recently, however, Culver *et al.* (2015) estimated minimum observed ranges for ocelots in Arizona and Sonora. The average minimum observed range of the three Arizona ocelots was 30.09 km^2 (11.62 mi^2), with minimum observed ranges ranging from 7.76 to 63.40 km^2 (3.00 to 24.48 mi^2). The minimum observed range of the ocelot detected in the Santa Rita Mountains was 19.11 km^2 (7.38 mi^2).

Based on limited records, in Arizona ocelots appear to be associated with Madrean evergreen woodland (Culver *et al.* 2015, Avila-Villegas and Jessica Lamberton-Moreno 2013), semidesert grassland, and Great Basin grassland biotic communities (Culver *et al.* 2015). In the Santa Rita Mountains, ocelots were detected by Culver *et al.* (2015) in semidesert grassland and Madrean evergreen woodland. Four of the

five ocelot detection cameras were located in semidesert grassland and one was located in Madrean evergreen woodland (Culver *et al.* 2015). As depicted in Figure 1b in Culver *et al.* (2015), the detection locations in semidesert grassland were close (<0.7 mile) to Madrean evergreen woodland; therefore the sites likely shared characteristics of both biotic communities. All ocelot detections in the Santa Rita Mountains were at night.

Distribution, Abundance, and Population Trends

Culver *et al.* (2015) recently documented ocelot use of the Santa Rita Mountains. Their team obtained 7 photographs (including 6 in Pima County and one in Santa Cruz County) of at least one adult male ocelot in the Santa Rita Mountains (one photo was not adequate for individual identification). The male ocelot was photographed 6 times by Culver *et al.* (2015) over a 43 day period, from April 2014 to May 2014. During this time, a private citizen also captured a video of this animal, the location of which was verified by Culver *et al.* (2015). Additionally, in December 2013, Culver *et al.* (2015) photographed an ocelot in the vicinity of the other photos of the male ocelot; however, they were not able to positively identify the ocelot due to the poor quality of the photograph. If it was the same individual as subsequently detected in April and May, the duration this ocelot was observed would increase to 150 days (Culver *et al.* 2015). Ocelot detections ranged from 0.3 to 11 miles (to the southwest) from the proposed project perimeter fence.

In addition to ocelots being recently detected in the Santa Rita, Huachuca, and Whetstone mountains of Arizona and the Sierra Azul of Sonora (as described above and in our last biological opinion), a male ocelot was also detected in the Patagonia Mountains in May 2012. The Patagonias lie between the Santa Ritas and the Sierra Azul and are connected to areas south of the border, do not have an impermeable border fence, and habitat there is similar to that found in the Sierra Azul.

Threats

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

Planning and Conservation Efforts

There have been no changes to this section as it appeared in the October 30, 2013, BO. The prior narrative is incorporated herein via reference.

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 (with the exception of our previous biological opinion for this project) 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 ocelot habitat and disturbance to ocelots. Construction and operation of the mine, including the associated roads, will result in removal, destruction, and degradation of ocelot and ocelot prey habitat and may disturb ocelots, 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.

Direct and Indirect Effects of Project Construction

The 2012 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). Project activities within the project area will cause direct ground disturbance and removal of habitat. The project area is 5,431 acres, which includes areas within the security fence (4,228 acres), the primary access road (226 acres), the utility line corridor (899 acres), road disturbance/new roads (39 acres), decommissioned roads (20 acres), and the rerouted Arizona National Scenic Trail (19 acres) (U.S. Forest Service Process Memorandum to File, June 15, 2015). According to Table 122 in the FEIS, the Barrel alternative will directly impact 4,846 acres of upland vegetation (including 2,312 acres of semidesert grassland, 2,523 acres of Madrean evergreen woodland, and 11 acres of Sonoran desertscrub) and 585 acres of riparian vegetation.

In our previous biological opinion, we anticipated that ocelots were more likely to use Madrean evergreen woodland than semidesert grassland. Since the issuance of that opinion, however, as described above, ocelots were detected more frequently by Culver *et al.* (2015) in semidesert grassland than in Madrean evergreen woodland. As also discussed above, the location of detection cameras in semidesert grassland were close to Madrean evergreen woodland, so it is likely that the sites shared characteristics of both biotic communities. Therefore, we now anticipate that ocelots are likely to use Madrean evergreen woodland or semidesert grassland, particularly when the semidesert grassland is relatively close to or shares some characteristics of Madrean evergreen woodland. Ocelots may also use riparian vegetation.

Although we do not know the average home range size of ocelots in Arizona, ocelot home ranges in other parts of their distribution range from an average of 2.0 to 38.8 km^2 (494 to 9,588 acres) (see Emmons 1988 and Crawshaw 1995, respectively). Note that the average minimum observed range of the three Arizona ocelots, 30.09 km^2 (11.62 mi^2), falls within this range. Therefore, using the habitat area of 5,420 acres [5,431-11 acres of Sonoran desertscrub]) that will be removed by the project (including Madrean evergreen woodland, semidesert grassland, and riparian areas), an equivalent of about 0.6 to 11 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. As of April 2016, however, one, possibly two, ocelots have been detected near the project area and we are currently not aware of overlapping ocelot home ranges in the Santa Rita Mountains. That said, no surveys specifically designed to detect ocelots have been conducted in the Santa Rita Mountains and ocelots are

known to be secretive animals that can be difficult to detect. In addition to removing 5,420 acres of ocelot habitat, the project will also result in the direct removal of the same acreage of ocelot prey habitat, possibly leading to a reduced prey base for ocelots. When the security fence is removed and if reclamation succeeds in reestablishing sufficient habitat, some of this area may be useable to ocelots and their prey in the future (30 plus years).

Outside of the security fence, a perimeter barbed-wire fence will be constructed. The perimeter fence will encompass 6,990 acres of land (U.S. Forest Service Process Memorandum to File, June 15, 2015); however, except where specific features such as the primary access road or utility line corridor are located, the habitat between the perimeter fence and the security fence will not be removed. Together, the perimeter fence plus roads, utility line corridor, decommissioned roads, and the Arizona Trail, will encompass a total of 8,199 acres, including 3,392 acres of Madrean evergreen woodland, 4,001 acres of semidesert grassland, 795 acres of riparian vegetation, and 11 acres of Sonoran desertscrub. Given the influence of human and vehicular activity, noise, and lighting (see discussion in the original biological opinion 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, will likely avoid most or all areas within the perimeter fence, as well as additional affected areas outside the perimeter fence. If this is the case, then the mine will directly impact an equivalent of about 0.8 to 16.6 potential ocelot home ranges, possibly more considering home range overlap (note, this home range impact calculation was made without 11 acres of Sonoran desertscrub because ocelots have not been documented using this vegetation type in Arizona). After all mine operations end and the perimeter fence is removed (about 25-30 years), the area between the security fence and the perimeter fence will likely be suitable for ocelot use.

Construction activities associated with all aspects of the project may disturb ocelots and cause them to flee and/or avoid the areas affected by light, noise, traffic, and other human activities. 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. The ocelot repeatedly detected in the vicinity of the proposed action may be subject to such effects if it occurs in the area when project construction begins; however other ocelots potentially occurring in the area in the future would also be affected.

Once project construction is complete and operations are underway, ocelots would be excluded from the project area as it will be devoid of habitat, as described above, as well as the larger area encompassed by the perimeter fence. Ocelot avoidance of this area could cause them to shift home ranges and 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., pumas, jaguars), and other stresses.

Effects of Lighting, Noise, and Vibrations from Mining Operations

There have been no changes to this section as it appeared in the October 30, 2013, BO.

Indirect Effects of Roads

There have been no changes to this section as it appeared in the October 30, 2013, BO.

Effects of Conservation Measures

There have been no changes to this section as it appeared in the October 30, 2013, BO, with the exception of the following. The description of the conservation measure concerning Sonoita Creek Ranch has been modified; please see the description of the proposed action for details.

We assume in our analysis that managing for connectivity between the Canelo Hills/Patagonia Mountains and the Santa Rita Mountains as stated in the conservation measures includes ensuring that ocelots can safely cross Highway 82, which runs between these mountain ranges, using crossings (e.g., underpasses or overpasses and associated fencing) appropriate for medium-sized cats. If this is not the case, connectivity between Canelo Hills/Patagonia Mountains and the Santa Rita Mountains will not be achieved. We provided suggested conservation measures to address connectivity between the Santa Rita and Patagonia Mountains; however, these measures were not incorporated into the Rosemont Mine proposed action.

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

There have been no changes to this section as it appeared in the October 30, 2013, BO.

Cumulative Effects - Ocelot

There have been no changes to this section as it appeared in the October 30, 2013, BO.

Conclusion - Ocelot

There have been no changes to this section as it appeared in the October 30, 2013, BO.

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 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). 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 - Ocelot

Confirmed ocelot detections have occurred within the action area as recently as May 2014. The detections were from trail cameras placed by researchers from the University of Arizona conducting a jaguar survey and monitoring project (see Culver *et al.* 2015). All detections were located on lands administered by the Coronado National Forest, photographed at night, and are suspected to be of a single male ocelot (although one photograph was too low quality to identify the ocelot). The detections ranged from 0.3 to 11 miles (to the southwest) from the proposed project perimeter fence. Thus, incidental take of an ocelot is likely to occur because trail cameras have detected a male ocelot within the area subject to direct and/or indirect effects of the proposed action (the action area).

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

> Disturbance of ocelots due to construction, operation, and reclamation 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 to cause ocelots to shift home range location and travel longer distances, possibly 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., pumas, jaguars), 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 on ocelots. In addition, Rosemont will report to us any mortality or injury of ocelots 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. An ocelot 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 ocelot(s) are documented in the action area and those ocelot(s) are reasonably certain to be taken by the proposed action. Presence of additional ocelots in the action area will not necessarily result in take being exceeded; however, if additional ocelots are detected in the action area, the Forest Service and FWS will immediately discuss the situation and determine if reinitiation of consultation is required.

In summary, and stated differently, the maximum allowable incidental take of ocelot is the harassment of one individual.

Effect of the Take

We conclude that this level of anticipated take is not likely to result in jeopardy to the ocelot, for the effects are not expected to appreciably reduce the survival and recovery of the species. Ocelots range from southern United States all the way to Argentina. Also, while there are no range-wide population estimates for ocelots, there are over an estimated 1,350 ocelots in Sonora and many thousands more range-wide. Therefore, the take of one ocelot in the form of harassment in the U.S. will not jeopardize the species.

REASONABLE AND PRUDENT MEASURES- OCELOT

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

1. Minimize the effects of disturbance from noise and roads to the ocelot.
2. Monitor ocelots in the area of the Santa Rita Mountains described in Term and Condition Number 2.
3. Monitor incidental take resulting from the proposed action and report to the FWS the findings of that monitoring.

TERMS AND CONDITIONS - OCELOT

To be exempt from the prohibitions of section 9 of the Act, The USFS shall ensure that Rosemont complies 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 Terms and Conditions implement Reasonable and Prudent Measure Number 1:

    a. The USFS and Corps shall ensure that the Rosemont Copper Company minimizes road-related noise, especially at night, through the use of techniques such as avoiding, to the extent practicable (i.e., that allows for safe driving conditions), horn use and "Jake-braking" (the use of an engine's compression combined with downshifting the transmission to slow a vehicle). Compliance with this Term and Condition may be demonstrated by placing signs advising vehicle operators to not employ "Jake-brakes" at both ends and the midpoint of the primary access road.

    b. The USFS and Corps shall ensure that the Rosemont Copper Company limits speeds on the primary and secondary access roads and the Sycamore connector road to no more than 25 miles per hour 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. Compliance with this term and condition may be demonstrated by placing speed limit signs in appropriate locations. Compliance may also be demonstrated

by placing signs cautioning vehicle operators of the presence of wildlife both at ends and the midpoint of the primary access road and at any other locations determined necessary by the USFS Biological Monitor (while implementing the wildlife movement-related Conservation Measure).

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

The USFS and Corps shall ensure that Rosemont conducts (or provide funding to conduct) ocelot surveys and monitoring for the life of the proposed mine and 5-years post-closure. Ocelot surveys and monitoring shall be conducted by a contractor with expertise in felid survey and monitoring, sampling design, GIS, and data analysis. Objectives of the survey and monitoring project include, but are not limited to the following: (1) determine if the male ocelot previously detected near the proposed mine continues to use the area; (2) determine if additional ocelots are present in the vicinity of the mine; (3) gather basic information on ocelot movement and habitat use patterns in the vicinity of the mine, including, if possible, determining travel routes; and (4) enable operations to take into account the presence of ocelots in the immediate vicinity. The exact design, scope, and location of the survey and monitoring project will be determined in the survey and monitoring plan and updated as needed to gather the best possible information on ocelots. Unless another survey and monitoring design of equal or lesser effort is determined to be potentially more scientifically effective (i.e., to allow for the best scientific information possible to be obtained), surveys and monitoring will be conducted for the first five years in a 38.8 km^2 area of ocelot habitat very roughly centered on the perimeter fence of the mine (because ocelots have been detected to the southwest of the mine, the survey polygon may include more area to the southwest and less in the other directions; however this will be refined in the survey and monitoring plan). Ocelots detected in this area will then be subject to focused monitoring. We note that 38 km^2 is the largest average home range size (the estimate was obtained via radio-telemetry by Crawshaw 1995) noted from the species range. After five years, FWS, USFS, other entities if appropriate, and Rosemont will meet to discuss and determine if the existing survey and monitoring design should be continued with the same level of effort, or if a new design with a similar level of effort should be employed; the goal of either effort will be to continue to obtain the best information possible on ocelots in the action area. The USFS shall ensure that Rosemont implements the new design, if warranted, for the life of project and 5-years post-closure, unless another design of equal or lesser effort is determined to be more effective.

All ocelot detections will be reported to FWS and AGFD within 24 hours.

Ocelot survey and monitoring must commence prior to significant surface disturbance. Ocelot survey and monitoring will be conducted through non-invasive means, including, but not limited to the use of trail cameras and/or scat-detection dogs. Prior to the commencement of any field work: (1) a survey and monitoring plan (draft and final) will be submitted to and approved by the FWS in coordination with AGFD; and (2) all necessary permits will be obtained, copies of which must be sent to FWS and other entities as applicable.

The survey and monitoring plan will include, among other information: (1) the objectives; (2) a detailed description of survey and monitoring methods and analysis techniques to be employed, including the location and spatial array of paired cameras, track plots, or scat-detection dog

transects, and frequency with which photos will be downloaded and viewed (at least monthly), track plots read, or scat-detection transects ran; (3) a communications plan that explains, among other things, how ocelot detections will be relayed to the FWS, AGFD, and the general public; and how media requests will be handled; (4) reporting format and schedule (reporting will include draft and final reports, as well as monthly updates); and (5) qualifications of the survey and monitoring team. All aspects of the plan and implementation of the plan (including, but not limited to, who will conduct the surveys and monitoring, how the survey and monitoring will be conducted, and when reports will be due) must be coordinated with FWS in coordination with AGFD and approved by FWS. Additionally, all survey and monitoring efforts must be coordinated with the USFS, FWS (in coordination with AGFD), affected land owners and managers, and other parties determined to be appropriate by the FWS.

The aforementioned survey and monitoring effort expands on the Conservation Measure in the Description of the Proposed Action of the BA which states "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." Please note that AGFD has requested that the agency not be referred to within task-oriented conservation measures; it only appears here due to the agency name appearing in quoted text. Reasonable and Prudent Measure Number 2 is required because the $50,000 camera study identified in the Conservation Measures is a small fraction of funding needed to conduct ocelot surveys and monitoring for the life of the proposed mine, and 5-years post-closure. To reduce study redundancy and possible disturbance to ocelots in the area, this Conservation Measure and the aforementioned survey and monitoring effort should be conducted by the same entity.

3. The following Term and Condition implements Reasonable and Prudent Measure Number 3:

To monitor incidental take resulting from the proposed action, the USFS and Corps shall ensure that Rosemont monitors the impacts of the action as they relate to ocelot and report these to the FWS for the life of the project. A report will be due to the FWS annually on December 31. The 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.

In summary, the FWS believes that no more than one ocelot 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 the impact of 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 reinitiation of consultation and review of the reasonable and prudent measures provided. USFS 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 - OCELOT

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:

1. 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. Coordinating the aforementioned Conservation Recommendations with FWS and other entities before the measures are employed.
2. Support ocelot recovery through implementing and/or funding priority recovery actions for the ocelot as determined by the Ocelot Recovery Team.
3. Provide funding to contribute toward the conservation and management of unprotected/undeveloped lands for wildlife connectivity in the wildlife corridor referred to as Strand B in the Patagonia-Santa Rita Linkage Design (Beier *et al.* 2008) or the wildlife corridor determined by the USFWS to be the best biological corridor for wildlife connecting the Santa Rita and Patagonia Mountains.
4. Provide funding to contribute toward the conservation and management of unprotected/undeveloped lands for wildlife connectivity in the best biological corridor for wildlife connecting the Santa Rita and Whetstone Mountains.
5. Provide funding to contribute to researchers' efforts to evaluate and enhance existing and/or construct new wildlife crossings (e.g., wildlife overpasses or underpasses and associated fencing) along and across Highways 82 and 83. These crossings would improve connectivity between the Santa Rita and Patagonia Mountains and the Santa Rita and Whetstone Mountains, respectively. To be effective, at least four wildlife crossings should be located along Highways 82 and 83 based on studies of carnivore movement in the area.
6. Protect ocelot habitat and corridors in Sonora to provide for connectivity of the Arizona-Sonora Management Unit.
7. Provide funding to FWS for a full-time Fish and Wildlife Biologist for the life of the project to assist in study design, and to track the implementation of all conservation measures and adherence to all terms and conditions of this Final BO.

LESSER LONG-NOSED BAT

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 (FWS 1988). No critical habitat has been designated for this species. A recovery plan was completed in 1997 (FWS 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 (FWS 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 (FWS 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 (FWS 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 (FWS 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 (FWS 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, FWS 2007b; 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, AGFD 2009a). 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 (FWS 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 (AGFD 2009a). 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 (FWS 2005a). 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 buffelgrass 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, although 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 percent 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 (FWS 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 (FWS 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 (FWS 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 (FWS 2009). 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 (FWS 2007c). The 2005 BO for implementation of the Coronado National Forest Land and Resource Management Plan (FWS 2005b) 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 (FWS 2004). 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 (FWS 2003). 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) (FWS 2007a).

The lesser long-nosed bat recovery plan (FWS 1997), listing document (FWS 1988), and the 5-year review summary and evaluation for the lesser long-nosed bat (FWS 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.

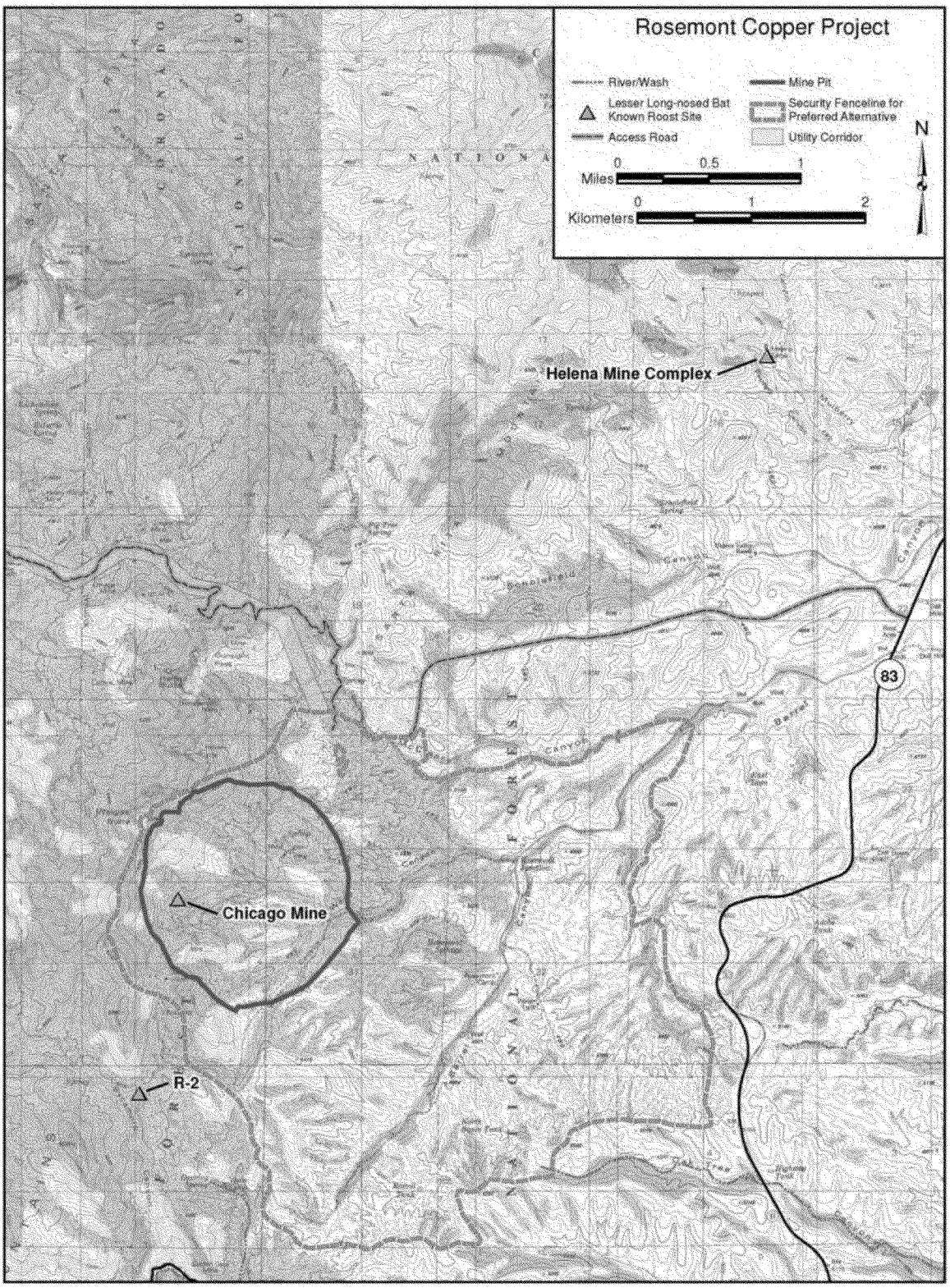


Figure LLB-1: Lesser Long-Nosed Bat roosts in the Action Area of the Rosemont Mine project

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.

In 2013, five features at the Helena Mine Complex were monitored through three emergence counts using video recordings. During the simultaneous surveys of regional lesser long-nosed bat roosts on August 21, 2013, approximately 7,800 lesser long-nosed bats were counted. A subsequent survey on September 4 found 5,700 lesser long-nosed bats, and a survey on September 13 found 2,700. No internal surveys were conducted on the Helena Mine Complex. During a nighttime visit to Adit R-2 on August 22, 2013, a "considerable amount" of lesser long-nosed bat activity was observed. When Adit R-2 was surveyed during the day, one roosting lesser long-nosed bat was observed, along with "extensive" nectivorous bat splatter. Because Chicago Mine's entrance construction does not allow for reliable night monitoring, it was only surveyed internally. Three lesser long-nosed bats were observed roosting, and a lot of fresh nectar bat splatter was observed.

Twenty-three new abandoned mine features were surveyed in 2013 within the 1-mile buffer. Two of the 23 new abandoned mine features contained nectivorous bat splatter (NS12 and NS14, both outside the perimeter fence but within the 1-mile buffer), but no bats were observed during surveys. Of the previously surveyed mines, seven contained some nectivorous bat splatter, but no bats were observed at these locations (30M and R-3 within the perimeter fences and R-5, R-5A, R-9, R-48, and DR-09 outside the perimeter fence but within the 1-mile buffer).

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. In the action area, efforts are ongoing 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

Effects to Roosts

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 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 noise and blasting, Rosemont will include a conservation measure as part of the proposed action that addresses 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. Studies show that 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 bats to predators, or attract additional human activity to the sites (Derusseau and Huntly 2012, King 2005, Currie 2001, Spanjer and Fenton 2005, Ludlow and Gore 2000). Rosemont has committed to coordinating these efforts with FWS and suitable entities 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, incidental 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 bats 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 percent 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 effect to lesser long-nosed bat from grazing on Palmer agave (FWS 2015, 2008, 2007d).

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 6.4 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 that in 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 2009b). 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.

Changes in Lesser Long-Nosed Bat Status Within the Action Area

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 effective 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 1997) 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 2007b) 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 and foraging areas, the protection of roosts elsewhere, the partial replacement of forage resources on-site, and the continued 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 percent 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. Because of the patchy and random distribution of agaves on the landscape, it is very difficult to estimate the total acres of available lesser long-nosed bat foraging habitat in southern Arizona. However, we can conclude that the acreage of lesser long-nosed bat foraging habitat affected by the proposed action is a very small proportion of the available foraging habitat. Nonetheless, the proposed loss of lesser long-nosed bat foraging habitat in the action area is locally significant. 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 noted 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 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 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). 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 - 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 locally-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 local forage and roost resources.

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

Take associated with roosts – 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 forced 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 more logical 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 the reasons described above, 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); this is a relatively small proportion of the total numbers of bats known from population surveys (see Status of the Species section, above).

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.

Indirect take associated with the loss of locally significant lesser long-nosed bat forage resources – 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 resources, 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 reduced 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 mining 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, and other environmental threats. As indicated in the Recovery Plan and the 5-Year Review, adequate forage appropriately distributed across the range of the lesser long-nosed bat is needed to achieve recovery of the population. The widespread failure of agave flowering in 2006 impacted the lesser long-nosed bat population through increased use of hummingbird feeders as a source of food and migration out of the area earlier that would occur under normal agave flowering conditions. If lack of forage on the landscape in southeast Arizona results in changes in lesser long-nosed bat migration patterns as was seen in 2006, this can affect whether forage resources are available to the bats along the migration route due to the need to time forage availability with occupancy of the landscape by lesser long-nosed bats. The ability of this species to migrate, breed, and over-winter is dependent on adequate forage available at the time the bats are present. If this does not happen, population level effects to the species could occur. Given a reduced baseline of available lesser long-nosed bat forage due to recent large, intense wildfires in the Chiricahua, Huachuca, and Atascosa mountains, additional forage losses due to the proposed action could limit available forage in the region and result in more widespread, population level impacts to this species resulting from the potential need to switch roosts, travel longer distances to forage, and possible changes to the timing of migration, which, if the timing of migration changes enough, may affect forage availability as the bats migrate south.

Therefore, we will use the number of acres of forage resources lost as a surrogate for take of individual lesser long-nosed bats. With regard to the amount of incidental take authorized under this BO, using

habitat as a surrogate for take of individual lesser long-nosed bats, the FWS authorizes take in the form of harm and harass due to the loss of significant forage resources for up to and including 5,431 acres (see the May 2015 Supplemental BA, USFS 2015) of lesser long-nosed bat foraging habitat (acres of habitat supporting Palmer's 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.

In summary, and stated differently, the maximum allowable incidental take of lesser long-nosed bats is: (1) harassment of 6,000 individuals at three post-maternity roosts; (2) harm of ten individuals at known lesser long-nosed bat roosts subject to the implementation of protective measures; and (3) loss of 5,401 acres of affected habitat containing Palmer's agave, a surrogate measure of take (via harm and harassment) of individuals. We estimate that approximately 80,000 lesser long-nosed bats occupy southern Arizona from April through October, using 40+ known roost sites. The number of bats using individual roosts fluctuates within and among years due to forage and weather conditions. The estimated level of take anticipated in this BO will not reduce the potential for recovery of this species because the numbers of bats and roosts affected by the proposed action is a small proportion of the bats and roosts statewide and represents post-maternity use that is naturally variable based on the lesser long-nosed bat's life history. The loss of 5,000+ acres of lesser long nosed bat foraging habitat, while locally important, will also not reduce the potential for recovery of this species rangewide because of the small fraction of available lesser long-nosed bat habitat that this represents.

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

The Rosemont Copper Company has included a number of measures and design elements within their proposed action that should, once completely implemented, reduce the proposed action's adverse effects to lesser long-nosed bats. The following Reasonable and Prudent Measures are necessary and appropriate to minimize the effects of take on lesser long-nosed bats:

1. The USFS (and Corps, as appropriate) shall ensure that Rosemont works with the USFS and FWS 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 over time, and these occurrences can be reasonably attributed to the proposed Rosemont Mine, the USFS (and Corps, as appropriate) shall ensure that Rosemont works with the USFS, Corps, and FWS to permanently protect an additional lesser long-nosed bat roost site (for a total of two sites, including the site protected in Reasonable and Prudent Measure 1, above) within the action area.

3. The USFS and Corps shall ensure that the Rosemont Copper Company Rosemont shall 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 (see the Description of the Proposed Action section in the October 30, 2013, Final BO) for lesser long-nosed bats, Rosemont shall 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. Rosemont shall 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, Rosemont shall 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. The USFS and Corps shall ensure that Rosemont implements 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 (in coordination with other appropriate wildlife agencies), and the USFS (for biological and technical input as well as to incorporate concerns with the agency's existing Abandoned Mine Lands program).
    b. Based on information gathered as outlined in the Conservation Measures for lesser long-nosed bats in the October 30, 2013, Final BO, if Rosemont or their agents observe during monitoring at either the R-2 or Helena lesser long-nosed bat roosts: (1) an up to 25 percent decline in the numbers of lesser long-nosed bats for 3 consecutive years; or (2) a greater than 25 percent decline in each of 2 years; or (3) a complete abandonment of the roost in 1 year, 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 and the FWS at the selected roost sites on National Forest System and/or Rosemont private lands shall include completion of any environmental compliance requirements and initiation of project

elements 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:

With input from the USFS, and FWS, in coordination with AGFD, and other bat experts, the USFS and Corps shall ensure that Rosemont implements 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 over existing levels, 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. Note that pre-installation monitoring must be conducted so that changes can be detected.
- the effectiveness of the protective measures in reducing disturbance and other impacts to lesser long-nosed bat roosts. Pre-installation assessment of the disturbance and other impacts must be conducted so that changes can be detected.

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. The USFS and Corps shall ensure that Rosemont reclaims the short road segment leading to the R-2 Adit roost site, including the use of agave planting (if the USFS, Rosemont, and FWS, in coordination with AGFD, determine site conditions would support the species) to reduce the likelihood of human intrusion at this roost site.

b. The USFS and Corps shall ensure that Rosemont investigates the feasibility of agave plantings at ecologically appropriate sites on proposed conservation lands, including Sonoita Creek Ranch, Davidson Canyon Watershed parcels, and Helvetia Ranch North parcels. Plant agaves at ecologically appropriate densities([as determined by Rosemont and FWS in coordination with AGFD) 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. The USFS and Corps shall ensure that Rosemont implements conservation measures related to known lesser long-nosed bat roost protection, to the proposed rerouting of the Arizona Trail, to 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 USFS and Corps shall ensure that Rosemont, or their agents, report to FWS as follows:

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, 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, 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 for which Rosemont has monitoring responsibility 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; (g) any other pertinent information related to monitoring and adaptive management under this project.

b. The USFS 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 USFS 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. Note that since the USFS Biological Monitor will be employed by the Coronado National Forest, this portion of the Term and Condition applies to the Forest Service.

Review requirement: The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effect of incidental take that might 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 and/or Corps 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 and Corps 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 and Corps participate in the development of a range-wide agave monitoring program with a standardized monitoring protocol.
3. We encourage the Coronado National Forest and Corps 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 Forest Service lands 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.

Pima Pineapple Cactus

Status of the Species - Pima Pineapple Cactus (*Coryphantha scheeri* var. *robustispina*)

The rangewide status of the Pima pineapple cactus remains substantively the same as it was described in our October 30, 2013, BO. The prior Status of the Species section is incorporated herein via reference with the following updates:

Abundance

As of the autumn of 2015, the Arizona Natural Heritage Program database of individual plant locations for this taxon consisted of 7,558 records, of which 1,837 were known to be dead. Most of the dead plants were reported as a result of a handful of development and mining projects over several years.

We are aware of four instances where repeat measures of individual Pima pineapple cactus have been conducted. First, on fourteen occasions between 1995 and 2010, 45 individual Pima pineapple cactus were followed in an exclosure on Coronado National Forest land in the Santa Cruz Valley. By the last check of these individuals in 2010, no living plants were found (Coronado National Forest 2010). It should be noted, however, that in a partial survey of this area in 2015, some Pima pineapple cactus were found both within and outside of this exclosure (FWS 2015b). Second, in 2003, a total of 260 individuals were located on six monitoring plots in the Altar Valley. These plants were evaluated on six additional occasions through 2012, when 93 of the original plants remained; new individuals were found in some years (Baker 2013). Third, on the Pima County Pima Pineapple Cactus Conservation Bank in 2006, 67 plants were located and mapped. These plants are monitored regularly and when last counted in 2014, 13 of the original plants remained alive and 11 new plants had been found (Pima County 2015). Fourth, on the Palo Alto Pima Pineapple Cactus Conservation Bank in 2001, 49 plants were located and mapped. These plants are monitored regularly and when last counted in 2015, 9 of the original individuals remained alive and 11 new plants were discovered (Westland 2015). In all of these studies, factors such as drought and predation by rodents and insects were the primary causes of death noted (Schmalzel and McGibbon 2010; Baker 2013; FWS 2015a).

Anthropogenic Effects

Urban and suburban development in the areas of Tucson, Green Valley, and Nogales, Arizona and mining in the Sierrita Mountains and Green Valley, threats first recognized in the 1980s (Phillips *et al.* 1981; Mills 1991; Reichenbacher 1985; FWS 2000), are responsible for complete and permanent modification of lands that previously supported Pima pineapple cactus and its pollinators. By 2000, we estimated that 43 percent of the total habitat surveyed to date had been modified or destroyed due to urbanization (FWS 2001). For example, 143 hectares (353 acres) of habitat and 47 individual plants were lost to a single housing development project in 1998 (FWS 1998). The trend continues; in 2014, 197 ha (487 ac) of suitable Pima pineapple cactus habitat and 99 individual plants were lost to a single infrastructure development project.

Since its listing in 1993, there have been 76 formal section 7 consultations under the Act involving Pima pineapple cactus in southern Arizona resulting in the direct mortality of more than one thousand individual Pima pineapple cactus , and 3,238 ha (8,000 acres) of suitable habitat, most of which were

related to construction activities. Consultations under the Act only occur for projects with a Federal nexus, either occurring on Federal lands or using Federal dollars or needing a Federal permit. Therefore, many projects that occur within the range of Pima pineapple cactus do not undergo section 7 consultations, and the FWS does not typically receive information regarding the status or loss of plants or habitat associated with those projects.

Predation

Predation by mammals and insects occurs on both adult and seedling Pima pineapple cactus (Phillips *et al.* 1981; Mills 1991; Roller 1996; Schmalzel & McGibbon 2010; Baker 2011; FWS 2015b).Primary insect predators of Pima pineapple cactus are the native cactus weevil (*Gerstaeckeria* sp.; Schmalzel 2002), the native cactus beetle (*Moneilema* sp.), and the native pyralid moth (*Cactobrosis* sp.; SWCA 1999). Harris' Antelope Squirrel (*Ammospermophilus harrisii*) , antelope jackrabbit (*Lepus alleni*), and desert cottontail (*Sylvilagus audubonii*) are known to eat stem material of Pima pineapple cactus, especially when other food sources are scarce, such as in times of drought (Phillips *et al.* 1981; Mills 1991; Schmalzel & McGibbon 2010; Baker 2011; FWS 2015a; FWS 2015b). Many individual Pima pineapple cactus die or become disposed to death annually from predation which has been recorded on numerous occasions over the past decade.

Fire and Non-native Plants

Occurring roughly every 10 to 20 years and following periods of adequate moisture, large-scale low-severity fire defined historical disturbance regimes of desert-grassland plant communities of southern Arizona and northern Mexico (McPherson and Weltzin 2000; Brooks and Pyke 2002; McDonald and McPherson 2011a). Desert-scrubland, where there is decreased annual precipitation compared to desert-grasslands, is typically characterized by low and discontinuous plant fuels, plants that lack fire-adapted characteristics, and fire return interval that may have historically been greater than 250 years (McLaughlin and Bowers 1982; Thomas 1991; Alford *et al.* 2005; Brooks and Pyke 2002; Brooks and Chambers 2011). Pima pineapple cacti occur in both the desert-grassland and desert-scrubland plant communities, especially in the ecotone of the two (Roller 1996, p. 9).

Non-native grasses in both communities compete with native plants for water and nutrients, reduce community composition and structure, and alter fire frequency and intensity. Response of cacti to alterations in fire frequency and intensity have been studied to some extent and some insight can be gleaned from studies of other cacti species. Most studies indicate that, in general, that cacti are not well adapted to fire (e.g. Humphrey and Everson 1951; Thomas 1991; Robinett 1996; Thomas 2006; Schmalzel 2000; McDonald and McPherson 2011b). It is largely believed that Pima pineapple cacti may escape fires in microsites with little fuel (Maender 1993; Roller and Halverson 1997; McDonald 2005; McDonald and McPherson 2006). Microsites become more scarce in non-native grass invaded landscapes (58 FR 49875; McPherson and Weltzin 2000; Brooks and Pyke 2002).

Drought and Climate Change

Southeastern Arizona and much of the American Southwest have experienced serious drought in recent decades (Bowers 2005; Overpeck *et al.* 2013; CLIMAS 2015a) and precipitation is projected to be less and temperatures higher in the future with climate change (Seager *et al.* 2007; Karl *et al.* 2009; Overpeck

et al. 2013). Plants already stressed from prolonged drought are more susceptible to insect attack and disease (Mattson and Haack 1987). Drought is also directly related to Pima pineapple cactus population health with regard to reproduction and establishment, as adequate precipitation during the seedling's first year of growth is essential for survival (Roller 1996). In addition, extreme temperatures can negatively impact seedling survival, and drought coupled with high temperatures lessens temperature tolerance in seedlings (Nobel 1984). These impacts will continue to affect the Pima pineapple cactus and its habitat throughout its range into the foreseeable future.

Genetics

Three varieties of *Coryphantha scheeri, robustispina*, *uncinata* and *scheeri*, have been investigated recently and were shown to be geographically isolated (Baker 2005), significantly different morphologically (Baker 2003), and significantly different genetically (Butterworth 2010; Baker and Butterworth 2013), warranting subspecific division.

Fehlberg and Nidey noted that cacti species, even rare species, may have higher levels of heterozygosity and outcrossing, in general, with Pima pineapple cactus being no exception (Fehlberg and Nidey 2015). Habitat fragmentation reduces the likelihood of successful pollination as Pima pineapple cactus become more and more isolated from one another and plant community diversity is reduced

Locally, loss of individual cacti reduces the genetic variability in the population through loss of these individuals and their contribution to random assortment. This decreases the potential to maintain and improve variability for adaptation to changing conditions. The implications of the loss of these individuals to the genetic neighborhood size and robustness of the portion of the population near the action area cannot be quantified, as the total number of individuals in the area was not included in surveys conducted, only the number of individuals that would be affected by project activities.

Environmental Baseline - Pima Pineapple Cactus

The Pima pineapple cactus' status in the action area remains substantively the same as that described in the October 30, 2013, BO. The prior Environmental Baseline is incorporated herein via reference, with the following addition based on data contained in the May 2015 SBA:

Recent Surveys

In 2012, WestLand conducted Pima pineapple cactus habitat evaluations on approximately 939 acres of land at Helvetia Ranch Annex North Parcels, 705 acres of which currently support Pima pineapple cactus or which contain soils and other habitat conditions suitable for the species (WestLand Resources Inc. 2012). WestLand surveyed approximately 117 acres (approximately 12 percent of the parcels, or 17 percent of the available habitat) for pineapple cactus. Crews walked parallel belt transects through suitable Pima pineapple cactus habitat. Fourteen Pima pineapple cactus were observed (13 live and 1 dead): 8 were west of the large wash that bisects the parcel, and 6 were west of Gunnery Range Wash. It is likely there are greater numbers of individual Pima pineapple cactus extant within the remaining unsurveyed suitable habitat on the Helvetia Ranch Annex North Parcels.

Recovery Planning – Pima Pineapple Cactus

We have prepared a Draft Recovery Plan for the Pima pineapple cactus (FWS 2016); it is currently under internal staff review and has not been subject to public comment and/or peer review. It must be noted that the draft criteria are subject to refinement during the internal FWS review process, and additional revisions are possible following the eventual public participation and peer review processes. The Draft Recovery Plan identifies the criteria that must be met before we can downlist or delist the taxon; delisting equates with recovery.

Downlisting of Pima pineapple cactus to threatened status may be considered when all of the following conditions have been met to address the threats and stressors to the species:

1. Threat-based objective: Reduce or mitigate habitat loss and degradation, non-native species spread and the resultant altered fire regimes and increased competition, and other stressors, to enhance the continued survival of Pima pineapple cactus and its pollinators.

   Criterion: The successful accomplishment of threat and stressor reduction and mitigation is demonstrated by an increased number of acres of optimal or good Pima pineapple cactus habitat. Habitat is considered optimal when: it is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of Pima pineapple cactus; it has less than 20 percent cover of non-native plant species; it contains contiguous habitat and corridors for pollinators; and where Pima pineapple cactus numbers are observed to be stable or increasing. Habitat is considered good when the cover of non-native plants is between 20 and 35 percent and the land is managed in such a way that promotes the continued existence or expansion of the Pima pineapple cactus population.

   Justification: Accomplishment of this criterion depends on successful promotion of habitat conservation (e.g. land preservation, conservation banking, and strategic habitat restoration) and land management planning to reduce threats and stressors to Pima pineapple cactus (e.g. non-native species management and restoration, land use planning, and soil compaction and erosion prevention) on all lands where Pima pineapple cactus occur.

2. Habitat-based objective: Conserve, restore, and properly manage the quantity and quality of habitat needed for the continued survival of Pima pineapple cactus and its pollinators.

   Criterion: At least 8,094 ha (20,000 acres) of Pima pineapple cactus habitat per recovery unit are documented to be in optimal condition. At least 24,281 ha (60,000 acres) of Pima pineapple cactus habitat per recovery unit are documented to be in good condition. Collectively, this represents approximately 43 percent of the known range of Pima pineapple cactus. Additional acres of lesser quality Pima pineapple cactus also exist throughout the range of the species; some of which occurs on lands where ongoing efforts may continue to improve habitat quality. While no analysis exists which can help us estimate the total acres of habitat needed to support a viable Pima pineapple cactus population, it is our conclusion that achieving the above targets of optimal and good habitat could significantly improve the conservation trajectory and status of this taxon to the point of downlisting under the Act.

   Justification: *Coryphantha scheeri* var. *robustispina* plants that occur in optimal or good condition

habitats, as defined above, should have the greatest resilience to non-native plant invasion and associated high severity fire, as well as, climatic extremes and other threats or stressors that are currently unknown. We expect that these habitats will have healthy pollinator populations that enable gene flow within and between Pima pineapple cactus individuals, thus maintaining their long-term genetic diversity.

3. Population-based objective: Conserve, protect, and restore existing and newly discovered Pima pineapple cactus individuals and their associated seedbanks needed for the continued survival of the taxon. The population must be self-sustaining, of sufficient number to endure climatic variation, stochastic events, and catastrophic losses, and must represent the full range of the species' geographic and genetic variability.

   Criterion: Protect mature Pima pineapple cactus individuals and their seedbanks in each recovery unit. Quantitative monitoring of established plots across a variety of land ownerships and with landowner support is conducted within each of the two recovery units every 3 to 5 years with plots demonstrating that the population is increasing a minimum of 10 years over a 15 year period.

   Justification: A mature individual is one that is capable of flowering and producing viable seed. Only mature individuals are considered in meeting this criterion, since large numbers of Pima pineapple cactus seeds may germinate following sporadic rainfall but not live long enough to reproduce. The number of monitoring plots and transects and their locations will be determined within a monitoring plan to be written within five years of the finalization of this document. The 15-year length of this time frame reflects the minimum period required to judge whether a population is stable, declining, or increasing. Due to the wide variation in the region's annual rainfall and the frequencies of severe droughts and freezes, populations will naturally fluctuate. The numbers of individuals during a single year or short span of years may provide a skewed representation of a population's longer-term trend.

<u>To delist Pima pineapple cactus</u>, the first two criteria for downlisting must be met or surpassed, and monitoring demonstrates the population is increasing for a minimum of 20 years over a 30-year period.

The following are the Internal Draft Recovery Plan's list of actions needed to recover Pima pineapple cactus:

1. Reduce the effects of human population growth and development by protecting Pima pineapple cactus habitat, seedbanks, and pollinator corridors.
2. Increase Pima pineapple cactus habitat quality by reducing non-native plant competition, improving native plant diversity and structure, and restoring ecosystem function and natural fire regimes.
3. Conduct research and monitoring that will facilitate better understanding of the taxon's: a) population dynamics and trends, b) life history, c) response to threats, stressors, and land management activities, d) distribution and genetics, and e) other relationships key to its recovery.
4. Develop effective propagation, transplant, and *in situ* planting strategies to promote the introduction and augmentation of Pima pineapple cactus throughout the range of the taxon.

5. Assure the long-term success of Pima pineapple cactus through collaborative partnerships, community involvement, application of regulations, and public education and outreach.
6. Practice adaptive management in which recovery is monitored and recovery tasks are revised by the FWS in coordination with a recovery implementation team as new information becomes available.

Again, we note that the draft recovery actions appearing above are subject to refinement during the internal FWS review process. Additional revisions are possible following the eventual public participation and peer review processes.

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 will result in direct effects to Pima pineapple cactus owing to the placement of electrical and water transmission lines and associated access roads. This permanent disturbance will remove portions of the seed bank, and areas of associated temporary disturbance could alter the taxon's seed bank. Disturbance of soils will 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. The FEIS confirms an increase in fugitive dust despite minimization measures.

The 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. We hypothesize that fugitive dust may also impact arthropod pollinators of Pima pineapple cactus via occlusion of respiratory spiracles.

The utility corridor component of the proposed action will result in the direct removal of 67 Pima pineapple cactus and permanent or temporary effects to approximately 33.2 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 67 individuals and effects to 33.2 acres of Pima pineapple cactus habitat to the known baselines. This represents a loss of approximately 3.3 percent of the known individuals and 0.2 percent of the surveyed area we have reviewed through section 7 consultations (including this one). 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. To put this into context, the Arizona Natural Heritage Program reports fewer than 6,000 extant individual Pima pineapple cacti throughout the range of the taxon.

To minimize the direct impacts to Pima pineapple cactus and its habitat in the utility corridor, Rosemont proposes to record a restrictive covenant on the Helvetia Ranch Annex North parcels, which contain approximately 939 acres of land that support approximately 705 acres of habitat for Pima pineapple cactus. These parcels were purchased from a developer and were being marketed for residential development. At least 13 individual Pima pineapple cactus were found during a survey of 117 acres of habitat (12 percent of the parcel, or 17 percent of the 705 acres of available habitat). It is likely additional individuals are present in the as-yet unsurveyed habitat. We cannot make estimates of the number or density of plants which may be present on the unsurveyed area because Pima pineapple cactus is not uniformly distributed within its suitable habitat.

To further minimize the indirect effects to Pima pineapple cactus and its habitat from invasive plant species that are likely to colonize disturbed areas within and around the mine site, Rosemont has developed an *Invasive Species Management Plan.* This plan, incorporated herein by reference, is distinct from and in addition to the more-recent Harmful Nonnative Species Management and Removal program, and 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 where they can compete with Pima pineapple cactus and/or increase fire frequencies in the cactus' habitat. We note that no comparable invasive species monitoring is proposed for the Helvetia Ranch Annex North parcels.

In summary, the proposed action will result in the direct loss of 67 Pima pineapple cactus and effects to 33.2 acres of Pima pineapple cactus habitat. The proposed action will also result in the protection of at least 13 individual Pima pineapple cactus and 705 acres of habitat for the taxon. Efforts will be undertaken to reduce the potential for invasive plants to colonize the mine site and spread to habitat occupied by Pima pineapple cactus.

Effects to Recovery – Pima Pineapple Cactus

The internal review version of the Draft Recovery Plan for the Pima pineapple cactus (FWS 2016) identifies the criteria that must be met before we can downlist or delists the taxon; delisting equates with recovery (see above). The proposed action is situated in the draft Santa Cruz Valley Recovery Unit.

The proposed action will adversely affect 33.2 acres of habitat occupied by 67 Pima pineapple cactus in the utility corridor, thus failing to implement draft recovery action 1 (reduction of the effects of human development by protecting habitat, seedbanks, and pollinator corridors). This, in turn, adversely affects the implementation of draft downlisting criterion 1 (threat and stressor reduction and mitigation via an increase increased number of acres of optimal or good Pima pineapple cactus habitat), draft downlisting criterion 2 (at least 20,000 acres of Pima pineapple cactus habitat per recovery unit in optimal condition

and at least 60,000 acres per recovery in good condition), and draft downlisting criterion 3 (protection of mature Pima pineapple cactus individuals and their seedbanks in each recovery unit). We do not have the data to indicate if the adversely-affected acreage is in optimal and/or good condition, but it supports 67 Pima pineapple cactus). Given that there is a reduced potential to achieving downlisting criteria 1, 2, or 3 in the adversely affected portion of the action area, the proposed action does not contribute to the potential to achieve the sole delisting (recovery) criterion (meeting or surpassing the first two downlisting criteria, and demonstrating, by monitoring, that the Pima pineapple cactus population is increasing for a minimum of 20 years over a 30 year period).

The proposed action will beneficially affect, via permanent conservation, at least 13 Pima pineapple cactus within 705 acres in the 939-acre Helvetia Ranch Annex North parcels, thus implementing draft recovery action 1 (reduction of the effects of human development by protecting habitat, seedbanks, and pollinator corridors). This, in turn beneficially affects the implementation of draft downlisting criterion 1 (threat and stressor reduction and mitigation via an increase increased number of acres of optimal or good Pima pineapple cactus habitat), draft downlisting criterion 2 (at least 20,000 acres of Pima pineapple cactus habitat per recovery unit in optimal condition and at least 60,000 acres per recovery in good condition), and draft downlisting criterion 3 (protection of mature Pima pineapple cactus individuals and their seedbanks in each recovery unit). Again, we do not have the data to indicate if this beneficially-affected conservation property acreage is in optimal and/or good condition, but a survey of 117 acres of the property found 13 individual Pima pineapple cactus; additional individuals are likely present. Monitoring for nonnative plants is not proposed for this site, but we note that the removal of unnecessary roads will involve revegetation with a native-species seed mix (see Description of the Proposed Action section, above). Overall, this aspect of the proposed action represents a positive contribution to achieving downlisting criteria 1, 2, or 3 and thus, the proposed action contributes to the potential to achieve the sole delisting (recovery) criterion.

The proposed *Invasive Species Management Plan* implements draft recovery action implements draft recovery action 2 (increase Pima pineapple cactus habitat quality by reducing non-native plant competition). This contributes to achievement of draft downlisting criterion 1 (threat and stressor reduction and mitigation via an increase increased number of acres of optimal or good Pima pineapple cactus habitat) in that it will minimize the potential for invasive plants to become established at the mine site and be spread to sites containing Pima pineapple cactus. This aspect of the proposed action represents a positive contribution to achieving downlisting criteria1or 2 and thus, the proposed action contributes to the potential to achieve the sole delisting (recovery) criterion.

The FEIS (Volume 2, pages 222-226) discloses that, despite mitigating measures, particulate emissions (which include fugitive dust) will increase. This manner of effect was not specifically considered within the recovery actions and criteria, but it most closely represents a failure to implement draft recovery action 1 (reduction of the effects of human development by protecting habitat, seedbanks, and pollinator corridors). This, in turn, adversely affects the implementation of draft downlisting criterion 1 (threat and stressor reduction and mitigation via an increase increased number of acres of optimal or good Pima pineapple cactus habitat), draft downlisting criterion 2 (at least 20,000 acres of Pima pineapple cactus habitat per recovery unit in optimal condition and at least 60,000 acres per recovery in good condition.), and draft downlisting criterion 3 (protection of mature Pima pineapple cactus individuals and their seedbanks in each recovery unit). This aspect of the proposed action represents a negative contribution to achieving downlisting criteria 1 and 2 thus reducing the potential to achieve the sole delisting (recovery)

criterion.

It is difficult to assess the net effect of the proposed action in terms of recovery. On an acreage basis, the adverse effect to 33.2 acres of Pima pineapple cactus in the utility corridor would appear to be more than minimized by the permanent protection of 705 acres of suitable habitat on Helvetia Ranch Annex North. We note, however, that the conservation property is already Pima pineapple habitat and supports individuals. Habitat is not being created, though it is being protected from potential future development. In terms of effects to individual Pima pineapple cactus, however, 67 cacti will be adversely affected in the corridor while 13 plants are known to occur within 117 acres of surveyed habitat on Helvetia Ranch Annex North. It is likely that additional Pima pineapple cacti exist in the 623 acres of unsurveyed area within the 705 acres of Pima pineapple cactus habitat on the parcel, but we cannot estimate their abundance. Further, no matter how many individual Pima pineapple cacti exist on the site, they are extant. No additional individuals are being established, but the cacti present are being protected from potential future development. The beneficial effects of the *Invasive Species Management Plan* are prospective, but they do minimize the potential for the newly-disturbed portions of the Rosemont Mine site to further facilitate nonnative plant invasions.

Recovery Tipping Point

The tipping point at which recovery of Pima pineapple cactus would be precluded requires that we determine the likelihood that the proposed action's effects to Pima pineapple cactus will appreciably impede or preclude the achievement of the draft down- and de-listing criteria; and if so, are the impediments and/or preclusions of such a scale and/or magnitude that the taxon can no longer be recovered? A tipping point and recovery analysis need not be conducted for critical habitat, as none has been designated for Pima pineapple cactus.

Again, the proposed action will result in a net negative effect to individual Pima pineapple cactus (67 adversely affected, 13 conserved) and a net positive effect to Pima pineapple cactus habitat (33.2 acres adversely affected, 705 acres conserved). The proposed action will minimize the spread of nonnative plants, but will increase particulate pollution.

The stated Recovery Strategy in the Draft Recovery Plan is to preserve and restore quality Pima pineapple cactus habitat to protect individuals and their seedbanks within two recovery units (the Altar and Santa Cruz valleys) which represent the range of the taxon. The preservation and restoration of habitat within these two recovery units will allow a stable, self-sustaining population to persist with some level of connectivity between individuals. Conservation of both individual Pima pineapple cactus and the taxon's habitat are emphases for recovery, but habitat is given greater weight in the draft downlisting criteria (1 and 2) while populations (groupings of individual plants) are a component of draft downlisting criterion 3. We therefore consider the net effects to Pima pineapple cactus habitat to have somewhat greater analytical importance than the net number of individuals lost.

Pima pineapple cactus habitat is found across approximately 368,702 acres of land within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including acreage of some lands that connect the two valleys. The proposed action will adversely affect 33.2 acres (minimized by the preservation of 705 acres) of existing Pima pineapple cactus habitat; this is an immeasurably small fraction of the 368,702 acres rangewide, regardless of the aforementioned effects to the species recovery

potential. Effects of this *de minimis* magnitude are incapable of tipping Pima pineapple cactus towards jeopardy.

With respect to the rangewide abundance of Pima pineapple cactus, the Arizona Natural Heritage Program database of locations for this taxon consisted of 5,721 records (7,558 total records, less 1,837 that were known to be dead) (Tonn pers. comm. November 4, 2015). The loss of 67 existing individual Pima pineapple cactus (partially minimized by the conservation of at least 13 existing individuals) is small relative to the taxon's overall abundance. Again, we anticipate that the proposed action's effects to habitat are incapable of tipping the Pima pineapple cactus towards jeopardy.

Cumulative Effects - Pima Pineapple Cactus

The effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area remains the same as described in our October 30, 2013, BO. The Cumulative Effects section for the Pima pineapple cactus from the prior consultation is therefore incorporated via reference.

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 67 Pima pineapple cactus and effects to 33.2 acres of Pima pineapple cactus habitat represents less than 0.8 percent of the 7,558 Pima pineapple cactus individuals for which HDMS data exist (Tonn, pers. comm.). 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 67 Pima pineapple cactus and 33.2 acres represent. However, based on the sites we have evaluated in prior consultations 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.
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 939 acres within the Helvetia Ranch Annex North parcels by recording a restrictive covenant on the property. The 939-acre parcel contains approximately 705 acres of suitable Pima pineapple cactus habitat; at least 13 individuals were found within 117 acres of the within the 705 acres of suitable habitat. This action 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.
4. The small magnitude of the effects described under Conclusion number 1, above, is not capable of delaying or precluding recovery of the species. Moreover, the conservation measures described under Conclusion statement number 3, above, may further minimize the adverse effects.

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. The FWS recommends that the USFS 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. The FWS recommends that USFS 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. The FWS recommends the USFS 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.) 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. The term of this monitoring would be 6 years post-closure (to allow for two post-closure surveys). Annual reports on the status of the conservation lands should be submitted to the FWS.

   (b.) Adequate funding should be provided to implement the management plan and required monitoring.

4. The FWS recommends the USFS work with our agency and Rosemont to seedbank and experimentally transplant to appropriate locations (i.e., with no future development potential, including areas with non-severed mineral rights) any of the 67 individual Pima pineapple cactus present within the utility corridor that will be otherwise directly affected by construction and operation of the corridor. We recommend the USFS work with Rosemont to secure seed of the plants in the project area and vicinity on FS lands in a secure seed-bank (preferably the USDA-National Center for Genetic Resources Preservation) for long-term storage and future use. At a minimum, seed for the plants expected to be removed or lost due to the project should be collected prior to their removal. We further recommend that monitoring be performed to test/determine if survivorship is better in an approach using immediate transplant to a new location, or by first transferring the removed plants to an off-site cultivation facility (botanical garden partner, etc.) until they have recovered and formed new root tissue, and then transplanting them to the wild later.

In order that we are 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.

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 and conference 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.

Please note that this consultation has been conducted based on complete implementation of the proposed action, including the proposed conservation measures. Should the conservation measures not be implemented, implemented incompletely, or altered – and those changes result in differing effects to threatened or endangered species and/or critical habitat – reinitiation of formal consultation must be requested. We make specific note of the Incidental Take Statements for the Gila chub, Gila topminnow, desert pupfish, northern Mexican gartersnake, Chiricahua leopard frog, yellow-billed cuckoo, and southwestern willow flycatcher. For these species, the authorized incidental take (or the surrogate measure of that incidental take) is the result of the total incidental take anticipated to result from the proposed action's adverse effects less the minimized level of take resulting from implementation of the Conservation Measures. In these cases where funding has been provided in lieu of a specific project or projects, a failure to complete the amount of restoration or enhancement that we have anticipated from the funding will result in less of the adverse effects' incidental take being minimized. This would necessitate an immediate analysis of the need to reinitiate formal consultation. The Huachuca water umbel is a plant and thus lacks an incidental take statement. Nevertheless, the species' effects analysis includes the beneficial effects of Conservation Measures; the adverse effects of the proposed action would be less effectively minimized if the Conservation Measures are not implemented or are implemented to a lesser extent than anticipated. This may constitute new information with respect to the proposed action's effects to Huachuca water umbel that was not considered in this opinion; thus also necessitating an immediate analysis of the need to reinitiate formal consultation.

The Incidental Take Statements for the lesser long-nosed bat, jaguar, ocelot, Chiricahua leopard frog, northern Mexican gartersnake, Gila chub, Gila topminnow, and desert pupfish contain Reasonable and Prudent Measures and Terms and Conditions that implement those measures. We reiterate that such

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t h b e i o l o g i c o a i t h p r e r o a j e n d c f t u r s t e h c e 7 r c i c o m s u w l t h a e t e i c o e n s s a r y .

I k e e p w i i r d g h t r r u e s s p o n t s A i m b e i r l l i n t a l y T m r a i n f b c e a r a c t p i r o c n p l o y s a n d g e n c y
n o i t t h D e e p a r c t f m r e t h e s r u i b o f , r e , e c 7 c i c o m s u l t h m a a t a y i f o f r l e n c d t l i a a m t d r s i , b a l
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I y f o h u a v q e u e s d c i c o m s a e b r o t u s t i c i s n s u d t t a c t o i n c s n u p t a d i g e s a e f r e a f e h l e e
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S i n c e r e l y ,

S t e l v S p a n g l e
F i e S l u p e r v i s o r

c c (h a c r o p y) :
F i e S l u p e r U v . i B s i o a r n h V d i l d S l e i r f v E i h c o e e A n r i i x z (o c n 2 c a p) i e s
J e G a l h A o s u s n i , F s i t e S l u p e r U v . i B s i o a r n h V d i l d S l e i r f v E i u c c e s A o Z n ,
M a r j B o l r a i S e e e P i r o c r V l a n c a l g e S r , m C y o r o p l E s n g i n T e u e c r s A o Z n ,

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C h i H e a f b , B t a t A c r h i , z G o a m m a e n F d i D e h a p a r P r m e e A t o Z i x ,
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Appendix A: Concurrence for the Mexican Spotted Owl

Species Information

A complete description of the biology of the Mexican spotted owl appears in our September 2012 *Mexican Spotted Owl Recovery Plan, First Revision* (FWS 2012). The rangewide status of the species, including critical habitat, appears in our June 5, 2015, *Biological Opinion on the Flagstaff Watershed Protection Plan* (File number 02EAAZ00-2013-F-0190). This information is incorporated herein via reference.

After the publication of the October 2012 BA and February 2013 SBA, a Mexican spotted owl or owls was/were documented in (or very near) the action area two times with images collected from University of Arizona wildlife cameras; however, due to the sensitive nature of this information, exact locations of wildlife cameras were not provided. Approximate occurrence locations within the action area are indicated in 2013 SBA Figure 8 and described below.

An individual owl was detected with wildlife cameras north of Box Canyon within the action area, approximately 1 mile west of the project area (Douglas 2015) in November 2014 (see the northernmost detection site in Figure MSO-1, below); another owl was documented in Cave Creek Canyon just north of Gardner Canyon (SWCA2015), also in November 2014 (see the southernmost site in Figure MSO-1). However, it is not known whether the second owl observation is within the action area or just outside it to the south, as the exact location of the wildlife camera is not known.

While no protocol-level surveys for Mexican spotted owls have been conducted in the action area, the species has been detected there. It is unlikely the owl(s) observed with wildlife cameras were breeding, given the late dates of the detections (November).

Background for Determination of Effects

The action area for this analysis is based on a combination of: (1) the area of the mine footprint (the project area, as described in the Description of the Proposed Action, above); (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 Coronado National Forest compiled all known Mexican spotted owl locations from the Santa Rita Mountains, and there were no records of owls within the action area prior to November 2014. There are three Mexican spotted owl protected activity centers (PACs) adjacent to (but not within) the action area (see Table MSO-1 and Figure MSO-1, below): (1) The Ramanote PAC; (2) the Sawmill PAC; and (3) the Florida Spring PAC. Please see Page VII in FWS 2012 for a description of the constituents of a PAC.

The closest occupied area is the Ramanote Canyon PAC, which is located approximately 0.7 mile to the west-southwest of the action area and 4.8 miles from the mine footprint. The Cave Creek-area detection occurred closer to the PACs and further from the mine footprint; the Box Canyon-area detection was more remote but closer to the mine footprint.

The mine footprint within the core of the greater action area contains areas with low topographic relief featuring semidesert grasslands and Madrean Encinal Woodlands (interchangeable with the term Madrean evergreen woodlands used elsewhere in this BO). Mexican spotted owls are known to occur in Madrean encinal woodlands, primarily within canyons (FWS 2012). Given that the two detections of Mexican spotted owls occurred outside of the March 1 through August 31 breeding season (FWS 2012), it is likely these were dispersing and/or foraging birds. It is unlikely that they were breeding, given the timing. Breeding activity is similarly unlikely within the mine site due to the absence of deeper canyons there.

One of the indirect effects that define the action area is the noise associated with the proposed action. The action area's sound-based limits were defined in the June 2012 BA, by 50 A-weighted decibel (dBA) surface blasting and 55 dBA traffic noise contours, an area that is approximately 54,336 acres (Tetra Tech 2008, 2009). We note that it has been determined that weighting systems developed for humans (i.e., dBA) are not necessarily appropriate for wildlife species; however, 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).

The Recovery Plan (FWS 2012) recommends breeding-season restrictions if an activity generates noise greater than 69 dBA at a nest site; elicitation of a flush response during breeding may have direct consequences in terms of reduced breeding success. The action area is, by definition, delimited by the 55 dBA contour; therefore it is unlikely that noise will be sufficient to affect Mexican spotted owls at their nest sites within the PACs. The larger action area also includes approximately 430 acres of critical habitat unit BR-W-12. The critical habitat is also within the area affected only by the 55 dBA contour. Again, this is below the disturbance threshold for breeding owls. The critical habitat is therefore also unaffected.

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 do contain Madrean encinal woodlands, but lack the canyons in which nesting and roosting typically occurs (FWS 2012). The owl or owls detected within or near the action area were unlikely to have been breeding there given the late date of the detections.
- 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. The project will not result in noise disturbance to Mexican spotted owls in those PACs during the breeding season (March 1 through August 31) or at any other time.
- The effects described in the paragraphs above and summarized in this section are insignificant and discountable and will not reduce the potential to achieve recovery of the Mexican spotted owl.
- There are 430 acres of Mexican spotted owl critical habitat in the action area; but like the Ramanote PAC, it will only be affected by noise at a level unlikely to disturb breeding owls. The proposed action will therefore result in no diminishment of the critical habitat's ability to contribute to the recovery of the Mexican spotted owl.

Conservation Recommendations- Mexican Spotted Owl

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:

- We recommend that the USFS conduct (or ensure that Rosemont conducts) Mexican spotted owl surveys within and near the action area prior to mining, with a special emphasis on Box Canyon. Two incidental detections of Mexican spotted owls with trail cameras intended to photograph terrestrial mammals indicate that owls may more frequently disperse through or forage within the action area than is presently known.

- We recommend that the USFS monitor the Ramanote Canyon, Sawmill Canyon, and Florida Spring PACs prior to mining activity to determine baseline conditions, then at regular intervals following initiation of mining activities.

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.

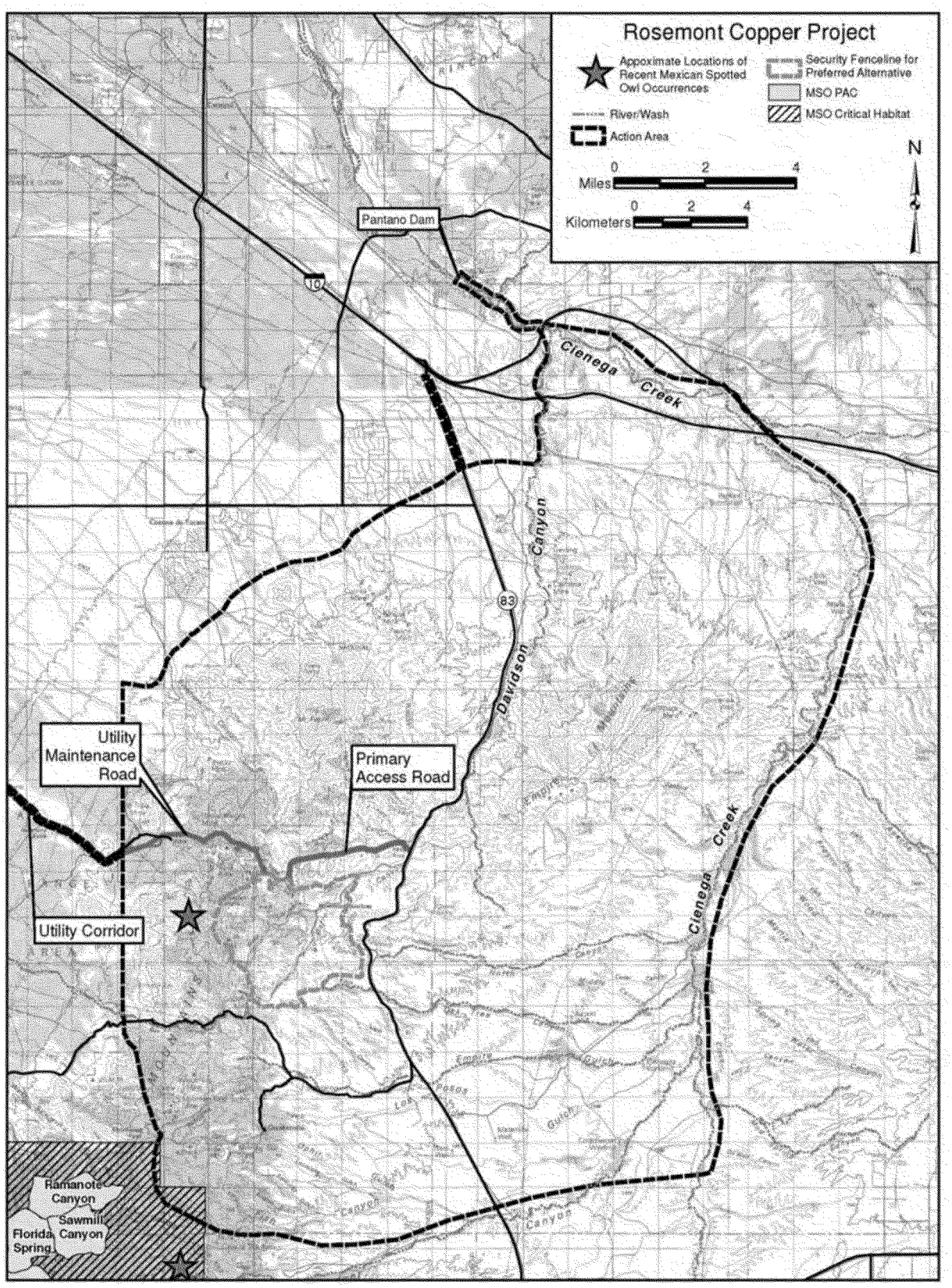

Figure MSO-1, adapted from Figure 8 in the May 2015 SBA

Literature Cited – Introduction and Description of the Proposed Action

Beier, P., E. Garding, and D. Majka. 2008. Arizona Missing Linkages: Patagonia – Santa Rita Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University.

Halterman, M., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2015. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: U.S. Fish and Wildlife Techniques and Methods, Draft. 45 p.

Kondolf, M. and J. Ashby. 2015. Technical Memorandum: Conceptual Design for Sonoita Creek, AZ, Technical Review Support (Order Number EP-G149-00241). PG Environmental, LLC. July 27, 2015. 23 pp.

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.

Rosemont 2016a. Correspondence from Rosemont Minerals/Rosemont Copper Company regarding Clarification of Conservation Measures. February 24, 2016. 2 pp. w/attachment.

Rosemont 2016b. Correspondence from Rosemont Minerals/Rosemont Copper Company regarding further Clarification of Conservation Measures. March 18, 2016. 2 pp.

Sogge, M.K., D. Ahlers, and S.J. Sferra. 2010. A natural history summary and survey protocol for the Southwestern Willow Flycatcher: U.S. Geological Survey Techniques and Methods 2A-10, 38 p.

U.S. Fish and Wildlife Service (FWS). 2001. Southwestern Willow Flycatcher Recovery Plan, Region 2, Albuquerque, NM.

U.S. Fish and Wildlife Service (FWS). 2002. Final Environmental Impact Statement for the Roosevelt Habitat Conservation Plan. Arizona Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Phoenix, AZ. 269 pp.

U.S. Fish and Wildlife Service (FWS). 2011. Southwestern Willow Flycatcher Critical Habitat Revision: Proposed Rule. Federal Register 76 (2): 50542

U.S. Fish and Wildlife Service (FWS). 2013. Southwestern Willow Flycatcher Critical Habitat Revision: Final Rule. Federal Register 78 (2):344.

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. Forest Service (USFS). 2012, 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). 2015. Third Supplement to the Biological Assessment for the Rosemont Copper Project. Prepared for U.S. Department of Agriculture Forest Service, Coronado National Forest for Submittal to U.S. Department of the Interior, Fish and Wildlife Service. Prepared by SWCA Environmental Consultants. May 2015. 93 pp. plus appendices.

Literature Cited – Effects to Aquatic Ecosystems

Garrett, C.N. 2016. Electronic mail communication between C. N. Garrett of SWCA, Inc. and J.M. Douglas of the U.S. Fish and Wildlife Service regarding definition of low flows in key reaches. 3 pp.

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.

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.

Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on Hydrology and Threatened and Endangered Species of the Cienega Creek Natural Preserve Tucson, Arizona: Pima County Office of Sustainability and Conservation, Pima County Regional Flood Control District. July 14.

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 FWS 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.

U.S. Forest Service (USFS). 2016. Attachment to an electronic mail message from Chris Garrett of SWCA entitled Additional uncertainty language for draft BO from USFS. 4 pp.

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. 2012b. Chapter 10 - Environmental Analysis. In FSH 1909.15 – National Environmental Policy Act Handbook. Amendment No.: 1909.15-2012-3. Washington, D.C.: U.S. Forest Service National Headquarters.

U.S. Geological Survey (USGS). 2012a. Review of Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on Hydrology and Threatened and Endangered Species of the Cienega Creek Natural Preserve Tucson, Arizona. 2 pp.

U.S. Geological Survey (USGS). 2012b. Review of WestLand Resources, Inc. 2012. Potential Effects of the Rosemont Project on Lower Cienega Creek. 2 pp.

WestLand Resources, Inc. (WestLand). 2012. Potential Effects of the Rosemont Project on Lower Cienega Creek. Prepared for the Rosemont Copper Company, Project No. 1049.21. November 14, 2012. 11pp. with figures.

Literature Cited – 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.

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: Bureau of Land Management, Tucson Field Office. January.

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.

Bureau of Land Management. 2007. Riparian Tree Monitoring: Las Cienegas NCA Woody Belt Transects: 1993-2006. Tucson, Arizona: Bureau of Land Management.

Fenner, P., W.W. Brady, and D.R. Patton. 1984. Observations on seeds and seedlings of Fremont cottonwood: Desert Plants 6:55-58.

Friggens, M.M., D.M. Finch, K.E. Bagne, S.J. Coe, and D.L. Hawksworth. 2013. Vulnerability of species to climate change in the Southwest: terrestrial species of the Middle Rio Grande. Gen. Tech. Rep. RMRS-GTR-306. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 191 p.

Hammond, J.D. 2011. It was built…did they come? Habitat characteristics of yellow-billed cuckoo in restored riparian forests along the Sacramento River, Calif. Masters Thesis, California State Univ., Chico, Chico, CA. 60 pp.

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.

Krueper, D. J., J. L. Bart, and T. D. Rich. 2003. Response of breeding birds to the removal of cattle on the San Pedro River, Arizona. Conservation Biology 17(2): 607-615.

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.

Parametrix. 2008. Restoration analysis and recommendations for the San Acacia reach of the Middle Rio Grande, NM. Albuquerque, NM.

Pima Association of Governments. 2014. Cienega Creek: After 3 Consecutive Years of Record Breaking Drought Conditions. Tucson, Arizona: Pima Association of Governments.

Powell, B. 2013. Water Resource Trends in the Cienega Creek Natural Preserve, Pima County, Arizona. An unpublished report to the Pima County Flood Control District. Tucson, Arizona: Pima County Office of Sustainability and Conservation. August.

Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on Hydrology and Threatened and Endangered Species of the Cienega Creek Natural Preserve Tucson, Arizona: Pima County Office of Sustainability and Conservation, Pima County Regional Flood Control District. July 14.

Price, J., H. Galbraith, M. Dixon, J. Stromberg, T. Root, D. MacMykowski, and T. Maddock. 2005. Potential Impacts of Climate Change on Ecological Resources and Biodiversity in the San Pedro Riparian National Conservation Area, Arizona. A report to U.S. EPA from the American Bird Conservancy. November. 543 pp.

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.

Simms, J. 2014. The Instream Flow Incremental Methodology. Tucson, Arizona: Bureau of Land Management. September.

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 FWS Section 7 consultation process. November 12, 2012. 65 pp.

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.

U.S. Forest Service (USFS). 2012, 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.

Wallace, C.S.A., M.L. Villarreal, and C.van Riper III. 2013. Influence of monsoon-related riparian phenology on yellow-billed cuckoo habitat selection in Arizona. Journal of Biogeography 40: 2094–2107.

WestLand Resources, Inc. (WestLand). 2015. NDVI Comparison for Select Riparian Areas in Empire Gulch and Cienega Creek. Project No. 1049.14. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources Inc. January 30.

Literature Cited – Gila Chub

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.

BLM. 2012. Programmatic aquatic special status species reintroductions at Las Cienegas National Conservation Area. EA#: DOI-BLM-AZ-G020-2011-0028. Tucson Field Office, Las Cienegas National Conservation Area.

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.

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.

Burns, D. C. 1991. Cumulative effect of small modifications to habitat. Fisheries 16:12–17.

Caldwell, D. 2014. Species Accounts for the 6/13/14 Wet/Dry Mapping, Pima County Cienega Creek Natural Preserve. Tucson, Arizona. June 17.

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.

Clarkson, R.W., B. R. Kesner, and P. C. Marsh. 2011. Long-term monitoring plan for fish populations in selected waters of the Gila River basin, Arizona: Revision No. 3. U.S. Bureau of Reclamation, Phoenix, AZ, and Marsh and Associates, Tempe, AZ, report prepared for USFWS, Phoenix, AZ.

Crowder, C.D. and A.T. Robinson. 2015. Gila River Basin Native Fishes Conservation Program: Arizona Game and Fish Department annual report for February 6, 2014 through February 4, 2015. A Gila River Basin Native Fishes Conservation Program Annual Report for U.S. Fish and Wildlife Service Cooperative Agreement No. F14AC00148. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Dahlburg, M. L. , D. L. Shumway, and P. Doudoroff. 1968. Influence of dissolved oxygen and carbon dioxide on swimming performance of largemouth bass and coho salmon. J. Fish. Res. Board Can. 25:49-70.

Dowling, D. C., and M. J. Wiley. 1986. The effects of dissolved oxygen, temperature, and low Stream flow on fishes: a literature review. Illinois Natural History Survey, Aquatic Biology Technical Report (2) Springfield City Water, Light, and Power Company.

Foster, D., and J. Simms. 2005. Cienega Creek fish surveys 2005 - Gila chub status investigation. Final Report to the Bureau of Land Management. Tucson, Arizona: Arizona Game and Fish Department.

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.

Hatch, M. 2015. Technical note regarding demographic processes of fish species in Cienega Creek, Arizona. Albuquerque, New Mexico: SWCA Environmental Consultants.

HudBay. 2016. Clarification of conservation measures. Letter to K. Dewberry, Forest Supervisor, Coronado National Forest, 24 February. 14pp.

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.

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.

Mason, A., Y. Jun Xu, P. Saksa, A. Viosca, J. M. Grace, J. Beebe, and R. Stich. 2007. Streamflow and nutrient dependence of temperature effects on dissolved oxygen in loworder Forest streams. *In* McFarland A., and A. Saleh, Eds., Watershed Management to Meet Water Quality Standards and TMDLS (Total Maximum Daily Load) Proceedings of the Fourth Conference 10-14 March 2007, ASABE Publication Number 701P0207, San Antonio, Texas.

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.

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.

Minckley, W. L. 1973. Fishes of Arizona. Ariz. Fish and Game Dept. Sims Printing Company, Inc., Phoenix, AZ. 293pp.

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.

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.

Moody, T., M.Wirtanen, and S. N. Yard. 2003. Regional relationships for bankfull stage in natural channels of the arid southwest. Natural Channel Design Inc., Flagstaff.

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.

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.

Patterson, J., and G. Annandale. 2012. Geomorphic Assessment of Barrel Creek. Project No.: 093-81962.0007. Technical Memorandum. Prepared for SWCA Environmental Consultants. Lakewood, CO: Golder Associates Inc. July 18.

Pima Association of Governments. 2003. Contribution of Davidson Canyon to base flows in Cienega Creek. November. 49pp.

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.

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.

Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on hydrology and threatened and endangered species of the Cienega Creek Natural Preserve. Tucson, Arizona:

Pima County Office of Sustainability and Conservation, Pima County Regional Flood Control District. July 14.

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.

Robinson, A. T., and C. D. Crowder. 2015. Gila River Basin Native Fishes Conservation Program: Arizona Game and Fish Department annual report for June 30, 2014 through June 30, 2015. A Gila River Basin Native Fishes Conservation Program Annual Performance Report for U.S. Fish and Wildlife Service Cooperative Agreement No. F14AC00148. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Rosemont Copper Company. 2012a. Integrated Watershed Summary. Tucson, AZ: Rosemont Copper Company. June.

Rosen, P. C., N. Steklis, D. J. Caldwell, and D. H. Hall. 2013. Restoring leopard frogs and habitat in Sky Island Grasslands (Arizona): Final Report. Project 2010-0023-000 Grant 18411. Prepared for National Fish and Wildlife Foundation. Tucson, Arizona: FROG Project, Frog and Fish Restoration Group. July 29.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Inc., Pagosa Springs, CO.

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.

Simms, J. R.. 2014. Trip Report: USFWS Tour of Aquatic, Wetland and Riparian Areas within the LCNCA. Tucson, Arizona: Bureau of Land Management. June.

Simms, J., and S. Ehret. 2014. Draft Report - Gila Chub Monitoring in Cienega Creek in 2005, 2007, 2008, 2011 and 2012, with notes on Gila Topminnow, Longfin Dace, Sonora Mud Turtle, and Huachucha Water Umbel. Tucson, Arizona: Bureau of Land Management and Arizona Game and Fish Department. July.

Simon, A., M. Doyle, M. Kondolf, F. D. Shields, B. Rhoads, and M. McPhillips. 2007. Critical evaluation of how the Rosgen classification and associated "natural channel design" methods fail to integrate and quantify processes and channel response. Journal of the American Water Resources Association. 43(5): 1117-1131.

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.

Stewart, N. E., D. L. Shumway, and P. Doudoroff. 1967. Influence of oxygen concentration on the growth of juvenile largemouth bass. J. Fish. Res. Board Can. 24(3):475-494.

SWCA. 2012. Agenda Rosemont-FWS-USFS consultation meeting. 16 November, 2012, unpublished white paper.

Tetra Tech. 2010. Regional groundwater flow model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874, Prepared for Rosemont Copper. Tucson, Arizona.

Timmons, R. T., and L. J. Upton. 2013. Fish monitoring of selected streams within the Gila River basin, 2012. In Partial fulfillment of: Bureau of Reclamation Contract No. R12PC32007. Arizona Game and Fish Department, Nongame Branch, Phoenix, AZ. 82 pp.

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). 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). 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. Biological opinion: 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. Memo, 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. Fish and Wildlife Service (FWS). 2013. Final Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona. Arizona Ecological Services Office, Phoenix, Arizona. 410 pp.

U.S. Fish and Wildlife Service (FWS). 2015. Gila chub (*Gila intermedia*) Draft Recovery Plan. U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico. 118 pp. + Appendices A-C.

U.S. Forest Services (USFS). 2013. Final Environmental Impact Statement for the Rosemont Copper Project, a Proposed Mining Operation, Coronado National Forest Pima County, Arizona. Volumes 1-6.

U.S. Geological Survey (USGS). 1997. Modeling Ground-Water Flow with MODFLOW and Related Programs. USGS Fact Sheet FS-121-97. 4 pp.

U.S. Geological Survey (USGS). 2014a. Technical review of WestLand Resources report "Rosemont Copper Project" potential effects of the Rosemont Copper Project on Lower Cienega Creek". In Letter from James Leenhouts, Director, USGS Arizona Water Science Center, to Jim Upchurch, Forest Supervisor, Coronado National Forest. Tucson, Arizona.

U.S. Geological Survey (USGS). 2014b. Technical review of Pima County report "Impacts of the Rosemont Mine on Hydrology and Threatened and Endangered Species of the Cienega Creek Natural Preserve". In Letter from James Leenhouts, Director, USGS Arizona Water Science Center, to Jim Upchurch, Forest Supervisor, Coronado National Forest. Tucson, Arizona: U.S. Geological Survey. September 30.

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.

WestLand Resources, Inc. (WestLand). 2012b Potential Effects of the Rosemont Project on Lower Cienega Creek. Prepared for Rosemont Copper Company. Tucson, Arizona. November 14.

Literature Cited – 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.

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.

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.

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.

Duncan, D. K. 2013. Gila topminnow interactions with western mosquitofish: an update. Pages 283-287 *in* Gottfried, G. J., P. F. Ffolliott, B. S. Gebow, L. G. Eskew, and L. C. Collins, comps., Merging Science & Management in a Rapidly Changing World: Biodiversity & Manage. of the Madrean Archipelago III and 7th Conf. on Research and Resource Manage. in the Southwestern Deserts; 2012 May 1-5; Tucson, AZ, Proc., USDA Forest Service, Rocky Mountain Research Station, RMRS-P-67, Fort Collins, CO. 593pp.

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., 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.

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.

Meffe, G. K., D. A., Hendrickson, and J. N. Rinne. 1982. Description of a new topminnow opulation in Arizona, with observations on topminnow/mosquitofish co-occurrence. Southwestern Naturalist 27(2):226-228.

Miller, R. R. 1961. Man and the changing fish fauna of the American Southwest. Pap. Michigan Acad. Sci., Arts, Lett. 46:365-404.

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.

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.

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.

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.

Timmons, R. T., and L. J. Upton. 2013. Fish monitoring of selected streams within the Gila River basin, 2012. In Partial fulfillment of: Bureau of Reclamation Contract No. R12PC32007. Arizona Game and Fish Department, Nongame Branch, Phoenix, AZ. 82 pp.

U.S. Fish and Wildlife Service. (FWS) 1984. Sonoran topminnow recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 56pp. 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., 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.

Literature Cited – Desert Pupfish

Arizona Game and Fish Department. 2015. Arizona Game and Fish Department's Section 10(A)1(a) Permit Annual Report 2014, TE-083636-0, Topminnow and Pupfish SHA Statewide. Phoenix, AZ. 7 pp.

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. 1991. A legacy of change; Historic human impact on vegetation of the Arizona borderlands. The University of Arizona Press. 231 pp.

Barlow, P. M., and S. A. Leake. 2012. Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow. U.S. Geological Survey Circular 1376. 84 p.

Black, G. F. 1980. Status of the desert pupfish, *Cyprinodon macularius* (Baird and Girard), in California. California Dept. Fish and Game, Inland Fisheries, Endangered Species Project, Rancho Cordova, CA.

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.

Bolster, B. C. 1990. Five year status report for desert pupfish, *Cyprinodon macularius macularius*. California Department of Fish and Game, Inland Fisheries Division, Endangered Species Project, Rancho Cordova, CA.

Brooks, G. R. 1964. An analysis of the food habits of the bullfrog, *Rana catesbeiana*, by body size, sex, month, and habitat. Virginia J. Sci. 15:173-186.

Brown, B. 1991. Land use trends surrounding Organ Pipe Cactus National Monument. Technical Report 39, Cooperative National Park Resources Studies Unit, School of Renewable Natural Resources, University of Arizona, Tucson.

Brown, M., and F. J. Abarca. 1992. An update status report of the Sonoran topminnow, *Poeciliopsis occidentalis*, and desert pupfish, *Cyprinodon macularius*, in Arizona. Arizona Game and Fish Department, Phoenix.

California Regional Water Quality Control Board. 1991. Issue paper on Salton Sea water quality: prepared by Regional Board staff for the November 20, 1991 public workshop. Palm Desert, CA. 5pp.

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.

Clarkson, R. W., and J. C. DeVos, Jr. 1986. The bullfrog, *Rana catesbeiana* Shaw, in the lower Colorado River, Arizona-California. Copeia (1986):42-49.

Cohen, N. W., and W. E. Howard. 1958. Bullfrog food and growth at the San Joaquin Experimental Range, California. Copeia (1958): 223-225.

Constantz, G.D. 1981. Life history patterns of desert fishes. Pp. 237-290 *in* Naiman R.J. and D.L. Soltz, eds., Fishes in North American Deserts, John Wiley and Sons, New York.

Cox, T .J. 1966. A behavioral and ecological study of the desert pupfish (*Cyprinodon macularius*) in Quitobaquito Springs, Organ Pipe Cactus National Monument, Arizona. PhD dissertation, Univ. of Arizona, 102pp.

Cox, T. J. 1972. The food habits of desert pupfish (*Cyprinodon macularius*) in the Quitobaquito Springs, Organ Pipe Cactus National Monument, Arizona. Journal of the Arizona-Nevada Academy of Science 7:25-27.

Crowder, C.D. and A.T. Robinson. 2015. Gila River Basin Native Fishes Conservation Program: Arizona Game and Fish Department annual report for February 6, 2014 through February 4, 2015. A Gila River Basin Native Fishes Conservation Program Annual Report for U.S. Fish and Wildlife Service Cooperative Agreement No. F14AC00148. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Deacon J .E., and W .L. Minckley. 1974. Desert fishes. Pages 385-488 *in* Brown, Jr., G. W., ed., Desert Biology, Volume 2. Academic Press, New York.

Desert Fishes Team. 2006. Analysis of recovery plan implementation for threatened and endangered warm water fishes of the Gila River basin. Report 3, Desert Fishes Team, Phoenix, Arizona. 87pp.

Douglas, M. R., M. E. Douglas, and P. C. Brunner. 2001. Population estimates, movements, and size structure of the endangered Quitobaquito pupfish, *Cyprinodon macularius eremus*. Southwestern Naturalist 46(2):141-150.

Duncan, D. K., and T. Tibbitts. 2008. Conservation and management of the Quitobaquito pupfish, *Cyprinodon eremus*, in Sonora and Arizona. Abstract of presentation at the 40th Annual Meeting of the Desert Fishes Council, Cuatro Cienegas, MX, 12-16 Nov., 2008. Pg. 17.

Echelle, A. A., R. A. Van Den Bussche, T. P. Mallory Jr., M. L. Hayne, and C. O. Minckley. 2000. Mitochondrial DNA variation in pupfishes assigned to the species *Cyprinodon macularius* (Atherinomorpha: Cyprinodontidae): taxonomic implications and conservation genetics. Copeia 2000(2):353-364.

Eigenmann, C. H., and R. S. Eigenmann. 1888. *Cyprinodon macularius* Girard. Western American Science 5:3-4.

Evermann, B. W. 1916. Fishes of the Salton Sea. Copeia 1916:61-63.

Fleischner, T. L. 1994. Ecological cost of livestock grazing in western North America. Conservation Biology 8(3):629-644.

Frost, S.W. 1935. The food of *Rana catesbeiana* Shaw. Copeia 1935:15-18.

Garman, S. 1895. The cyprinodonts. Memoirs of the Museum of Comparative Zoology 19:1-179.

Gilbert, C. H., and N. B. Scofield. 1898. Notes on a collection of fishes from the Colorado Basin in Arizona. Proceedings of the US National Museum 20:487-499.

Glenn, E.P., and P.L. Nagler. 2005. Comparative ecophysiology of Tamarix ramosissima and native trees in western U.S. riparian zones. Journal of Arid Environments 61:419-446.

Hanes, T. 1996. Tonto Creek Riparian Unit geomorphic and watershed conditions and analysis of streamflow and hydrologic data: 1995 and 1996 water years. Unpublished report prepared by Hydroscience for Garcia and Associates, Tiburon, CA. 50pp.

Hendrickson, D. A., and W. L. Minckley. 1984. Cienegas - vanishing climax communities of the American southwest. Desert Plants 6(3):131-175.

Hendrickson, D. A., and A. Varela-Romero. 1989. Conservation status of desert pupfish, *Cyprinodon macularius*, in Mexico and Arizona. Copeia 1989:478-483.

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.

Keeney, S. 2010a. Status of pupfish populations. Unpublished Report, California Department of Fish and Game. 3pp.

Keeney, S. 2010b. Desert pupfish 5-year review. California Department of Fish and Game. E-mail 2 August 2010 to Doug Duncan, U.S. Fish and Wildlife Service. 1p.

Keeney, S. 2013. Current status of California Desert pupfish populations. Unpub. Rep., May 2013, California Department of Fish and Game

Keeney, S. 2015. Electronic mail: RE: Reunión Binacional Pez cachorrito del Desierto / Binational Meeting Desert Pupfish, to Doug Duncan, June 3 2015.

Kodric-Brown, A., and J.H. Brown. 2008. Conservation of aquatic and riparian systems: the need to evaluate alternative management strategies. Abstract of presentation at the 40th Annual Meeting of the Desert Fishes Council, Cuatro Cienegas, MX, 12-16 Nov., 2008. Pg. 17.

Koike, H., A.A. Echelle, D. Loftis, and R.A. Van Den Bussche. 2008. Microsatellite DNA analysis of success in conserving genetic diversity after 33 years of refuge management for the desert pupfish complex. Animal Conservation 11(2008):321-329.

Lau, S., and C. Boehm. 1991. A distribution survey of desert pupfish (*Cyprinodon macularius*) around the Salton Sea, Califorina. Final Report for Section 6, Project No. EF9oXII-1, prepared for California Department of Fish and Game, Inland Fisheries Division.

Loftis, D. G. 2007. Genetic structure of remnant wild populations of the desert pupfish complex (Cyprinodontidae: *Cyprinodon macularius* and *C. eremus*). M.S. Thesis, Oklahoma State University, Stillwater. 42pp.

Loftis, D. G., A. A. Echelle, H. Koike, R. A. Van den Bussche, and C. O. Minckley. 2009. Genetic structure of wild populations of the endangered desert pupfish complex (Cyprinodontidae: *Cyprinodon*). Conservation Genetics 10:453-463.

Love-Chezem, S. T., A. T. Robinson, and C. D. Crowder. 2015. Attempted establishment of Gila topminnow and desert pupfish within Las Cienegas and San Pedro Riparian National Conservation Areas: Progress thru 2014. Progress Report to Gila River Basin Native Fishes Conservation Program, Under Task 3-75a; U.S. Fish and Wildlife Service Cooperative Agreement No. F09AC00084. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Martin, B. A., and M. K. Saiki. 2005. Relation of desert pupfish abundance to selected environmental variable in natural and manmade habitats in the Salton Sea basin. Environmental Biology of Fishes 73:97-107.

Matsui, M. L. 1981. The effects of introduced teleost species on the social behavior of *Cyprinodon macularius californiensis*. M.S. Thesis, Occidental College, Los Angeles. 61pp.

Matsui, M. L., J. E. Hose, P. Garrahan, and G. A. Jordan. 1992. Developmental defects in fish embryos from Salton Sea, California. Bulletin of Environmental Contaminants and Toxicology 48:914-920.

McClurg, S. 1994. The Salton Sea. Western Water, Water Education Foundation. Accessed 5 August 2010 at kttp://www.sci.sdsu.edu/salton/envirneconvaluesaltonsea.html. 17pp.

McCoy, C. J. 1967. Diet of bullfrogs (*Rana catesbeiana*) in central Oklahoma farm ponds. Proceedings of the Oklahoma Academy of Sciences 48:44-45.

Miller, R. R. 1943. The status of *Cyprinodon macularius* and *Cyprinodon nevadensis*, two desert fishes of western North America. Occasional Papers of the Museum of Zoology, University of Michigan. 473:1-25.

Miller, R. R. 1961. Man and the changing fish fauna of the American Southwest. Papers of the Michigan Academy of Sciences, Arts and Letters 46:365-404.

Miller, R. R., and L. A. Fuiman. 1987. Description and conservation status of Cyprinodon macularius eremus, a new subspecies of pupfish from Organ Pipe Cactus National Monument, Arizona. Copeia 1987(3):593-609.

Minckley, C. 2000. Trip to Cienega de Santa Clara, 19-22 June 2000. Memo to Stewart Jacks PL-AZFRO, Charlie Sanchez, ARD International Affairs; USFWS, Arizona Fishery Resource Offices – Parker, Parker, AZ. 2pp.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix.

Minckley, W. L. 1980. *Cyprinodon macularius* Baird and Girard. Desert pupfish. Pages 497 *in* Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr., eds., Atlas of North American Freshwater Fishes, North Carolina Museum of Natural History, Raleigh, North Carolina.

Minckley, W. L. 1985. Native fishes and natural aquatic habitats in U.S. Fish and Wildlife Service Region II west of the continental divide. Report to the U.S. Fish and Wildlife Service, Albuquerque.

Minckley, W. L., and P. C. Marsh. 2009. Inland fishes of the greater Southwest: Chronicle of a vanishing biota. University of Arizona Press, Tucson. 576pp.

Minckley, W. L., R. R. Miller, and S. M. Norris. 2002. Three new pupfish species, *Cyprinodon* (Teleostei, Cyprinodontidae), from Chihuahua, Mexico, and Arizona, USA. Copeia 2002:687-705.

Moyle, P. B. 2002. Inland fishes of California (Revised and Expanded). University of California Press Ltd., London. 502pp.

Naiman, R. J. 1979. Preliminary food studies of *Cyprinodon macularius* and *Cyprinodon nevadensis* (Cyprinodontidae). Southwestern Naturalist 24(3):538-541.

Parmenter, S. C., M. T. Bogan, R. Bloom, S. Keeney, and E. Konno. 2004. 2002 California Area Report. Hendrickson, D. A., and L .T. Findley, eds., Proceedings of the Desert Fishes Council, Desert Fishes Council, Bishop, California 34:34-35.

Pearson, G., and C.W. Conner. 2000. The Quitobaquito desert pupfish, an endangered species within Organ Pipe Cactus National Monument: Historical significance and management challenges. Natural Resources Journal 40:379-410.

Powell, B. 2013. Water Resource Trends in the Cienega Creek Natural Preserve, Pima County, Arizona. An unpublished report to the Pima County Flood Control District. Tucson, Arizona: Pima County Office of Sustainability and Conservation. August.

Roberts, B.C. and R.G. White. 1992. Effects of angler wading on survival of trout eggs and preemergent fry. North American Journal of Fisheries Management 12:450-459.

Robinson, A. T. 2009. Muleshoe Cooperative Management Area native fish repatriations, one-year post-stocking monitoring and first augmentation stocking September 15-17, 2008. A Gila River Basin Native Fishes Conservation Program Annual Performance Report. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Robinson, A. T., and C. D. Crowder. 2015. Gila River Basin Native Fishes Conservation Program: Arizona Game and Fish Department annual report for June 30, 2014 through June 30, 2015. A Gila River Basin Native Fishes Conservation Program Annual Performance Report for U.S. Fish and Wildlife Service Cooperative Agreement No. F14AC00148. Arizona Game and Fish Department, Nongame Wildlife Branch, Phoenix.

Rosen, P. C. 2003. Taxonomic status of the Sonoyta mud turtle (*Kinosternon sonoriense longifemorale* Iverson) based on mitochondrial D-loop sequence, with a discussion of phylogeography. Unpublished report, School of Renewable Natural Resources, University of Arizona, Tucson. 35pp.

Saiki, M. K. 1990. Elemental concentrations in fishes from the Salton Sea, southeastern California. Water, Air, and Soil Pollution 52:41-56.

Saiki, M. L, B. A. Martin, and T. W. May. 2008. Year 3 summary report: baseline selenium monitoring of agricultural drains operated by the Imperial Irrigation District in the Salton Sea Basin. U.S. Geological Survey Open-File Report 2008-1271, Dixon, California. 70pp.

Schoenherr, A. A. 1988. A review of the life history and status of the desert pupfish, *Cyprinodon macularius*. Bulletin of the Southern California Academy of Sciences 87:104-134.

Simons, L. H. 1987. Status of the Gila topminnow (*Poeciliopsis occidentalis occidentalis*) in the United States. Arizona Game and Fish Department, Phoenix.

Tibbitts, T. 2009. Threatened and endangered species, annual summary of activities – 2008, USFWS Permit # TE819458-0. National Park Service, Organ Pipe Cactus National Monument, Ajo, AZ. 27pp.

Turner, B. J. 1983. Genetic variation and differentiation of remnant natural populations of the desert pupfish, *Cyprinodon macularius*. Evolution 37:690-700.

U.S. Bureau of Reclamation. 2005. Environmental assessment and finding of no significant impact: Salton Sea shallow water habitat pilot project. Lower Colorado Regional Office, Boulder City, Nevada. 65pp.

U.S. Fish and Wildlife Service. 1993. Desert pupfish recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2010. Desert pupfish (*Cyprinodon macularius*) 5-Year Review: Summary and Evaluation. USFWS, Arizona Ecological Services Office, Phoenix, Arizona. 43pp.

U.S. Fish and Wildlife Service. 2015. Gila chub (*Gila intermedia*) Draft Recovery Plan. U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico. 118pp. + Appendices A-C.

Varela-Romero, A., G. Ruiz-Campos, L. M. Yepiz-Velazquez, and J. Alaniz-Garcia. 2002. Distribution, habitat, and conservation status of desert pupfish (*Cyprinodon macularius*) in the lower Colorado River basin, Mexico. Review in Fish Biology and Fisheries 12:157-165.

Voeltz, J. B., and R .H. Bettaso. 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, Arizona.

Weedman, D. A., and K. L. Young. 1997. Status of the Gila topminnow and desert pupfish in Arizona. Nongame and Endangered Wildlife Program Technical Report 118, Arizona Game and Fish Department, Phoenix, Arizona. Nongame Technical Report 91, Phoenix, AZ. 111pp.

WestLand Resources, Inc. (WestLand). 2012. Potential effects of the Rosemont Project on lower Cienega Creek. Prepared for Rosemont Copper Company. Tucson, Arizona. November 14.

Literature Cited – Chiricahua Leopard Frog

Akins, C. 2015. E-mail correspondence from Christina Akins, Wildlife Specialist, Randi Frogs Project, Amphibians and Reptiles Program, Nongame Branch, Arizona Game and Fish Department (October 15, 2016; 1402 hrs).

Akins, C. 2016b. E-mail correspondence from Christina Akins, Wildlife Specialist, Randi Frogs Project, Amphibians and Reptiles Program, Nongame Branch, Arizona Game and Fish Department (March 31, 2016; 0941 hrs).

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.

U.S. Environmental Protection Agency (EPA). 1997. Mercury Study Report to Congress: An Ecological Assessment for Anthropogenic Mercury Emissions in the United States. Vol. 6. EPA-452/R-97-008 U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development. December.

U.S. Environmental Protection Agency (EPA). 2004. Draft Aquatic Life Water Quality Criteria for Selenium–2004. EPA-822-D-04-001. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. November.

U.S. Environmental Protection Agency (EPA). 2011. Ecological Toxicity Information. Available at: http://www.epa.gov/region5superfund/ecology/toxprofiles.htm. Accessed June 5, 2012.

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.

Forrest M. J. and M. A. Schlaepfer. 2011. Nothing a hot bath won't cure: Infection rates of amphibian chytrid fungus correlate negatively with water temperature under natural field settings. PLoS ONE 6(12): e28444. doi:10.1371/journal.pone.0028444.

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.

Hale, S. F. and J. L. Jarchow. The status of the Tarahumara frog (*Rana tarahumarae*) in the United States and Mexico: part II. 1988.

Halliday, T.R. 1998. A declining amphibian conundrum. Nature 394:418-419.

Hall, D. 2015. Phone conversation between Cat Crawford, USFWS, and David Hall, University of Arizona. (November 13, 2015)

Hall, D. 2016. E-mail correspondence from David Hall, Wildlife Biologist, University of Arizona. (March

8, 2016; 1551 hrs.).

Hall, D. 2016b. E-mail correspondence from David Hall, Wildlife Biologist, University of Arizona. (April 13, 2016; 1136 hrs.).

Hall, D., P. C. Rosen, D. J. Caldwell. 2015. Annual Report: 2014-2015 FROG Project Accomplishments at Las Ciénegas National Conservation Area, Arizona. Unpublished Report. 7 pp.

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.

McCall, H. 2016. E-mail correspondence and draft report from Hunter McCall, Wildlife Specialist, Arizona Game and Fish Department . (February 16, 2016; 0830 hrs.).

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.

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.

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.

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.

Rosen, P. C., N. Steklis, D. J. Caldwell, and D. H. Hall. 2013. Restoring leopard frogs and habitat in sky island grasslands, Arizona, Final Report. Unpublished report. 152 pp.

Rowley, J. J. L. and R. A. Alford. 2013. Hot bodies protect amphibians against chytrid infection in nature. Scientific Reports 3 (2013).

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.

Southwest Endangered Species Act Team. 2008. Chiricahua leopard frog (*Lithobates* [*Rana*] *chiricahuensis*): Considerations for making effects determinations and recommendations for reducing and avoiding adverse effects. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico. 75 pp.

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.

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.

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.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874, Prepared for Rosemont Copper. Tucson, Arizona.

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.

U.S. Fish and Wildlife Service (FWS). 2011. Chiricahua leopard frog (*Rana chiricahuensis*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Arizona Ecological Services Office, Phoenix, Arizona. 39 pp.

U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Listing and Designation of Critical Habitat for the Chiricahua Leopard Frog. Final Rule. 77 FR 16324.

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. 2014. E-mail correspondence from Eric Wallace, Biologist, WestLand Resources, Inc. (February 21, 2014; 1746 hrs.).

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.

Literature Cited – Northern Mexican Gartersnake

Akins, C. 2016b. E-mail correspondence from Christina Akins, Wildlife Specialist, Randi Frogs Project, Amphibians and Reptiles Program, Nongame Branch, Arizona Game and Fish Department (March 31, 2016; 0941 hrs).

Alfaro, M. E. 2002. Forward attack modes of aquatic feeding garter snakes. Functional Ecology 16:2004-215.

Brennan, T. C., P. C. Rosen, and L. Hellekson. 2009. *Diadophis punctatus regalis* (regal ring-necked snake) diet. Sonoran Herpetologist 22(11): 123.

Caldwell, D. 2008a. E-mail correspondence from Dennis Caldwell (June 08, 2008; 1712 hrs).

Caldwell, D. 2008b. Mexican gartersnake project spring of 2008 Cienega Creek snake hunt. 3 pp. June 23, 2008.

Caldwell, D. 2012. E-mail correspondence from Dennis Caldwell. (May 21, 2012; 1629 hrs.).

Caldwell, D. 2014. Species accounts for the 6/13/14 wet/dry mapping Pima County Cienega Creek Preserve. 3 pp.

Cogan, R. 2015. E-mail correspondence from Roger Cogan, Conservation Coordinator at Appleton-Whittell Research Ranch, National Audubon Society (April 7, 2015; 1117 hrs).

Crawford, C. 2015. E-mail correspondence from Cat Crawford (Fish and Wildlife Biologist, Arizona Ecological Services, U.S. Fish and Wildlife Service). June 19, 2015; 1045 hrs.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.

Drummond, H. and C. Macías Garcia. 1983. Limitations of a generalist: a field comparison of foraging snakes. Behaviour 108(1/2):23-43.

Emmons, I. and E. Nowak. 2013. Northern Mexican gartersnake surveys 2012: interim report. Colorado Plateau Research Station, Northern Arizona University. Flagstaff, Arizona. 20 pp.

Fitzgerald, L. A. 1986. A preliminary status survey of *Thamnophis rufipunctatus* and *Thamnophis eques* in New Mexico. Unpubl. report to New Mexico Department of Game and Fish, Albuquerque, New Mexico.

Frederick, G. 2008. Telephone interview with Mr. Glenn Frederick, District Wildlife Biologist, Coronado National Forest (August 1, 2008).

Hall, D. 2012. E-mail correspondence from David Hall, Wildlife Biologist, University of Arizona. (March 26, 2012; 1448 hrs.).

Hall, D. 2016b. E-mail correspondence from David Hall, Wildlife Biologist, University of Arizona. (April 13, 2016; 1136 hrs.).

Hall, D., P. C. Rosen, D. J. Caldwell. 2015. Annual Report: 2014-2015 FROG Project Accomplishments at Las Ciénegas National Conservation Area, Arizona. Unpublished Report. 7 pp.

Hendrickson, D. A. and W. L. Minckley. 1984. Cienagas - vanishing climax communities of the American Southwest. Desert Plants 6(3):131-175.

Holycross, A. T., W. P. Burger, E. J. Nigro, and T. C. Brennan. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* along the Mogollon Rim and New Mexico. A Report to Submitted to the Arizona Game and Fish Department. 94 pp.

Lashway, S. 2015. E-mail correspondence from Sharon Lashway, Aquatic Wildlife Specialist, Arizona Game and Fish Department (June 25, 2015; 1554 hrs.).

Nowak, E. M. and V. L. Boyarski. 2012. *Thamnophis eques megalops* (Northern Mexican Gartersnake). Reproduction: Litter size. Herpetological Review 43(2):351-352.

Price, A. H. 1980. Geographic Distribution Notes: *Thamnophis eques megalops*. Herpetological Review 11(2):39.

Rosen, P. C. and D. J. Caldwell. 2004. Aquatic and riparian herpetofauna of Las Cienegas National Conservation Area, Empire-Cienega Ranch, Pima County, Arizona. Final Report to the U.S. Bureau of Land Management, Tucson Office. 52 pp.

Rosen, P. C. and C. R. Schwalbe. 1988. Status of the Mexican and narrow-headed garter snakes (*Thamnophis eques megalops* and *Thamnophis rufipunctatus rufipunctatus*) in Arizona. Unpubl. report from Arizona Game and Fish Dept. (Phoenix, Arizona) to U.S. Fish and Wildlife Service, Albuquerque, New Mexico. iv + 50 pp + appendices.

Rosen, P. C., E. J. Wallace, and C. R. Schwalbe. 2001. Resurvey of the Mexican Garter Snake (*Thamnophis eques*) in Southeastern Arizona Pp. 70-94 in P. C. Rosen and C. R. Schwalbe. 2002. Conservation of wetland herpetofauna in southeastern Arizona. Final Report to the Arizona Game and Fish Department (Heritage Grant #I99016) and U.S. Fish and Wildlife Service. 160 pp.

Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The Garter Snakes. University of Oklahoma Press: Norman, Oklahoma. 332 pp.

Servoss, J. M., Burger, B. and Y. D. Cage. 2007. Trip Report: Mexican gartersnake survey/collection effort (at) Las Cienegas National Conservation Area September 6-8, 2007. Submitted to the Gartersnake Conservation Working Group. 12 pp.

Stefferud, J. A. and S. E. Stefferud. 2004. Aquatic and riparian surveys of selected stream courses on Sierra Vista and Nogales Ranger Districts, Coronado National forest, Cochise and Santa Cruz counties, Arizona. Unpublished report. 636 pp.

Timmons, Ross T. and Lara J. Upton. 2013. Fish monitoring of selected streams within the Gila River basin, 2012. In Partial fulfillment of: Bureau of Reclamation Contract No. R12PC32007. Arizona Game and Fish Department, Nongame Branch, Phoenix, AZ. 82 pp.

U.S. Fish and Wildlife Service (USFWS). 2011b. Biological and Conference Opinion for Wildlife and Sport Fish Restoration Funding of Arizona Game and Fish Department's Statewide and Urban Fisheries Stocking Program for 2011-2021. 781 pp.

Literature Cited – Huachuca Water Umbel

Affolter, J.M. 1985. A Monograph of the Genus *Lilaeopsis* (Umbelliferae). Systematic Botany Monographs Volume 6: 1-140.

Anderson, G. 2006. Huachuca water umbel in the Upper San Pedro watershed of Sonora, Mexico: A Section 6 Research Project for the US Fish and Wildlife Service. January 2006. 37 pp.

Bahre, C. 1991. A legacy of change; Historic human impact on vegetation of the Arizona borderlands. The University of Arizona Press. 231 pp.

Bowers, J. 2005. Effects of drought on shrub survival and longevity in the northern Sonoran Desert. Journal of the Torrey Botanical Society 32(3):421-431.

Bureau of Land Management (BLM). 2011. Dataset: Huachuca water umbel patch survey 2011 Cienega Creek, Arizona.

CLIMAS. 2014. March southwest climate outlook. http://www.climas.arizona.edu/files/climas/pdfs/periodicals/SWClimateOutlook_June2014_1.pdf accessed Nov 25, 2014. (Also see other 2014 months at this website).

Coulter, J. and J. Rose. 1902. Monograph of the North American Umbelliferae. Pp. 295-408. U.S. Department of Agriculture, Division of Botany. Contributions from the U.S. National Herbarium Vol. VII Systematic and Geographic Botany, and Aboriginal Uses of Plants. Government Printing Office.

Edwards, B. 2001. Letter from Bill Edwards, U.S. Forest Service Range Conservationist, to the U.S. Forest Service District Ranger, biologist, and permittee. Re. Lone Mountain Riparian Monitoring. February 21, 2001.

Engineering and Environmental Consultants (EEC). 2001. Final report – Huachuca water umbel surveys - Cienega Creek Preserve, Bingham Cienega Preserve, La Cebadilla property, Pima, County, Arizona. A report prepared for the Pima County Flood Control District. 47 pp.

Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. 2013. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Gori, D. 1995. Monitoring plan for Huachuca water umbel *Lilaeopsis schaffneriana* ssp. *recurva* at Cottonwood Spring. 12 pp.

Harper J.L. 1977. Population Biology of Plants --Ch 23 Community Structure and Diversity . Academic Press, London.

Hendrickson, D. and W. Minckley. 1984. Cienegas – vanishing climax communities of the American Southwest. Desert Plants 6(3): 131-176.

Hereford, R. 1993. Geomorphic evolution of the San Pedro River channel since 1900 in the San Pedro Riparian National Conservation Area, southeast Arizona. Open file report 92-339. Prepared in cooperation with the Bureau of Land Management. 77 pp.

Karl, T., J. Melillo, and T. Peterson. 2009. Global Climate Change Impacts in the United States. Cambridge University Press New York, NY. Available online from: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/download-the-report.

Krueper, D. 1996. Effects of livestock management on southwestern riparian ecosystems. *In*: Shaw, Douglas W.; Finch, Deborah M., Technical Coordinators. Desired future conditions for Southwestern riparian ecosystems: Bringing interests and concerns together. 1995 Sept. 18-22, 1995; Albuquerque, NM. General Technical Report RM-GTR-272. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 281-301.

Malcom, J. and W. Radke. 2008. Livestock trampling and *Lilaeopsis schaffneriana* ssp. *recurva* (Brassicaceae). Madroño 55(1): 81.

Morrow, C. 2015. pp. 13-15. Habitat conducive to sexual reproduction in *Lilaeopsis schaffneriana* ssp. *recurva*. Conservation and science; Phoenix Zoo Arizona Center for Nature Conservation. May 2015.

National Fish, Wildlife and Plants Climate Change Adaptation Partnership. 2012. National Fish Wildlife and Plants Climate Adaptation Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Greak Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, D.C.

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. 2013. Chapter 1: summary for decision makers. *In*: Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. 2013. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Powell, B. 2013. E-mail correspondence from Brian Powell, Program Manager, Pima County Office of Sustainability and Conservation, to Julie Crawford, U.S. Fish and Wildlife Service. Re: *Lilaeopsis schaffneriana* ssp. *recurva* at Cienega Creek Preserve. October 1, 2013.

Radke, M. 2014. E-mail correspondence from Marcia Radke, Bureau of Land Management, to Julie Crawford, U.S. Fish and Wildlife Service. Re: Partial *Lilaeopsis schaffneriana* ssp. *recurva* survey at Las Cienegas National Conservation Area. June 13, 2014.

Rebman, J. 1991. *Lilaeopsis shaffneriana* ssp. *recurva* Herbarium Specimen. Collected from Empire Cienega and its fringe areas on the east side of Hwy. 83 north of Sonoita, Santa Cruz County, Arizona. Catalogue number 208229; Record number 1240; Collected June 10, 1991.

Rorabaugh, J. 2013. Additional *Lilaeopsis* Records for Chihuahua, Sonora, and Arizona. 7 pp.

Schuetze, S. 2014. Personal communication with Julie Crawford of the U.S. Fish and Wildlife Service regarding Heritage Data management System Geographic Information System Data. August 5, 2014.

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.

Simms, J. 2011. E-mail correspondence from Jeff Simms, Bureau of Land Management, to Priscilla Titus, Ecologist. Re: *Lilaeopsis schaffneriana* ssp. *recurva* information request. October 26, 2011.

Titus, J. and P. Titus. 2008a. Assessing the reintroduction potential of the endangered Huachuca water umbel in Southeastern Arizona. Ecological Restoration 26:311-321.

Titus, J. and P. Titus. 2008b. Seedbank of Bingham Cienega, a spring-fed marsh in southeastern Arizona. Southwestern Naturalist 53:393-399.

Titus, P. and J. Titus. 2008c. Ecological monitoring of the endangered Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*: Apiaceae). Southwestern Naturalist 53:458-465.

Titus, P. and J. Titus. 2006a. E-mail correspondence from Priscilla Titus, Ecologist and John Titus, Assistant Professor of Biology, SUNY at Fredonia, to Kerry Baldwin, Pima County. Re: *Lilaeopsis schaffneriana* ssp. *recurva* survey summary at Cienega Creek Preserve. June 20, 2006.

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. 62 FR 665. 25 pp.

U.S. Fish and Wildlife Service (FWS). 1999a. Endangered and threatened wildlife and plants; designation of critical habitat for the Huachuca water umbel, a plant. 64 FR 37441. 13 pp.

U.S. Fish and Wildlife Service (FWS). 1999b. Biological Opinion. On-going and long-term grazing on the Coronado National Forest. July 29, 1999. 380 pp.

U.S. Fish and Wildlife Service (FWS). 2002. Biological and conference opinion summary: Effects of the proposed Las Cienegas National Conservation Area resources management plan in Pima and Santa Cruz Counties, Arizona. October 4, 2002. 209 pp.

U.S. Fish and Wildlife Service (FWS). 2009. Biological Opinion on the Leslie Canyon Watershed Safe Harbor Agreement. 56 pp.

U.S. Fish and Wildlife Service (FWS). 2014a. Memo to Files: March 20-21, 2014 - *Lilaeopsis schaffneriana* ssp. *recurva* surveys at Parker Canyon Lake, Mud Spring, Joaquin Canyon, and Lone Mountain Canyon, Coronado National Forest. 8 pp.

U.S. Fish and Wildlife Service (FWS). 2014b. Biological opinion for Ongoing and Future Military Operations and Activities at Fort Huachuca, Arizona. 464 pp.

U.S. Fish and Wildlife Service (FWS). 2014c. Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*) 5-Year Review: Summary and Evaluation. 60 pp.

U.S. Fish and Wildlife Service (FWS). 2016. Draft Recovery Plan for *Lilaeopsis schaffneriana* ssp. *recurva* (Huachuca water umbel). U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 84 pp.

Vernadero Group 2011. 2010 Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) transplant report – San Pedro National Conservation Area, Cochise County, Arizona. January 2011. Report prepared for the Environmental and Natural Resource Division Directorate of Public Works U.S. Army Garrison Fort Huachuca, Arizona. 44 pp.

Vernadero Group and the Desert Botanical Garden. 2012. Assessing genetic distinctness of Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) on Fort Huachuca, Arizona and other regional sites. Report prepared for the Environmental and Natural Resource Division Directorate of Public Works U.S. Army Garrison Fort Huachuca, Arizona. 60 pp.

Warren, P., L. Anderson, and P. Shaffroth. 1989. Population studies of sensitive plants of the Huachuca and Patagonia Mountains, Arizona. Unpublished report. Coronado National Forest, Tucson, Arizona. 99 pp.

Warren, P., D. Gori, L. Anderson, and B. 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. 1996. E-mail correspondence from Peter Warren, The Nature Conservancy, to Jesse Juen, Bureau of Land Management. Re: First discovery of Lilaeopsis schaffneriana ssp. recurva in Empire Cienega area. April 4, 1996.

Literature Cited – Western Yellow-Billed Cuckoo

American Birding Association. Accessed on September 30, 2014 at http://birding.aba.org/maillist/AZ

American Ornithologists Union (AOU). 1957. Checklist of North American birds. 5th ed. American Ornithologists' Union, Baltimore, MD.

AOU.1983. Checklist of North American birds. 6th ed. American Ornithologists' Union, Washington, D.C.

AOU. 1998. Checklist of North American birds. 7th ed. American Ornithologists' Union, Washington, D.C.

Arizona Game and Fish Department (AGFD). 2015. Arizona cuckoo records. Heritage Data Management System. Phoenix, AZ.

Brown, D.E. 1994. Biotic communities of the Southwestern United States and northwestern Mexico. University of Utah Press, Salt Lake City, 342 pp.

Brown, D.E. and C.H. Lowe. 1982. Biotic Communities of the Southwest [map]. Scale 1:1,000,000. General Technical Report RM-78. U. S. Forest Service, Fort Collins. Reprinted (and revised) 1994 by University of Utah Press, Salt Lake City.

Brown, D.E., T.C. Brennan, and P.J. Unmack. 2007. A digitized biotic community map for plotting and comparing North American Plant and Animal Distributions. Arizona State University. Canotia Vol. 3 (1).

Bureau of Land Management (BLM). 2013a. Water data for Las Cienegas National Conservation Area. Tucson, Arizona: Bureau of Land Management. November 4.

Bureau of Land Management (BLM). 2013b. Wet/dry mapping data received from BLM. Tucson, Arizona: Bureau of Land Management. November 21.

Bureau of Land Management (BLM). 2014. LCNCA wet/dry data forms: 2008-2014. Tucson, Arizona: Bureau of Land Management.

Cantu-Soto, E; M. Meza-Montenegro, A. Valenzuela-Quintanar; A. Félix-Fuentes; P. Grajeda-Cota; J. Balderas-Cortes; C. Osorio-Rosas; G. Acuña-García; and M. Aguilar-Apodaca. 2011. Residues of Organochlorine Pesticides in Soils from the Southern Sonora, Mexico. Bulletin of Environmental Contamination and Toxicology 87:556–560.

Carstensen, D., D. Ahlers, and D. Moore. 2015. Yellow-billed Cuckoo Study Results – 2014, Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico. Prepared for Albuquerque Area Office, Bureau of Reclamation, Albuquerque, NM. Technical Service Center, Fisheries and Wildlife Resources Group, Bureau of Reclamation, Denver, CO.

Colyer, M. in litt. 2001. Letter from Marilyn Colyer to Wayne White regarding yellow-billed cuckoos distribution in southwestern Colorado. 5 February 2001.

Corman, T. E., and R. T. Magill. 2000. Western yellow-billed cuckoo in Arizona: 1998 and 1999 survey report to the Nongame and Endangered Wildlife Program, Arizona Game and Fish Department. Technical Report 150. Phoenix, Arizona.

Corman, T. E., and C. Wise-Gervais. 2005. Arizona breeding bird atlas. University of New Mexico Press, Albuquerque, New Mexico.

Cornell Lab of Ornithology. 2016. E-bird web site. http://ebird.org/content/ebird/about/

Ehrlich P.R., D.S. Dobkin, and D. Wheye. 1992. Birds in Jeopardy. Stanford University Press, Stanford, CA.

Franzreb, K.E., and S.A. Laymon. 1993. A reassessment of the taxonomic status of the yellow billed cuckoo. Western Birds 24:17–28.

Gaines, D. and S.A. Laymon. 1984. Decline, status, and preservation of the yellow-billed cuckoo in California. Western Birds 15:49–80.

Garrett, C. 2016. February 18, 2016 electronic mail message entitled "Can you look at this example?" from Chris Garrett, SWCA, to Susan Sferra, U.S. Fish and Wildlife Service regarding a hydrological explanation on why we are excluding the non-mine-influenced vegetation on the east side of Cienega Creek from analyses.

Goodwin, S.E. and W. G. Shriver 2010. Effects of traf□c noise on occupancy patterns of forest birds. Conservation Biology. Vol. 25, No. 2: 406–411.

Grocki, D.R.J. and D.W. Johnston. 1974. Chlorinated hydrocarbon pesticides in North American cuckoos. Auk 91:186–187.

Halterman, M.M. 2009. Sexual dimorphism, detection probability, home range, and parental care in the yellow-billed cuckoo. Ph.D. Dissertation, Univ. of Nevada, Reno, NV.

Halterman, M., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2011. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo. Draft

Halterman, M., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2015. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: U.S. Fish and Wildlife Techniques and Methods, Draft. 45 pp.

Hamilton, W.J. III, and M.E. Hamilton. 1965. Breeding characteristics of yellow-billed cuckoos in Arizona. Proceedings California Academy of Sciences, 4th Series, 32:405–432.

Holmes, J.A., C. Calvo, and M.J. Johnson. 2008. Yellow-billed cuckoo distribution, abundance, habitat

use, and breeding ecology in the Verde River watershed of Arizona, 2004–2005. Final Report. Admin Rept. Arizona Game and Fish Dept. 34 pp.

Hopwood, J., S.H. Black, M. Vaughan, and E. Lee-Mader. 2013. Beyond the birds and bees: Effects of Neonicotinoid insecticides on agriculturally important beneficial invertebrates. The Xerces Society. 25 pp.

Hughes, J. M. 1999. Yellow-billed cuckoo (Coccyzus americanus). In A. Poole and F. Gills, editors. The Birds of North America, no. 418. The Birds of North America, Inc, Philadelphia, Pennsylvania.

Johnson, M.J., S.L. Durst, C.M. Calvo, L. Stewart, M.K. Sogge, G. Bland, and T. Arundel. 2008. Yellow-billed cuckoo distribution, abundance, and habitat use along the lower Colorado River and its tributaries, 2007 annual report. USGS Open-file report 2008–1177. 284 pp.

Kondolf, M. and J. Ashby. 2015. Technical Memorandum: Conceptual Design for Sonoita Creek, AZ, Technical Review Support (Order Number EP-G149-00241). PG Environmental, LLC. July 27, 2015. 23 pp.

Klump, G. A. 1996. Bird communication in the noisy world. Pages 321–338 in D. E. Kroodsma, and E. H. Miller, editors. Ecology and evolution of acoustic communication in birds. Comstock Publishing, Ithaca, New York.

Kirkpatrick, C., C. J. Conway, D. D. LaRoche, and G. Robinson. 2010. The influence of water quality on the health of riparian bird communities in Arizona. Wildlife Research report 2009-03, U.S. Geological Survey, Arizona Cooperitve Fish and Wildlife Research Unit, Tucson, AZ.

Krebbs, K., and J. Moss. 2009. Continued surveys for the yellow-billed cuckoo (Coccyzus americanus occidentalis) at Tumacacori National Historical Park. Unpublished report for the National Park Service, Tumacacori, Arizona.

Krueper, D. J., J. L. Bart, and T. D. Rich. 2003. Response of breeding birds to the removal of cattle on the San Pedro River, Arizona. Conservation Biology 17(2): 607-615.

Laymon, S.A. 1980. Feeding and nesting behavior of the yellow-billed cuckoo in the Sacramento Valley. California Dept. of Fish and Game, Wildlife Management Branch, Sacramento, CA, Admin Rep. 80-2.

Laymon, S.A. 1998. Partners in flight bird conservation plan: Yellow-billed cuckoo (*Coccycus americanus*).

Laymon, S.A. and M.D. Halterman. 1989. A proposed habitat management plan for yellow-billed cuckoos in California. USDA Forest Service Gen. Tech. Rep. PSW-110 pp. 272-277.

Laymon, S.A., and M.D. Halterman. 1987. Distribution and status of the yellow billed cuckoo in California. Final report to the California Department of Fish and Game, Contract #C–1845.

Sacramento, CA. 35 pp.

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.

McGill, R.R. 1975. Land use changes in the Sacramento River riparian zone, Redding to Colusa. State of California Water Resources. 23 pp.

McNeil, S.E., D. Tracy, J.R. Stanek, J.E. Stanek, and M.D. Halterman. 2011. Yellow-billed cuckoo distribution, abundance, and habitat use on the lower Colorado River and tributaries, 2010 annual report. Lower Colorado River Multi-species Conservation Program, Bureau of Reclamation, Boulder City, NV. 179 pp.

McNeil, S.E., D. Tracy, J.R. Stanek, and J.E. Stanek. 2012. Yellow-billed cuckoo distribution, abundance, and habitat use on the lower Colorado River and tributaries, 2011 annual report. Lower Colorado River Multi-species Conservation Program, Bureau of Reclamation, Boulder City, NV. 121 pp.

McNeil, S.E., D. Tracy, J.R. Stanek, and J.E. Stanek. 2013. Yellow-billed cuckoo distribution, abundance and habitat use on the lower Colorado River and tributaries, 2008–2012 summary report. Bureau of Reclamation, Multi-Species Conservation Program, Boulder City NV, by SSRS. http://www.lcrmscp.gov/reports/2012/d7_sumrep_08-12.pdf.

Mineau, P. and C. Palmer. 2013. The impact of the Nation's most widely used insecticides on birds. American Bird Conservancy. 96 pp.

Mineau, P. and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification. PLOS One (February 2013, e57457) 8:1–8.

NoiseQuest. n.d. [2012]. What Does Noise Affect? Available at: http://www.noisequest.psu.edu/noiseeffects-wildlife.html. Accessed May 04/0716.

Pater, L. L., T. G. Grubb, and D. K. Delaney. 2009. Recommendations for improved assessment of noise impacts on wildlife. Journal of Wildlife Management 73:788-795.

Patricelli, G. L., and J. L. Blickley. 2006. Avian communication in urban noise: causes and consequences of vocal adjustment. Auk 123:639–649.

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.

Phillips, A., J. Marshall, and G. Monson. 1964. The birds of Arizona. University of Arizona Press, Tucson, Arizona.

Pima Association of Governments. 2003. Contribution of Davidson Canyon to Base Flows in Cienega

Creek. Tucson, Arizona: Pima Association of Governments. November.

Pima Association of Governments. 2014. Cienega Creek: after 3 consecutive years of record breaking drought conditions. Tucson, Arizona: Pima Association of Governments.

Pima Association of Governments. 2015. 2015 Annual Report. Local Drought Impact Group. Pima County. Tucson, Arizona.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. BioScience 47:769–784.

Powell, B. F. 2000. Results of yellow-billed cuckoo surveys adjacent to Tumacacori National Historical Park in Arizona: A report on the 2000 breeding season. U.S. Geological Service, Sonoran Desert Field Station. University of Arizona, Tucson, Arizona.

Powell, B. 2013a. Results of Yellow-billed Cuckoo Surveys at the Cienega Creek Natural Preseve: 2013. Tucson, Arizona: Pima County Office of Sustainability and Conservation.

Powell, B. F. 2013b. Water resource trends in the Cienega Creek Natural Preserve, Pima County, Arizona. An unpublished report to the Pima County Flood Control District, Tucson, AZ.

Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on hydrology and threatened and endangered species of the Cienega Creek Natural Preserve. Pima County, Arizona.

Radke, M. 2016. Personal communication with Susan Sferra, USFWS, regarding gradual improvement of habitat along Cienega Creek since cattle were removed and potential development of small patches of suitable habitat prior to mine activity. January 27, 2016.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona, Tucson, AZ.

Russell, S.M., and G. Monson. 1998. The birds of Sonora. University of Arizona Press, Tucson, AZ.

Sechrist, J., V. Johanson, and D. Ahlers. 2009. Western yellow-billed cuckoo radio telemetry study results middle Rio Grande, New Mexico: 2007–2008. U.S. Bureau of Reclamation, Technical Services Center, Denver, CO. 58 pp.

Sechrist, J.D., E.H. Paxton, D.D. Ahlers, R.H. Doster, and V.M. Ryan. 2012. One year of migration data for a western yellow-billed cuckoo. Western Birds 43:2–11.

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. 2009. Supplemental Noise Study, Rosemont Copper Project. Prepared for Rosemont Copper Company. Report dated April, 2009.

Tetra Tech. 2010a. Davidson Canyon hydrogeologic conceptual model and assessment of spring impacts. Tetra Tech Project No. 114-320869. Prepared for Rosemont Copper. Tucson, Arizona.

Tetra Tech. 2010b. Technical Memorandum. Barrel only alternative noise analysis to Kathy Arnold (Rosemont Copper Company) from Robert Sculley. January 15, 2010. Doc #: 025/10-320871-5.3.

Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Annals of the Association of American Geographers 51:294–315.

Tucson Audubon. 2015a. Re: Proposed Western Yellow-billed Cuckoo Critical Habitat Designation. March 13, 2015 comment letter to U.S. Fish and Wildlife Service Director Dan Ash. Docket No. Attn: Docket No. FWS–R8–ES–2013–0011; 4500030114.

Tucson Audubon. 2015b. 2015 Yellow-billed Cuckoo Survey in Coronado National Forest. Draft. Tucson Arizona.

U.S. Fish and Wildlife Service (USFWS). 2002. Final Recovery Plan for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Prepared by Southwestern Willow flycatcher Recovery Team Technical Subgroup, prepared for USFWS Region 2, Albuquerque, NM. I-ii +210 pp., Appendices A-0.

U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; Southwestern Willow Flycatcher Critical Habitat Revision: Final rule. Federal Register Vol. 78 (2):344.January 3, 2013.

U.S. Fish and Wildlife Service. 2014a. Endangered and threatended wildlife and plants: Designation of Critical Habitat for western distinct population segment of the yellow-billed cuckoo; Proposed rule. Federal Registry Volume 79 No. 158.

U.S. Fish and Wildlife Service. 2014b. Endangerd and threatened wildlife and plants; Determination of threatened status for the western distinct population segment of the yellow-billed cuckoo (*Coccyzus americanus*). Federal Register Vol. 79 No. 192.

U.S. Forest Service (USFS). 2012, 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). 2015a, Third supplement to the biological assessment for the Rosemont Copper Project, Rosemont Copper Company Project, Santa Rita Mountains. Prepared by SWCA Environmental Consultants. Tucson, Arizona

U.S. Forest Service (USFS). 2015b. Rosemont Copper Supplemental Information Report. Prepared by

SWCA HudBay. Tucson, Arizona

Warren P. S., M. Katti, M. Ermann, and A. Brazel. 2006. Urban bioacoustics: it's not just noise. Animal Behaviour 71:491–502.

WestLand Resources, Inc. 2011. Offsite Riparian Habitat Analysis and Mapping. : Effects of surface water and groundwater diversion on offsite riparian habitats in Davidson Canyon. Report to the Rosemont Copper Company, Tucson, Arizona. WestLand Resources, Inc. August 17, 2011. 1049.14.

WestLand Resources, Inc. 2012a. Rosemont Copper Project: Potential effects of lighting associated with the rosemont project on endangered species. Prepared for Rosemont Copper Company. Tucson, AZ.

WesLand Resources, Inc. 2012b. Trip Report for Cienega Creek Site Visit Conducted on October 26-28, 2011 and November 3, 2011. Rosemont Copper Company WestLand Resources, Inc. May 4, 2012. Project 1049.14

WestLand Resources, Inc. 2013a. Revised 2012 Survey For Yellow-Billed Cuckoo (*Coccyzus americanus*) in the Patagonia Mountains, Near Harshaw, Arizona. April. Prepared for Arizona Minerals, Inc. Tucson, AZ.

WestLand Resources, Inc. 2013b. 2013 Survey for Yellow-Billed Cuckoo (*Coccyzus americanus*) In The Patagonia Mountains, near Harshaw, Arizona. Prepared for Arizona Minerals, Inc. Tucson, AZ.

WestLand Resources Inc. 2014. Rosemont Copper Project Revised Habitat Mitigation and Monitoring Plan, Permit No. SPL-2008-00816-MB. Project No. 1049315 800. Prepared for Rosemont Copper. Tucson, Arizona: WestLand Resources. September 26. Further mention of the HMMP in this report will not be accompanied by a formal citation.

WestLand Resources, Inc. 2015a. 2013 Survey for Yellow-billed Cuckoo (*Coccyzus americanus*) survey. Rosemont Project. Prepared for HudBay. Tucson, AZ.WestLand Resources, Inc. 2015b. 2014 Yellow-Billed Cuckoo (*Coccyzus americanus*) survey. Rosemont Project. Prepared for HudBay. Tucson, AZ.

WestLand Resources, Inc. 2015c. 2015 Yellow-billed Cuckoo survey data sheets for Barrel, McCleary, and Wasp canyons. Prepared for HudBay. Tucson AZ.

WestLand Resources, Inc. 2016. Letter to Jean Calhoun, Assistant Field Supervisor, USFWS from Westland Resources, Inc. Summary of Rosemont Copper Company's Sonoita Creek Ranch Restoration Project. Westland Project . Riparian vegetation along portions of Davidson Canyon Wash and Cienega Creek; Rosemont Copper Project. Prepared for Rosemont Copper Company. Project No. 1049.14.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pp. 237–256. In: Conservation Biology: Science of Scarcity and Diversity. M. Soulé ed. Sinauer

Associates, Sunderland, MA. 584 pp.

Wood, W. E., and S. M. Yezerinac. 2006. Song sparrow (Melospiza melodia) song varies with urban noise. Auk 123:650–659.

Literature Cited – Southwestern Willow Flycatcher

Bureau of Land Management (BLM). 2013. Agency Review of the Internal Working Draft of the Rosemont Copper Company Draft Biological Opinion. 8 pp.

Bureau of Land Management (BLM). 2014. Southwestern willow flycatcher survey data and information: 2003-2014. TucsonArizona: Bureau of Land Management.

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 □nal survey and nest monitoring report. Arizona Game and Fish Department, Research Branch, Research Technical Guidance Bulletin 10.

Finch, D.M. and S.H. Stoleson, eds. 2000. Status, ecology, and conservation of the southwesternwillow flycatcher. Gen. Tech. Rep. RMRS-GTR-60. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 131 p.

Garrett, C. 2016. February 16, 2016 email from Chris Garrett, SWCA to Susan Sferra, U.S. Fish and Wildlife Service, clarifying that habitat impacts were not assumed to occur beyond the estimated boundary of the shallow alluvial aquifers along Cienega Creek and Empire Gulch, unless those areas are directly disturbed by the mine footprint.

Institute for Bird Populations. 2006. MAPS breeding status information. Available at: http://www.birdpop.org/nbii2006/status/statusresults.asp?strStation=12334. Accessed January 9, 2012.

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.

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.

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.

Paxton, E.H., T.C. Theimer, and M.K. Sogge. 2007. Tamarisk biocontrol using tamarisk beetles: potential consequences for riparian birds.in the southwestern U.S. Condor 113(2):255–265.

Pima Association of Governments. 2015. 2015 Annual Report. Local Drought Impact Group. Pima County. Tucson, Arizona.

Powell, B. 2013. Water Resource Trends in the Cienega Creek Natural Preserve, Pima County, Arizona. An unpublished report to the Pima County Flood Control District. Tucson, Arizona: Pima County Office of Sustainability and Conservation. August.

Powell, B., L. Orchard, J. Fonseca, and F. Postillion. 2014. Impacts of the Rosemont Mine on hydrology and threatened and endangered species of the Cienega Creek Natural Preserve. Pima County, Arizona.

Radke, M. 2015. Discussion between Marcia Radke, Bureau of Land Management, and Susan Sferra, U.S. Fish and Wildlife Service, regarding willow flycatcher habitat and detections in Empire Gulch and upper Cienega Creek. Dec 9, 2015.

Radke, M. 2016. E-mail correspondence from Marcia Radke, Bureau of Land Management, to Susan Sferra, U.S. Fish and Wildlife Service. Re: Request for input on current and future Willow Flycatcher habitat in Empire Cienega and Cienega Creek. Jan 26, 2016.

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.

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., Ahlers, Darrell, and Sferra, S.J., 2010, A natural history summary and survey protocol for the Southwestern Willow Flycatcher: U.S. Geological Survey Techniques and Methods 2A-10, 38 pp.

Stillwater Sciences. 2015. El Rio Vegetation Management Plan, Lower Gila River, Maricopa County, AZ-Draft Interim Report #2: Reliminary Vegetation Management Units and Implementation Elements. Prepared by Stillwater Sciences for the Flood Control District of Maricopa County.

Tetra Tech. 2010. Regional Groundwater Flow Model, Rosemont Copper Project. Tetra Tech Project No,. 114-320874, Prepared for Rosemont Copper. Tucson, Arizona.

U.S. Fish and Wildlife Service (FWS). 1995. Biological Opinion on BLM's Cienega Creek Interim Grazing Plan on the Empire-Cienega Resource Conservation Area. (RCA1995; 2-21-95-F-177. Arizona Ecological Services Office, Phoenix

U.S. Fish and Wildlife Service (FWS). 1998a. Biological Opinion and Concurrences for BLM's Phoenix Resource Management Area and Environmental Impact Statement. (1998; 2-21-88-F-167). Arizona Ecological Services Office, Phoenix.

U.S. Fish and Wildlife Service (FWS). 1998b. Biological Opinion on the Cienega Creek Stream Restoration Project. (1998; 2-21-98-F-373). Arizona Ecological Services Office, Phoenix.

U.S. Fish and Wildlife Service (FWS). 2001. Biological opinion on U.S. Army Corps of Engineers (Corps) issuance of a Section 404 permit to Arizona Department of Transportation (ADOT) for construction of a scour protection project on the Interstate I-19 and frontage road bridges over Peck Canyon near the confluence with the Santa Cruz River, Santa Cruz County, Arizona. (1999; 2-21-99-F-096; 2012). Arizona Ecological Services Office, Phoenix.

U.S. Fish and Wildlife Service (FWS). 2002a. Southwestern Willow Flycatcher Recovery Plan, Region 2, Albuquerque, NM.(Appendix D, G, H, & I). Prepared by Southwestern Willow flycatcher Recovery Team Technical Subgroup, prepared for USFWS Region 2, Albuquerque, NM. I-ii +210 pp., Appendices A-0.

U.S. Fish and Wildlife Service (FWS). 2002c. Biological Opinion and Conference on Las Cienegas National Conservation Area Resource Management Plan. (2002; 02-21-02-F-162). Arizona Ecological Services Office, Arizona.

U.S. Fish and Wildlife Service (FWS). 2006. Biological Opinion for the Proposed Tamarisk Removal, Hazardous Fuels Treatment, and Boundary Fence Construction at Tumacácori National Historical Park. Phoenix, Arizona. (2006; 02-21-05-F-0829

U.S. Fish and Wildlife Service (FWS). 2011. Southwestern Willow Flycatcher Critical Habitat Revision: Proposed Rule. Federal Register 76 (2): 50542.

U.S. Fish and Wildlife Service (FWS). 2012. Programmatic biological opinion regarding the implementation of the Natural Resources Conservation Service's Working Lands for Wildlife Project for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) and its critical habitat as well as 68 other federally listed and candidate species on eligible private lands in the states of Arizona, California, Colorado, New Mexico, Texas and Utah. Phoenix, AZ. (2012; 02E0000-2012-F-0013).

U.S. Fish and Wildlife Service (FWS). 2013. Designation of Critical Habitat for the Southwestern Willow Flycatcher: Final Rule. Federal Register 78(2): 344-534.

U.S. Fish and Wildlife Service (FWS). 2014. Southwestern Willow Flycatcher (*Empidonax traillii extimus*). 5-Year Review: Summary and Evaluation. Arizona Ecological Services, Phoenix, AZ.

U.S. Forest Service (USFS). 2015a, Third supplement to the biological assessment for the Rosemont Copper Project, Rosemont Copper Company Project, Santa Rita Mountains. Prepared by SWCA Environmental Consultants. Tucson, Arizona

U.S. Forest Service (USFS). 2015b. Rosemont Copper Supplemental Information Report. Prepared by SWCA. Tucson, Arizona.

Literature Cited – Jaguar

Arizona Game and Fish Department. 2012 Rosemont Game/Hunter Effects table. Attachment to January 18, 2012, comments on the Draft Environmental Impact Statement. Phoenix, Arizona.

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., and C.A. López-González. 2001. Borderland jaguars: tigres de la frontera. University of Utah Press. 170 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.

Childs, J. L. 1998. Tracking the felids of the borderlands. Printing Corner Press, El Paso, TX. 77 pp.

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.

Figueroa, O. 2013. The ecology and conservation of jaguars in central Belize. PhD Thesis. University of Florida, Florida, USA.

Glenn, W. 1996. Eyes of fire: encounter with a borderlands jaguar. Printing Corner Press, El Paso, Texas. 28 pp.

Hernandez-Santin. 2007. Movements and range sizes of jaguars in Paraguay based on GPS-telemetry. MSc Thesis. Sul Ross State University, Texas, USA.

López-González 2011, pers. comm.

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.

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.

Powell, R.A. and M.S. Mitchell. 2012. What is a home range? Journal of Mammalogy, 93(4):948-958.

Rabinowitz, A., and K.A. Zeller. 2010. A range-wide model of landscape connectivity and conservation for the jaguar, Panthera onca. Biological Conservation 143: 939-945.

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.

Sanderson, E.W., and K. Fisher. 2013. Jaguar Habitat Modeling and Database Update (Final Report). Wildlife Conservation Society. Bronx, New York. 10 pp. plus appendices.

Seymour, K.L. 1989. *Panthera onca*. Mammalian Species 340:1-9.

Swank, W.G. and J.G. Teer. 1989. Status of the jaguar - 1987. Oryx 23:14-21.

U.S. Fish and Wildlife Service (FWS). 2012. 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). 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Jaguar: Proposed Rule. Revised. 78 FR 39237-39250.

U.S. Fish and Wildlife Service (FWS). 2014. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Jaguar: Final Rule. 79 FR 12571-12654.

Literature Cited – Ocelot

Aprile G., Cuyckens, E., De Angelo, C., Di Bitetti, M., Lucherini, M., Muzzachiodi, N., Palacios, R., Paviolo, A., Quiroga, V. and Soler, L. 2012. Family: Felidae. In: R.A. Ojeda, V. Chillo, Vand G.B. Díaz Isenrath (ed.), Libro Rojo de los Mamíferos Amenazados de la Argentina, SAREM, Mendoza.

Avila-Villegas, S. and J.A. Lamberton-Moreno. 2013. "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. 2013. 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., E. Garding, and D. Majka. 2008. Arizona Missing Linkages: Patagonia – Santa Rita Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University. http://corridordesign.org/dl/linkages/reports/Patagonia-SantaRita_LinkageDesign.pdf

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.

Culver M, Malusa S, Bugbee C, Childs J, Emerson K, Fagan T, Harveson P, Haynes L, Sanderson J, Sheehy J, Skinner T, Smith N, Thompson K, Thompson R. 2015. Jaguar Surveying and Monitoring in the United States. Final Completion Report for USFWS Contract Number F11PXO5778.

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.

Emmons, L.H. 1988. A field study of ocelots (*Felis pardalis*) in Peru. Review of Ecology (*Terre Vie*) 43:133-157.

Featherstone, R., S. Jacobs, S. Avila-Villegas, and S. Doumas. 2013. Wildlife Surveys and Monitoring with the use of remote camera traps in the Greater Oak Flat Watershed near Superior, Arizona. Pages 441-447 *in* G.J. Gottfried, P.F. Folliott, B.S. Gebow, L.G. Eskew, and L.C. Collins, editors. Merging science and management in a rapidly changing world: biodiversity and management of the Madrean Archipelago. RMRS-P-67. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

Fernandez, E. C. 2002. Ocelot (*Leopardus pardalis*) ecology in the Chamela-Cuixmala Biosphere Reserve, Jalisco, Mexico. M.S. thesis. University of Wyoming, Laramie, WY.

Gómez-Ramírez, M.A. 2015. Densidad poblacional del ocelote Leopardus pardalis en Sahuaripa, Sonora, México. Thesis, Universidad Autónoma de Querétaro, Querétaro México.

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.

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.

Murray, J. L. and G. L. Gardner. 1997. *Leopardus pardalis*. Mammalian Species 548:1-10.

Oliveira, T.G. de, Almeida, L.B. de and Campos, C.B. de. 2013. Avaliação do risco de extinção da jaguatirica Leopardus pardalis no Brasil. Biodiversidade Brasileira 3(1): 66-75.

Stasey, W.C. 2012. Evaluating translocation strategies for ocelot in the Tamaulipan Biotic Province.

Dissertation. Texas A&M University - Kingsville, Kingsville, Texas, USA.

U.S. Fish and Wildlife Service (FWS). 2010. Draft Ocelot *(Leopardus pardalis)* Recovery Plan (revised). FWS, Southwest Region, Albuquerque, NM. 170 pp.

Literature Cited – 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). 2009a. Lesser long-nosed bat roost count summary data (2005 – 2009) provided by Angela McIntire, AGFD Bat Program Manager, to Scott Richardson, FWS, on August 13, 2009. Arizona Game and Fish Department, Phoenix, AZ.

Arizona Game and Fish Department (AGFD). 2009b. 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.

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.

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.

Buecher, D.C., R. Sidner, T. Strong, and A.L. Best. 2010. *Rosemont Holdings 2009 Bat Roost Survey*. Project No. 1049.14 CCO2 350B. Tucson, Arizona: WestLand Resources Inc. January 14.

Buecher, D.C., R. Sidner, T. Strong, and A.L. Best. 2011. *Rosemont Project 2010 Bat Roost Surveys*. Project No. 1049.18 A 345. Tucson, Arizona: WestLand Resources Inc. September.

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.

Currie, R.R. 2001. An overview of the response of bats to protection measures. In: Vories, K.C. and Throgmorton D., editors. Proceedings of bat conservation and mining: A technical interactive forum. Carbondale, IL: United States Department of the Interior. Pp. 173 – 183.

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.

Derusseau, S.N. and N.J. Huntly. 2012. Effects of gates on the nighttime use of mines by bats I northern Idaho. Northwestern Naturalist 93: 60 – 66.

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.

Gauthreaux, S.A., Jr., and C. G. Belser. 2006. Effects of artificial night lighting on migrating birds. Pages 67-93. In: Rich, C., and T. Longcore, eds. 2006. Ecological Consequences of Artificial Night Lighting. Island Press, Washington.

Gentry, H.S. 1982. Agaves of continental North America. Pages 443-447 and 538-545, University of Arizona Press, Tucson, Arizona.

Goodquarry. 2011. Dust Impacts: Ecology and agriculture. Available at: http://www.goodquarry.com/article.aspx?id=56&navid=2. Accessed May 3, 2011.

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.

Hughes. T. 2011. Biological assessment for the Bureau of Land Management's Copper Duke AML project. Consultation #02EAAZ00-2012-I-0122.

King, R. H. 2005. Microclimate Effects from Closing Abandoned Mines with Culvert and Bat Gates. Bureau of Land Management, Technical Note 416. 142 pp.

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.

Monrad. 2012. Rosemont Copper Project light pollution mitigation report: Revision1, 18 June 2012.

Nabhan, G.P. and T.H. Fleming. 1993. The conservation of new world mutualisms. Conservation Biology 7(3): 457 – 459.

NoiseQuest. 2011. What Does Noise Affect? Available at: http://www.noisequest.psu.edu/pmwiki.php?n=NoiseAffect.Wildlife. Accessed August 29, 2011.

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.

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.

Petryszyn, Y. 1997. Personal communication with Yar Petryszyn, University of Arizona, regarding ongoing lesser long-nosed bat work.

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.

Rich, C., and T. Longcore, eds. 2006. Ecological Consequences of Artificial Night Lighting. Island Press, Washington. 458 p.

Richardson, S. 2008. Personal communication with Scott Richardson, U.S. Fish and Wildlife Service, regarding increased reports of lesser long-nosed bats using hummingbird feeders in the Tucson area.

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.

Snow, T. 1999. Personal communication with Tim Snow, Nongame Biologist in Region V, regarding the AGFD lesser long-nosed bat capture and telemetry project.

Spanjer, G.R and M.B Fenton. 2005. Behavioral responses of bats to gates at caves and mines. Wildlife Society Bulletin 33: 1101 – 1112.

Steidl, R. 2001. Personal communication with Rober t Steidl, University of Arizona, regarding telemetry results from the graduate student project (Holly Ober) being conducted on lesser long-nosed bats in southeastern Arizona.

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. 2009. Annual report for threatened and endangered species permit No. TE19458. Resources Management Division. Organ Pipe Cactus National Monument, Ajo, Ariozna.

Tibbitts, T. 2006. Annual report for threatened and endangered species permit No. TE19458. Resources Management Division. Organ Pipe Cactus National Monument, Ajo, Arizona.

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 (FWS). 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 (FWS). 1997. Lesser long-nosed bat recovery plan. Albuquerque, New Mexico. 49pp.

U.S. Fish and Wildlife Service (FWS). 2003. Biological Opinion for the Ongoing Activities by the Marine Corps Air Station - Yuma (02-21-95-F-0114 R4).

U.S. Fish and Wildlife Service (FWS). 2004. Biological and Conference Opinion for the BLM Arizona Statewide Land Use Plan Amendment for Fire, Fuels, and Air Quality Management (02-21-03-F-0210).

U.S. Fish and Wildlife Service (FWS). 2005a. 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 (FWS). 2005b. Programmatic Biological and Conference Opinion on the Continued Implementation of the Land and Resource Management Plans for the Eleven National Forests and National Grasslands of the Southwestern Region .

U.S. Fish and Wildlife Service (FWS). 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 (FWS). 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 (FWS). 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.

U.S. Fish and Wildlife Service (FWS). 2007d. Letter of concurrence for informal section 7 consultation on the Pole Cat, and Oak Canyon Allotment AMPs. U.S. Forest Service.

U.S. Fish and Wildlife Service (FWS). 2008. Letter of concurrence for informal section 7 consultation on the Canada del Oro and other allotments. U.S. Forest Service, CoronadoNational Forest.

U.S. Fish and Wildlife Service (FWS). 2009. Biological Opinion on SBInet Ajo-1 Tower Project, Ajo Area of Responsibility, U.S. Border Patrol, Tucson Sector, Arizona (22410-F-2009-0089)

U.S. Fish and Wildlife Service (FWS). 2010. Biological Opinion for the National Park Service's AML Mine Closure projects in southern Arizona. Consultation 22410-2009-F-0452. Arizona Ecological Services Office, Phoenix.

U.S. Fish and Wildlife Service (FWS). 2015. Letter of concurrence for informal section 7 consultation on the Sunflower Allotment analysis. U.S. Forest Service, Tonto National Forest.

Weiss, J.L., and J.T. Overpeck. 2005. Is the Sonoran Desert losing its cool? Global Change Biology 11:2065-2077.

Westland Resources. 2009e. *Agave Survey of the Rosemont Holdings and Vicinity*. Project No. 1049.10 350 350. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources, Inc. March 11.

Westland Resources. 2009f. *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. 2011f. *Preliminary Summary of 2011 Rosemont Bat Roost Survey*. Project No. 1049.23 B 300. Prepared for Rosemont Copper Company. Tucson, Arizona: WestLand Resources Inc. October 28.

WestLand Resources. 2012f. Rosemont Copper Project: Potential effects of lighting associated with the Rosemont Project on Endangered Species. Unpublished report, 30 November 2012.

WestLand Resources. 2012g. Rosemont Copper Project: Potential effects of lighting associated with the Rosemont Project on Endangered Species. Unpublished report, 07 December 2012.

Westland Resources, 2012j. Rosemont Copper Project: Biological Assessment Supplement Lesser Long-Nosed Bat Forage and Roost Conservation Measures. December 2012.

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*).

Literature Cited – Pima Pineapple Cactus

Alford, E., J. Brock, and G. Gottfried. 2005. Effects of fire on Sonoran Desert plant communities. USDA Forest Service Proceedings RMRS-P-36.

Baker, M. 2003. A morphomeric analysis of the pineapple cactus, *Coryphantha robustispina*. First progress report. Prepared for U.S. Fish and Wildlife Service under the Arizona Board of Regents, University of Arizona, Tucson, Arizona.

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. 2011. A demographic study *of Coryphantha robustispina* ssp. *robustispina*: Progress report for the 2011 field season. Status report prepared for Bureau of Reclamation. Glendale, Arizona.

Baker, M. 2013. A demographic study of *Coryphantha robustispina* ssp. *robustispina* - Progress report for the 2012 field season and final report for the study. November 7, 2013. 66 pp.

Baker, M. and C. Butterworth. 2013. Geographic distribution and taxonomic circumscription of populations within Coryphantha section Robustispina (Cactaceae). American Journal of Botany 100(5):984-997.

Brooks, M. and D. Pyke. 2002. Invasive plants and fire in the deserts of North America. Pp. 1–14 *In*: K. Galley and T. Wilson (editors). Proceedings of the Invasive Species Workshop: the Role of Fire in the Control and Spread of Invasive Species. Fire Conference 2000: the First National Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 11, Tall Timbers

Research Station, Tallahassee, FL.

Brooks, M. and J. Chambers. 2011. Resistance to invasion and resilience to fire in desert shrublands of North America. Rangeland Ecology and Management 64(5):431-438.

Butterworth, C. 2010. Genetic study of Pima pineapple cactus (*Coryphantha robustispina* ssp. *robustispina*) and phylogenetic study of the genus *Coryphantha*. Final Report prepared for the U. S. Department of the Interior Bureau of Reclamation, Phoenix, Arizona. 30 pp.

CLIMAS. 2015. SW Climate Outlook. http://www.climas.arizona.edu/swco/may-2015/southwest-climate-outlook-may-2015. Accessed June 5, 2015.

Coronado National Forest. 2010. Pima pineapple cactus longevity from 1995 to 2010. Alisos Allotment, Sierra Vista Ranger District.

Fehlberg, S. and T. Nidey. 2015. Population genetic study of the Cochise pincushion cactus (*Coryphantha robbinsorum*) in Arizona. 17 pp.

Goodquarry. 2011. Dust Impacts: Ecology and agriculture. Available at: http://www.goodquarry.com/article.aspx?id=56&navid=2. Accessed May 3, 2011.

Humphrey, R. R. and A. C. Everson. 1951. Effects of fire on a mixed grass-shrub range in southern Arizona. Journal of Range Management. 4:264-266.

Karl, T.R., J.M. Melillo, and T.C. Peterson. 2009. Global Climate Change Impacts in the United States. Cambridge University Press New York, NY. Available online from: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/download-the-report. Accessed on February 28, 2012.

Maender, J. 1993. King's Ranch, State Lease 05-717. Notes to accompany photographic prints regarding *Coryphantha scheeri* var. *robustispina* located within prescribed burn of 1991. March 31, 1993 and April 7, 1993.

Mattson, W. and R. Haack. 1987. The role of drought in outbreaks of plant-eating insects. BioScience 37(2):110-118.

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, University of Arizona. 82 pp.

McDonald, C. and G. McPherson. 2011a. Absence of a grass/fire cycle in a semiarid grassland: Response to prescribed fire and grazing. Rangeland Ecology and Management 64(4):384-393.

McDonald, C. and G. McPherson. 2011b. Fire behavior characteristics of buffelgrass-fueled fires and native plant community composition in invaded patches. Journal of Arid Environments 75(11): 1147–1154.

McDonald, C. and G. McPherson. 2006. Conservation of the rare Pima pineapple cactus (Coryphantha scheeri var. robustispina): recruitment after fires and pollination in the Altar Valley of Southern Arizona. Report prepared for the Bureau of Reclamation, Phoenix, Arizona. 85pp.

McLaughlin, S. and J. Bowers. 1982. Effects of wildfire on a Sonoran Desert plant community. Ecology 63(1):246-248.

McPherson, G. and J. Weltzin. 2000. Disturbance and climate change in United States / Mexico borderland plant communities: A state-of-the-knowledge review. USDA FS RMRS GTR 50. April 2000. 30pp.

Mills, G. 1991. Miscellaneous notes on *Coryphantha scheeri* var. *robustispina.* Unpublished report. U. S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona. 23 pp.

Nobel, P.S. 1984. Extreme temperatures and thermal tolerances for seedlings of desert succulents. Oecologia (Berlin) 62:310-317.

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. 2013. Pp. 1-20 *In*: Garfin, G. A. Jardine, R. Merideth, M. Black, S. LeRoy. 2013. Assessment of climate change in the southwest United States: A report prepared for the national climate assessment. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Phillips, A., B. Phillips, and N. Brian. 1981. Status report for *Coryphantha scheeri* var. *robustispina.* Report submitted to Office of Endangered Species, Fish and Wildlife Service, U. S. Department of the Interior, Albuquerque, New Mexico. 15 pp.

Pima County. 2015. Pima County Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*) conservation bank status update, January 2015. 4 pp.

Reichenbacher, F. W. 1985. Rare plant survey: Selected areas of the Schuk Toak and San Xavier Districts of the Papago Indian Reservation, Sells, Arizona. 72 p.

Robinett, D. 1996. John King – Anvil Ranch. Summary of information regarding a 1995 controlled burn and 1996 observations. Note in File. 1 p.

Roller, P. 1996. Distribution, growth, and reproduction of Pima pineapple cactus (Coryphantha scheeri Kuntz var. robustispina Schott). M.S. Thesis University of Arizona, Tucson, Arizona.

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. 267-274.

Schmalzel, R. 2000. Growth and age-structure of a clonal cactus, Coryphantha scheeri var. robustispina, and notes on its performance with respect to soil age and to banner-tailed kangaroo rat mounds.

West San Pedro Pasture, King Anvil Ranch. Arizona Department of Agriculture Final Report, June 2000. 11 pp. plus appendices.

Schmalzel, R. 2002. Quarterly report # 9. *Coryphantha scheer*i var. *robustispina* study to National Fish and Wildlife Foundation, Tucson, Arizona. 41 pp.

Schmalzel, R. and M. McGibbon. 2010. Pima Pineapple Cactus (*Coryphantha robustispina*), Third Monitoring Report for the Phase I Conservation Land (T 17S, R 9E, NW portion of section 26) of the Palo Alto Ranch Conservation Bank, Altar Valley, Pima County, Arizona. Report prepared for the Altar Valley Conservation Alliance, Anvil Ranch, Tucson, Arizona and the U. S. Fish and Wildlife Service, Phoenix, Arizona. 35 pp.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316:1181-1184. Available online from: http://www.sciencemag.org/content/316/5828/1181.full.pdf. Accessed on August 21, 2012.

Thomas, P. 1991. Response of succulents to fire: A review. International Journal of Wildland Fire 1(1): 11-22.

Thomas, P. 2006. Mortality over 16 years of cacti in a burnt desert grassland. Plant Ecology 183:9-17.

Tonn, S. Email from Sabra Tonn, HDMS Program Supervisor, Arizona Game and Fish Department, to Julie Crawford, U.S. Fish and Wildlife Service Plant Ecologist. November 4, 2015.

United States Fish and Wildlife Service (FWS). 1998. Biological Opinion for the proposed issuance of a permit to authorize discharge of fill material into 2.7 ha (6.6 acres) of unnamed washes for the residential development of property named Las Campanas Housing Development. May 26, 1998.

United States Fish and Wildlife Service (FWS). 2000 Biological Opinion for the Tohono O'odham Gaming Authority located in Pima County, Arizona. January 5, 2000.

United States Fish and Wildlife Service (FWS). 2001. Biological Opinion for the proposed construction of the Green Valley Performing Arts Center on 7.7-ha (19-ac) site in Green Valley, Arizona. December 20, 2001.

United States Fish and Wildlife Service (FWS). 2015a. Memo to Files: March 9, 2015 - *Coryphantha scheeri* var. *robustispina* (Pima pineapple cactus)(PPC) partial survey of the Pima County PPC Conservation Bank, Madera Highlands. 1 p.

United States Fish and Wildlife Service (FWS). 2015b. Memo to Files: April 13, 2015 – *Coryphantha scheeri* var. *robustispina* (Pima pineapple cactus (PPC)) partial re-measure of US Forest Service east and west exclosure individual plants (Alisos Allotment, Mesquital Pasture, next to the Granger Corrals). 7 pp.

U.S. Fish and Wildlife Service. 2016. Internal Review Draft Recovery Plan for *Coryphantha scheeri* var.

robustispina (Pima pineapple cactus), April 2016. U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 74 pp.

Vasek, F.C., H.B. Johnson, and D.H. Eslinger. 1975. Effects of pipeline construction on creosotebush scrub vegetation of the Mojave Desert. Madroño 23: 1-13.

WestLand Resources Inc. 2012. Helvetia Ranch North Parcel Pima Pineapple Cactus Survey. WestLand Job No. 1049.21. Prepared for Rosemont Copper Mining. Tucson, Arizona: WestLand Resources Inc. April 19.

WestLand Resources, Inc. (Westland). 2015. 2015 Palo Alto Pima pineapple cactus conservation bank monitoring. A report prepared for the Altar Valley Conservation Alliance. August 26, 2015. 26 pp.

Literature Cited - Mexican Spotted Owl (see Appendix A)

Douglas, J. 2015. Spotted owl near Box Canyon. Email communication between Angela Barclay, Senior Natural Resources Specialist, SWCA Environmental Consultants, and Jason M. Douglas, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service.

Forest Service (FS). 2014. Correspondence of August 22, 2014, from James Copeland, Nogales District Ranger, Coronado National Forest to Kathy Arnold, Vice President of Environmental and Regulatory Affairs, Rosemont Minerals, regarding approval of activities on National Forest System Roads incidental to Rosemont's activities on private lands on the east side of the Santa Rita Mountains. 2 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.

SWCA Environmental Consultants. 2015. Use of Wildlife Photos for Ocelot/Jaguar Occurrence. Memorandum to file from Chris Garrett, SWCA Environmental Consultants. Tucson, Arizona. March 4.

Tetra Tech. 2009. 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. 2008. Background Ambient Noise Study. Project No. 114-320776 (100-SFO-T22436). Prepared for Rosemont Copper Company. Tucson, Arizona: Tetra Tech. October.

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.