

DRAFT

Memorandum

To: File

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From: Chris Garrett, SWCA

Date: June 22, 2013

Re: Incorporation of Geomorphic Reclamation Techniques and Ideas into the Rosemont Copper Project

The purpose of this memo is to summarize the process followed by the Coronado National Forest (Coronado) in order to investigate and attempt to incorporate elements of geomorphic reclamation (also commonly known as “landforming”) into the project design.

Geomorphic reclamation is a process that takes place during closure of a mine that results in an entirely different topography than standard closure. The concept of geomorphic reclamation is to “...recreate a topography that reflects the natural analogs of both the underlying area to be disturbed as well as that which surrounds it in terms of character and geomorphology, relating in particular to existing landforms, slope shapes, rock presence, and run-off patterns, while creating opportunities for diverse revegetation...” (Schor 2010) Specifically, geomorphic reclamation is intended to eliminate some of the standard elements of conventional mine design: uniform slopes, large plateaus, and abrupt changes from man-made to natural topography. Instead the goal is to better mimic both the form and function of the natural landscape.

Several specific investigations were undertaken by the Coronado in an attempt to incorporate these concepts into the Rosemont Copper project.

- 1) Prior to the DEIS, development of a stand-alone alternative incorporating geomorphic reclamation concepts;

- 2) Research and interviews to determine the state-of-the-art with respect to incorporating geomorphic reclamation into existing mines, and to develop additional ideas for incorporation into the Rosemont Copper project;
- 3) In response to public comments on the DEIS, investigation of whether geomorphic reclamation concepts could be incorporated specifically into the Barrel (Preferred) Alternative.

Development of a Stand-Alone Alternative

The concept of geomorphic reclamation was brought to the attention of the Coronado during the alternatives development process. In 2010, on behalf of the Coronado, SWCA contracted Mr. Horst Schor to undertake the development of a geomorphic reclamation alternative. Mr. Schor, a recognized expert in geomorphic reclamation design and coauthor of *Landforming: An Environmental Approach to Hillside Development, Mine Reclamation, and Watershed Restoration* (Schor & Gray 2007), developed a landform utilizing geomorphic reclamation principles intended to encompass the combined 1.2 billion cubic yard volume of all the waste rock, tailings, and spent heap material produced by the proposed Rosemont Mine. The Coronado provided several sideboards for development of the alternative, including the avoidance of McCleary Canyon, eastern limit of SR 83, southern limit of the watershed boundary, and western limit of the pit and plant site. The Barrel Alternative was used as the starting point for Mr. Schor's work, to be modified within the sideboards given above. The constraints, process, and results are documented in the report: Schor, H.J., 2010. *Landform Design Report for the Rosemont Mine Project*, May 19.

Given the sideboards established by the Coronado, the conceptual alternative developed by Schor did not accommodate the full amount of material, and the alternative falls approximately 12 percent short of containing the necessary total volume of 1.2 billion cubic yards. The design prepared by Schor would only be feasible by conducting partial backfill of the pit, disposing of material elsewhere, or reconfiguring the landform during final design. (Note that both partial and full pit backfilling as alternatives have been fully investigated by the Coronado; the results of the pit backfill investigation are summarized in Chapter 2 of the FEIS and described in a separate process paper in the record.)

Components of the Schor alternative ultimately led to the development of the Barrel Trail Alternative. However, the Barrel Trail alternative could not be considered to be a full geomorphic reclamation alternative.

Key process steps:

- February 17, 2010. Report produced by Golder Associates titled: *Rosemont Mine Landforming, Evaluation of Mine Waste Slope Geometry*. (Report available in project record)
- March 31, 2010. Memorandum produced by Dale Ortman titled: *Landform Layout Constraints and Comments Provided by Rosemont Copper Company – Final Version for Inclusion in H. Schor Report*. (Memo available in project record)
- May 19, 2010. Schor report titled *Landform Design Report for the Rosemont Mine Project*. (Report available in project record)
- May 24, 2010. Meeting to discuss Schor alternative. (Minutes available in project record)
- June 4, 2010. Meeting to discuss Schor alternative. (Minutes available in project record)
- July 9, 2010. Final meeting to discuss Schor alternative, conclusion of landforming task workgroup (Minutes available in project record)

Investigation of Geomorphic Reclamation Concepts

The Forest Supervisor directed the team to continue to investigate ways to apply geomorphic concepts to the Barrel Alternative, to the extent possible. The team was not directed to fully develop a viable alternative that utilized geomorphic reclamation (which would have needed a footprint similar to or larger than the Barrel Trail Alternative). However, this did not halt the interest in incorporating elements of geomorphic reclamation into the Preferred Alternative that was identified in the October 2011 DEIS. The Coronado developed an additional approach in four phases to identify what state-of-the-art procedures or techniques might have been attempted or used at existing mines that could be brought forward for consideration in the Rosemont Copper project:

- Phase 1 – Telephone Survey to Locate Potential Examples
- Phase 2 – Questionnaire to Gather and Record Information
- Phase 3 – Interview to Gather and Record Additional Information (if required)
- Phase 4 – Report of Findings

Dale Ortman, PE was subcontracted by SWCA to manage and conduct the investigation. The results of Phases 1 and 2 were summarized in a status briefing for the Coronado dated September 20, 2011. Between July 18, 2011 and August 29, 2011, approximately 120 individuals were contacted from federal regulatory

agencies, state regulatory agencies, academic institutions, mining companies, consulting firms, and other organizations. Of these 120 contacts, 53 consented to being provided with a written project questionnaire developed by the Coronado. From the project questionnaires sent out, 11 contacts returned questionnaires, for a total of 24 specific projects. Of these, no projects were identified by the Coronado as similar enough to Rosemont Copper to conduct further interviews (Phase 3).

Results of the investigations were analyzed and reported (Phase 4) (Ortman, D. 2011. *Project Memorandum: Geomorphic Reclamation Information Gathering Task, Preliminary Findings*. September 28). None of the projects were applicable to the Rosemont Copper project. In the end, it was concluded that the preliminary information obtained from the questionnaires was not adequate to demonstrate widespread use of geomorphic reclamation methods for mining projects of similar type and scale or subjected to similar climatic conditions as the proposed Rosemont project.

Key process steps:

- June 2011. Scope of work prepared by SWCA and approved by Coronado
- September 20, 2011. Status briefing paper. (Available in project record)
- September 28, 2011. Project memorandum with preliminary findings. (Available in project record)
- October 6, 2011. Management meeting with Forest Supervisor to review results (Minutes available in project record)
- January 9, 2012. Management meeting with Forest Supervisor to identify approach forward (Minutes available in project record)

Response to Public Comments and Redesign of Barrel Alternative

Public comments were received on the DEIS from October 2011 through January 2012. Numerous public comments were received expressing concern over both operational and post-closure stormwater management of the mine, and in particular the intent to retain stormwater on-site, even after closure. In conjunction with Rosemont Copper, the Coronado undertook a collaborative investigation to determine whether incorporating geomorphic reclamation concepts on the Preferred (Barrel) Alternative could improve downstream flows.

A series of meetings were held between February and May 2012, involving the Coronado, SWCA, Golder Associates (subcontracted through SWCA), Rosemont Copper, and their subcontractors. To initiate the process the Forest Supervisor identified several sideboards to guide the process:

- The mine facility was to remain solely on the west side of Highway 83 in order to avoid impacts to the state highway and additional Forest Service resources;
- Certain archaeological sites (particularly the "Ballcourt" site) were to be avoided;
- The Barrel Alternative footprint was not to be expanded in order to avoid additional impacts to habitat for wildlife and plants (including habitat for threatened, endangered and sensitive species), and Waters of the U.S.; and
- For the purposes of controlling any potential water quality issues, it was desirable to maintain the hydrologic sink caused by the mine pit lake. This is pertinent because it precludes full or partial backfill of the mine pit. As noted above, the feasibility of full or partial pit backfill was investigated separately by the Coronado.

The landforming team (without Rosemont Copper) met on February 3, 2012 and agreed on a list of conceptual goals for the design:

- Long term stability, control of erosion, and low post-closure maintenance were desirable.
- Due to the desire to maintain the hydraulic sink, backfill of material into the pit was not to be considered.
- Based on concerns raised by the public and cooperating agencies (including the USEPA and USACE), the IDT determined that it was important to route as much surface water downstream to Davidson Canyon as practicable. In particular, it was determined that post-closure no water should be stored on the top or benches of the waste rock/tailings facility, not only to allow that water to proceed downstream but to reduce the potential for infiltration of stormwater into the waste rock facility.
- In order to minimize potential long-term maintenance issues, the ID Team determined it was desirable to remove under drains if feasible.
- As noted, one of the reasons that investigation of geomorphic reclamation was undertaken was concern over impacts to visual resources. While mitigating visual impacts was desirable across the entire landform, the IDT focused concern over visual resources on the portion of the landform most visible from Highway 83, Sonoita, and recreationists on the Forest. It was determined that visual mitigation was most desirable on the east side of the landform, and was less critical on the west (pit) side of landform. Visual mitigation concepts considered included reducing the

number of benches and applying more natural-looking contours to the profile (as opposed to flat tops like many tailings facilities).

On February 14, 2012, the landforming team (without Rosemont Copper) met with the Forest Supervisor and several consultants that were brought in with specific expertise in landforming mining projects: Dirk van Zyl (University of British Columbia) and George Annandale (Golder Associates). The team's goals were proposed to the Forest Supervisor. The consultants also discussed the realities and limitations of applying certain techniques to mining sites, including the requirement for hard engineered structures for erosion control, and limitations of landforming techniques. They also provided some examples of before and after pictures from mine sites that have attempted to integrate some of these measures. The Forest Supervisor directed the team to continue exploring these measures and apply them to the Barrel alternative without expanding the footprint.

On March 22, 2012, the landforming team met and two stormwater/landform concepts were discussed to be more thoroughly developed. The following lists requirements to integrate into the design:

- Surface water structure stability & resists erosion, to prevent long term maintenance issues and promote post-closure watershed health.
- No pit backfill, keep within the preferred alternative footprint, in order to maintain the hydraulic sink control for potential water quality issues.
- Route stormwater to Davidson Canyon to the greatest extent possible to reduce impacts to riparian systems and Outstanding Arizona Waters.
- Iterative design review, to allow incorporation of Forest input into the design.
- No stored water on top of waste/tails, to reduce the potential for generation of seepage.
- Hard engineering/steep slopes on west side, if needed, to increase volume of landform and allow for greater incorporation of geomorphic reclamation concepts.
- Remove flow through drains under tails- all together or at closure- if possible, to reduce long term maintenance issues and reduce potential for contamination of stormwater.
- Avoid flat tops, with water drainage to west side (preferred), in order to reduce visual impacts.

Two concepts were put forth for preliminary design:

Geomorphic Design:	Conventional Design:
Overall visual/landform priorities: east, then N/S, then west	Cross and down drains (benches)
Undulating tops (more hilly)	No rip rap drop structures
Hidden drainage structures	Drop structures- robust & flexible
Concave slopes (per Golder report)	Straight line slopes 3:1
Irregular ridge profiles without concentrating water flow	Allows drainage toward east (including structures)
Durability of waste rock supply over time	No repetitive/regular “wavy gravy” landforming
West side can be different than east side	

Rosemont's engineering and design staff worked with the Landforming team during the months of March and April to deliberate over options to achieve these goals and designs. When concerns of reduced capacity of these landforms were discussed, Rosemont's design team was able to make up volumes by increasing the height and contours on top of the waste rock piles.

The team presented a final three options to the Forest Supervisor (as described in CDM Memo dated 5/4/2012) on May 8, 2012:

- **Option 1: Conventional approach-** The slopes of the landform include 50-foot wide benches spaced between 3H:1V (horizontal:vertical) slopes that are approximately 300 to 350 feet long. This corresponds to a vertical rise of about 100 feet between benches and an overall out-slope of about 3.5H:1V. Benches include drainage channels/swales to convey stormwater to the toe of the landform.
- **Option 2: Tiered slope approach** - This landform has fewer benches. It is similar to the conventional approach but incorporates a 100-foot wide bench between 3H:1V slopes that are approximately 600 to 700 feet long. This corresponds to a vertical rise of about 200 feet between benches and an overall slope of about 3.5H:1V. Benches include larger drainage channels/swales to convey stormwater to the toe of the landform.
- **Option 3: Concave tiered slope approach-** This option is similar to Option 2 with respect to slope length and bench sizing but the slope between the benches is shaped in a concave fashion with increasing steepness towards the top of the slope. This is based on Figure 6 of the Golder report (2010), the base slope would start at 5H:1V, gradually steepening to 2H:1V at the top of slope with an overall out-slope slope of about 3.6H:1V.

The Forest Supervisor decided to move forward with applying the Option 2 to the landform with a small portion of the lower slope (northeast section, bottom

tier) to be a concave slope in order to provide some long term understanding of how concave slopes could be used on a mine site. Option 2 provided a balance between improving stormwater management, incorporating shaping and geomorphic design concepts, and reducing the need for long-term maintenance.

The primary success of the redesign was to allow more water to flow downstream. Prior to the redesign, modeling indicated that about 34% of the runoff would be lost to the downstream watershed. The redesign reduced this loss to 17% by eliminating storage on the top and benches of the waste rock and tailings facilities.

Key process steps:

- February 14, 2012 – Kickoff meeting for Barrel Alternative refinement, development of criteria and constraints by Coronado (Minutes available in project record)
- March 22, 2012 – Meeting to convey criteria/constraints to Rosemont Copper (Minutes available in project record)
- April 19, 2012 – Meeting to review preliminary designs from Rosemont Copper (Minutes available in project record)
- April 27, 2012 – Meeting to review design refinements from Rosemont Copper (Minutes available in project record)
- May 4, 2012 – Meeting to review design refinements from Rosemont Copper (Minutes available in project record)
- May 6, 2012 – Written comments received from Golder Associates on design refinements (Notes available in project record)
- May 8, 2012 – Management meeting with Forest Supervisor to present design alternatives; decision from Forest Supervisor on design to pursue (Minutes available in project record)
- May 11, 2012 – Letter sent to Rosemont Copper by Coronado requesting revisions based on selected design (Correspondence available in project record)

Ramifications of Redesign – Removal of Heap Leach and Underdrains

Throughout June and July, Rosemont Copper began developing detailed stacking and engineering plans for the conceptual design selected by the Forest Supervisor. The landforming team worked directly with Rosemont Copper's engineering and design team throughout the work described above, and Rosemont had committed to the Forest that the options presented to the Forest Supervisor were feasible, both technically and financially.

Rosemont Copper notified the Forest Supervisor on 7/10/2012, that the redesign had some unintentional consequences: "the operational sequencing required

under this alternative does not allow Rosemont sufficient time to complete the leaching process and fully recover the copper from the oxide ore materials.” Rosemont Copper indicated in this letter that after reviewing public comments themselves, and considering ongoing concerns about the heap leach facility presented by agencies, including the USEPA, they recommended that, since the phasing did not allow heap leach to be conducted successfully, the heap leach be voluntarily removed from consideration in the Barrel Alternative.

The Forest Service does not have the legal authority to require Rosemont Copper to forgo any of their mineral processing, as described in Chapter 1 of the EIS. Therefore, the Coronado could not require Rosemont Copper to remove the heap leach facility from the Barrel alternative- or from any other alternative. Rosemont Copper could have requested further changes to the Barrel alternative layout in order to still be able to access the heap leach area as long as necessary to exhaust that mineral resource. Instead, they presented the Coronado with the option to remove that facility from the Barrel alternative. The Forest Supervisor recognized this as an opportunity to reduce impacts, respond to public and agency comments, and reduce the need for long term maintenance of a heap leach facility that could affect Forest Service surface resources. The Forest Supervisor decided to remove the heap leach processing facility from the Barrel alternative, as proposed by Rosemont.

The under drains were a component of the stormwater design that Coronado consultants and specialists had a great many concerns over from the beginning of the proposed action. These concerns began with the Central Drain concept in the proposed action, and concerns over this design drove the development of the under drains used in the Phased Tailings, Barrel, and Barrel Trail alternatives in the DEIS. However, even though these under drains were seen as an improvement over the Central Drain concept, concerns about long-term maintenance and comingling of stormwater and seepage remained. The landforming team that began the work to refine the Barrel alternative in response to public comments, asked that the under drain be removed from under the tailings, or entire facility. A number of agencies, including the EPA voiced a number of concerns to the Coronado with these drains as well. Rosemont provided the opportunity to remove these in their letter and the Forest Supervisor agreed.