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January 2, 2018

Brig. General D. Peter Helmlinger
Commander, South Pacific Division
U.S. Army Corps of Engineers
1455 Market Street
San Francisco, CA 94103-1398

RE: Review of the Sonoita Creek Mitigation Project Proposal for the Proposed Rosemont Copper Mine

Dear General Helmlinger,

You will find attached a report by fluvial geomorphologist Dr. Mathias Kondolf. It consists of his analysis and critique of the Sonoita Creek restoration portion of the recent Hudbay mitigation proposal ("Final Habitat Mitigation and Monitoring Plan") for the proposed Rosemont Mine in the Santa Rita Mountains of southeast Arizona.

We appreciate the attention your office has given to the many concerns about this proposal. We hope you will also give this report careful attention as you consider Hudbay's application for a 404 permit under the Clean Water Act. Additionally, we ask that it be made part of the project record.

Sincerely,

Gayle G. Hartmann

Gayle Hartmann, president
(on behalf of the Board of SSSR)

Cc:

William James, National Mining Expert, U.S. Army Corps of Engineers
Colonel Kirk Gibbs, District Commander, Los Angeles District, U.S. Army Corps of Engineers
Kerwin Dewberry, Supervisor, Coronado National Forest
Ray Suazo, Arizona State Director, Bureau of Land Management
Alexis Straus, Acting Regional Administrator, Region 9, Environmental Protection Agency
C. H. Huckelberry, Administrator, Pima County
Edward D. Manuel, Chairman, Tohono O'odham Nation

Review of the Sonoita Creek Mitigation Project Proposal for the Proposed Rosemont Copper Mine

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29 December 2017

Report submitted to
Save the Scenic Santa Ritas
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Key Findings

The HMMP proposes to fill reaches of the existing channel of Sonoita Creek in Rail X Ranch and in Sonoita Creek Ranch, and to build a new channel a few hundred feet away elsewhere in the floodplain. The HMMP does not propose any mitigation for filling 8.9 acres of waters of the US in existing Sonoita Creek, apparently dismissing the value of Sonoita Creek by asserting that the stream is performing its functions "poorly". This unscientific assertion is not supported by any objective, quantitative assessment of "function" and is not justified.

The new channel proposed in the HMMP would have a sinuosity of 1.39, far more sinuous than the 'reference reaches' cited by the HMMP, and more sinuous than other reaches of Sonoita Creek undisturbed since 1935 (sinuosity about 1.07). The unnaturally high sinuosity of the proposed channel is evidently intended to maximize mitigation acreage.

The HMMP significantly misstates (overstates) the sinuosity of the existing reaches of Sonoita Creek and misstates (understates) the sinuosity of the proposed reconstructed channel, which could easily mislead the reader into thinking that the sinuosity of the proposed new channel was consistent with that of the reference reaches and existing reaches of Sonoita Creek.

Channel reconstructions elsewhere, with sinuous meander bends similar to those proposed for Sonoita Creek, have frequently failed, as documented in the literature. The failure mechanism is commonly by the stream cutting across constructed meander bends. Meander bends with artificially high sinuosity, such as proposed for the reconstructed channel of Sonoita Creek, would likely wash out in the first few moderate stormflows, resulting in a much straighter, shorter stream. As a result, there would be less acreage of stream channel than promised for mitigation.

The HMMP contradicts itself regarding whether the channel would be free to migrate or if it would be 'repaired' if it erodes. The HMMP states that if the channel erodes outside of its permitted meander belt, it would be controlled by riprap or rebuilt in its imposed meandering form. However, the more likely scenario is that the stream cuts a straight channel through the meander bends, but this is not acknowledged in the HMMP. If the channel is allowed to erode, it is likely wash out the meander bends upon which the mitigation acreage is based. The HMMP does not clearly state if this would trigger the cycle of 'repairs' as described in the HMMP: riprap to stabilize the channel, or complete reconstruction of the meandering channel. If the channel is not "repaired", the acreage of channel upon which the mitigation credits are based would not be sustained.

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Introduction and Scope

Rosemont Copper Company proposes to mitigate anticipated impacts to waters of the US in the Cienega Creek watershed by a channel reconstruction project on Sonoita Creek. I reviewed the Final Habitat Mitigation and Monitoring Plan (HMMP), the Final Design of the Sonoita Creek Mitigation Project (WET 2017), and other relevant documents to evaluate the proposed mitigation. In 2014-2015, I reviewed an earlier iteration of a proposed mitigation project on Sonoita Creek (Kondolf and PG Environmental 2015). At that time I walked most of the length of Sonoita Creek that would be affected by the proposed project, and examined historical aerial imagery and other sources. In preparation for the current review, I also visited the channel of Walnut Gulch in the Walnut Gulch Experimental Watershed (cited as a reference reach for the current proposal). My review is based on my field observations in 2014 and currently, review of documents and available data, and scientific literature. My review is not a comprehensive review of all aspects of the HMMP, but rather focuses on aspects of the Sonoita Creek channel reconstruction project particularly relevant to my research focus on river restoration.

Qualifications Relevant to This Review

I am a fluvial geomorphologist and Professor of Environmental Planning at the University of California Berkeley, where I teach courses in hydrology, river restoration, environmental science, and environmental planning. I conduct research on human-river interactions, including managing flood-prone lands, urban rivers, sediment in rivers and reservoirs, Mediterranean/semi-arid river processes, and river restoration, topics on which I have published over 200 journal articles, books, book chapters, and reports. I have over three decades of experience in the field of fluvial geomorphology, and my book, *Tools in Fluvial Geomorphology* (published by John Wiley & Sons 2016, now in its second edition) is a standard reference in the field. From 2002-2007, I served as a member of the Environmental Advisory Board to the Chief of the US Army Corps of Engineers, and was appointed as Clarke Scholar at the Institute for Water Resources of the US Army Corps (Washington) in 2011. I also served as a member of the Independent External Peer Review Committee for the US Army Corps of Engineers Agency Technical Review, Greater Mississippi Basin Post-Flood Assessment, 2012-2015, on two panels of the National Academy of Science (Klamath River 2005-2007, and Mississippi Delta 2012-2013), and other government advisory panels. I have provided expert testimony before the US Supreme Court, US Congress, the International Court of Justice (the Hague), the Permanent Court of Arbitration (the Hague), the California legislature, California Water Resources Control Board, and other legal proceedings in the US.

Changes in the Proposed Sonoita Creek Project

The 'Conceptual Design for Ephemeral Channel Adjacent to Sonoita Creek' (WET 2014) proposed constructing secondary channels in the bottomland intended to divert flow from Sonoita Creek and return the flow downstream. The area of the new channels was to be counted as mitigation acreage. This proposal was flawed on many levels. Among the issues were the unrealistic expectation that the channel would remain stable at the points

of diversion and confluence, the lack of adequate flow to inundate the new channels, and the massive quantities of excavated material to be spoiled.

The Sonoita Creek project as now proposed would eliminate the additional, secondary channels, but proposes to fill the existing Sonoita Creek channel in two sections, and reconstruct the filled channel elsewhere in the bottomland, as a single-thread meandering channel with higher sinuosity than the current channel. The sinuosity would also be higher than the 'reference reaches' cited as a basis of the design. The higher sinuosity would yield more mitigation acres, but as discussed below, the channel is unlikely to persist in the as-built form.

Neither the former nor current mitigation proposals address a fundamental problem: the mitigation proposed on Sonoita Creek is on a very different kind of system than the headwater reaches of the Cienega Creek tributaries that would be filled by the mine. Thus, actions on Sonoita Creek would not mitigate for loss of aquatic resources in the Cienega Creek watershed. The comparison of physical attributes of the impacted and mitigation sites (HMMP p.41) does not support the choice of mitigation site, but rather provides evidence that Sonoita Creek is not a suitable substitute for the headwater stream habitat that would be lost by construction of the mine.

Filling of Existing Sonoita Creek is Not Mitigated

The HMMP proposes to fill reaches of the existing channel of Sonoita Creek in Rail X Ranch and in Sonoita Creek Ranch, amounting to 8.9 acres in extent. Typically, if a development project were to fill channels such as Sonoita Creek, mitigation for such impacts would be required under the Clean Water Act. The destruction of these existing reaches of Sonoita Creek is not justified, and no mitigation for filling of these Waters of the US is proposed. In addition, 12.1 acres of existing floodplain and riparian habitat would be impacted by the project. Excavation of the new channels would result in production of earth requiring disposal. The HMMP proposes to create eight spoil piles, which would cumulatively affect 116 acres of wetland habitat (sacaton grassland and mesquite floodplain habitat, and riparian habitat). As noted in the HMMP (p.13), the sacaton grassland and mesquite floodplain habitats were identified by TNC as important resources in this part of Sonoita Creek, upstream of the preserve. However, no mitigation for the impacts on these riparian habitats is proposed.

The HMMP (p.41) states that channelized reaches of Sonoita Creek "…are currently performing most functions poorly," apparently as justification for filling these Waters of the US. This assertion is unsupported and unscientific. The HMMP provides no quantitative, scientific measures of "functions" that these reaches are alleged to be now performing "poorly". Moreover, the HMMP uses Site 6 of Sonoita Creek on the Rail X Ranch as a reference site for its channel design. Site 6 is part of a reach of Sonoita Creek that has not been straightened or otherwise undergone major changes since 1935 (as evidenced by historical aerial photography presented by Kondolf and Ashby 2015). Despite using this undisturbed reach as a 'reference reach' for channel design

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downstream, the HMMP proposes to fill part of this undisturbed channel and reconstruct a new channel with more extreme meander bends.

Channel Reconstructions Commonly Fail

The channel reconstruction proposed for Sonoita Creek would involve complete, artificial reconstruction of the creek in a new location on the floodplain as a more sinuous channel. Mitigation credits would be based on the area of the stream, which would be greater than the existing Sonoita Creek because the new channel would be longer and more sinuous, thus covering more area. However, reconstructed meandering channels commonly fail. Unfortunately, these reconstruction projects are rarely subject to adequate monitoring and objective post-project evaluation, but in the projects that have been evaluated, many failures have been documented.

In humid Atlantic climates, one of the best-documented projects of this kind was the reconstruction of Deep Run, at the transition from the Piedmont to the Coastal Plain (known as the Fall Line) in Maryland, which took an irregularly-sinuous channel with riparian corridor and replaced it with an idealized meandering channel, whose meander bends were locked in place by large boulders and logs. The new channel failed within a few years, as Deep Run cut straight across most of the constructed meander bends. Smith and Prestegaard (2005) documented increased overbank flow velocities, which eroded chute channels across the floodplain. Many such projects have been built in North Carolina, with many failures (Kochel et al 2005). Of 40 channel reconstruction projects in North Carolina assessed by Miller et al. (2006), many had failed, been reconstructed, and failed again. In one third of the projects, 70% of the instream structures (such as vanes, boulder clusters, log structures) had failed as of 2006.

Elliot and Capesius (2008) undertook careful documentation pre-and post project of three projects in snowmelt-dominated streams in the Colorado Rockies. Two were constructed single-thread meandering channels where the channel had previously been braided (Uncompahgre and North Fork Gunnison Rivers). These experienced 4 and 6-year return period flows, respectively, and exhibited extensive failure. The third project (Lake Fork) was to improve fish habitat by adding structures and evidently narrowing the channel; it experienced only a 2.5-y flow, and evinced little change. Thus, the results of this before-and-after study indicate that projects of this kind can fail in floods as small as 4-6-year return period. Both the humid Atlantic climate and snowmelt-runoff examples reported here would represent the kind of conditions where such projects would have the best chance of persisting, and yet they demonstrate widespread failure.

In semi-arid and Mediterranean climates, dominated by infrequent episodic events, the likelihood of success is lower still, given the nature of the flow and sediment regimes, and the very dynamic nature of the channels, which naturally erode, deposit, and shift position on alluvial bottomlands during high flows. Two case studies from California documented in the literature provide information that is illustrative. Cuneo Ck was a braided stream in the Mediterranean-climate Coast Ranges of northern California, with very high sediment loads resulting from destabilization of slopes in its catchment from

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historical logging. In the mid-1990s, it was reconstructed into an idealized meander pattern (with boulders and logs installed in the outside banks to stabilize it in place), but it failed within a few years of construction, such that no trace of the constructed channel was visible (Kondolf 2006). Similarly, Uvas Creek, also in the California Coast Ranges, was reconstructed as an idealized single-thread meandering channel. It failed three months after construction in a 6-year return period flood (Kondolf et al. 2001). Both Cuneo and Uvas Creeks experience highly variable flows and periodically high sediment loads, conditions to which the reconstructed channel proposed for Sonoita Creek would be exposed.

In general, semi-arid streams are highly dynamic in response to frequent high flows, and commonly go through cycles of narrowing during years without high flows, and widening during high flows. The channels are straighter than their humid-climate counterparts and commonly braided (Levick et al. 2008). It is unlikely that an artificially imposed sinuous, meandering channel form would long persist in this setting. Relatively few channel reconstruction projects have been monitored over time, but the available data do not inspire confidence that the meandering channel construction proposed for Sonoita Creek would remain stable. Rather, geomorphic principles and experience with prior channel reconstruction projects indicate that the first high flows (with return periods of 5 years or greater) are likely to cause Sonoita Creek to cut across the artificially constructed meander bends. The result would be a shorter, straighter channel; lost would be the large meander bends upon which much of the proposed project's mitigation credits are based.

Excessive Sinuosity Proposed

WET (2017:25) states that the reconstructed channel sinuosity "mimics the measured sinuosity of natural, least-altered reaches of Sonoita Creek…Typical values of sinuosity observed in the least altered reaches of Sonoita Creek ranged from 1.1 to 1.4." This statement is not true. The asserted values do not agree with my independent measurements of sinuosity for the existing reaches of Sonoita Creek. For Sonoita Creek in Rail X Ranch, I measured a sinuosity of 1.07; from 'Reference Reach 6' downstream to the point where Sonoita Creek becomes adjacent to Hwy 82, a sinuosity of 1.07 (Figure 1a); and from the end of the Hwy 82 adjacent section to the road crossing downstream of Reference Reach 8, a sinuosity of 1.29. The latter value is exceptional, occurring only in this more sinuous and dynamic reach. The "typical" values are certainly lower, and well represented by the measured 1.07. Sinuosity does not reach 1.4 on these reaches of Sonoita Creek. At the Reference site 6, which was used by WET (2017) as a basis for design of the proposed channel reconstruction, the channel is nearly straight, as reflected in the measured sinuosity of 1.07.

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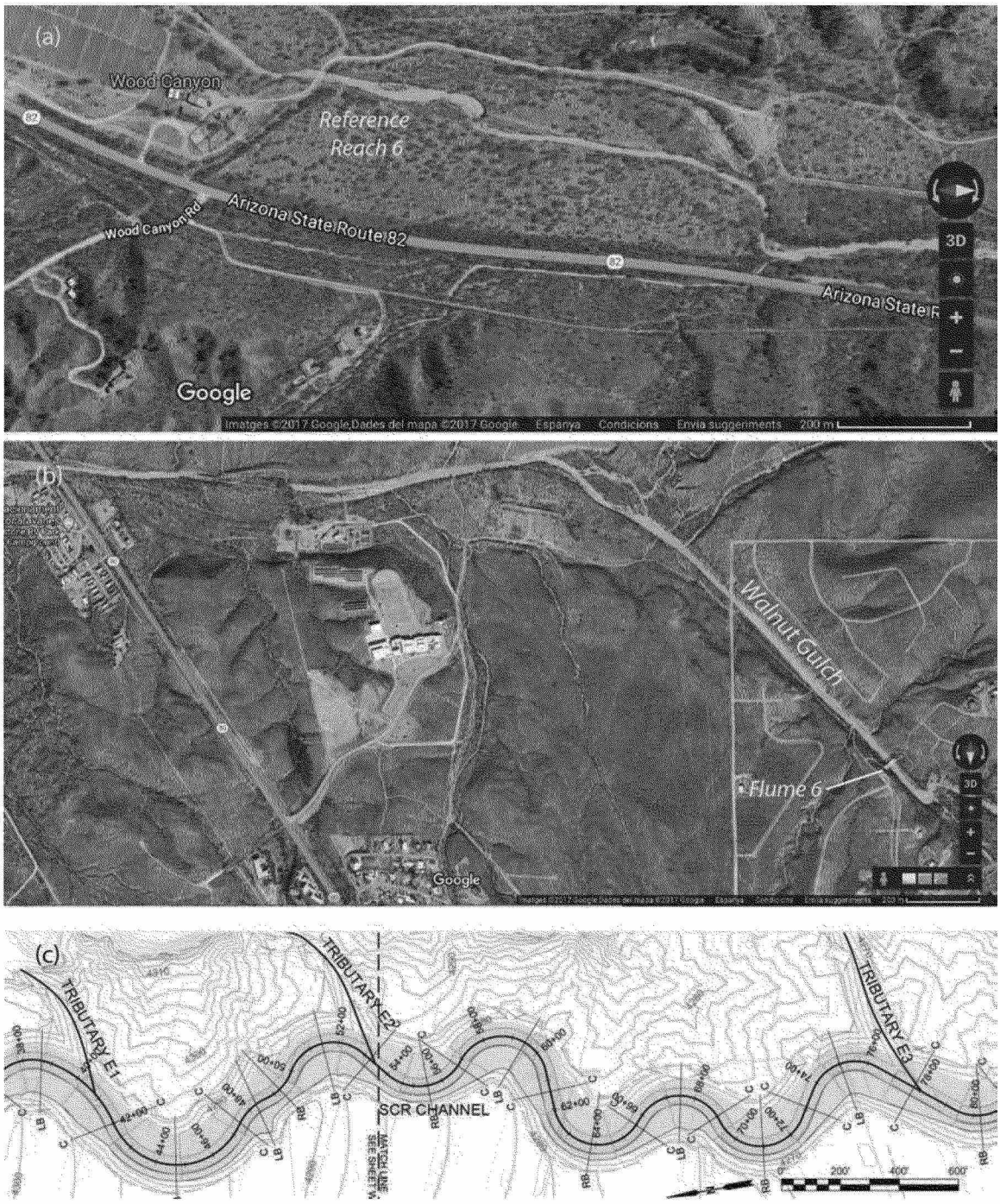

Figure 1. Comparison of channel patterns and sinuosities for reference reaches and proposed reconstructed channel design. (a) Sonoita Creek near Reference Reach 6. (b) Walnut Gulch downstream of Flume 6. (c) detail of proposed channel reconstruction in Sonoita Creek Ranch section. (Source: (a) and (b) from Google Maps; (c) from WET Drawing 11.)

Similarly, WET (2017) also uses Walnut Gulch near Flume 6, in the Walnut Gulch Experimental Watershed near Tombstone, Arizona, as a reference reach (Figure 1b). This reach is almost perfectly straight before going through an approximately 30-degree bend to the left, and thus depending on the length of reach selected, its sinuosity could be as low as 1.0 (taking only the straightaway before the bend), or about 1.07 (including the bend and continuing downstream to the highway bridge). Thus, this reference reach does not provide support for a highly sinuous channel design on Sonoita Creek.

WET (2017:25) states "The restored channels have a sinuosity that ranges from 1.1 to 1.2." This is false. The proposed channel design is much more sinuous than asserted in this statement, much more sinuous than the existing channels in Sonoita Creek, and more sinuous than the reference reaches in Sonoita Creek and Walnut Gulch (Figure 1).

The proposed meandering channel has a sinuosity of about 1.39, as measured from Tributary E1 confluence to the Tributary E3 confluence (Figure 1c). This would be a very large increase in sinuosity over the typical sinuosity of 1.07 prevailing today. This has significant implications for the proposed mitigation project. As discussed below, to build a channel with such an artificially high sinuosity imposed is likely unsustainable, and after a few moderate storms, the result would probably be that the meander bends wash out, leaving a shorter, straighter channel.

Contradictions Regarding Stability vs Dynamism

The HMMP is contradictory regarding expectations for the channel. On one hand it states that the channel would be free to migrate and change (WET 2017:6), "a dynamic system that is not intended to remain fixed in form" (WET 2017:33), "restoring hydrologic and geomorphic processes to achieve a dynamic state" (HMMP:54). This is a commendable goal, consistent with current ecological theory and concepts of process restoration (Florsheim et al. 2008, Roni and Beechie 2013). However, the HMMP calculates its mitigation credits based on the as-built configuration with artificially constructed, sinuous meander bends. If, as most likely, the highly sinuous meander bends would be cut off during a flood, the area occupied by the channel would be less and thus fewer mitigation credit acres would be justified. This is a fundamental contradiction. Sonoita Creek would likely cut off the constructed meander bends, but this possibility was not even broached in the HMMP, nor its implications for mitigation credits considered.

Contradicting the statement that the channel would be free to migrate, the HMMP (p.42) states, "Rehabilitation of Sonoita Creek will result in a more stable channel, thereby reducing bank erosion and excessive sediment transport…" (The HMMP does not define "excessive sediment transport," nor does it present any evidence or citations to explain what is meant by this evidently unscientific assertion.) Moreover, WET states that "maintenance" (presumably putting the channel back in its as-built configuration after it erodes) "may be necessary" (WET 2017:7).

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Under 'Adaptive Management Plan', the HMMP (p.66) states that "Should the re-established channel system fail to meet performance standards, then corrective actions will be implemented…" but does not indicate what those performance standards are. Is it to be a dynamic channel free to migrate, or a "stable" channel? The HMMP goes on to describe "a possible repair for excessive lateral migration outside of the migration corridor," which apparently refers to growth of the meander bends by erosion of the outside banks beyond the limits of the designated meander belt. In HMMP Figures 17 and 18, the designated lateral migration belt is shown as about 650 ft wide along the reconstructed channel proposed for Rail X Ranch and about 850 ft wide along the reconstructed channel proposed for Sonoita Creek Ranch. In both cases 30-ft "buffer" strips are shown along the margins of the lateral migration area, which the HMMP states would serve as an "action trigger" (HMMP:51). Evidently if erosion reaches the buffer strip, "repairs" would be undertaken to prevent erosion from affecting infrastructure such as the highway.

While such erosion and channel migration is certainly possible, what is more likely is the response documented in other projects that have attempted to impose more sinuous channel forms on dynamic streams: that the meander bends are cut off and a straighter channel results, but the HMMP does not mention this possibility.

The possible repairs mentioned for the "excessive lateral erosion" include "an earthwork-only repair that re-aligns the re-established channel" and "armoring the streambank with riprap to prevent channel migration (e.g., buried riprap)." (HMMP:67). The implication is that to maintain the artificially imposed meander pattern, more sinuous than would have occurred in nature, the stream channel would be riprapped, which contradicts the goal of "a dynamic system that is not intended to remain fixed in form" (WET 2017:33), or it would be rebuilt in the desired, though unsustainable, condition, only to fail again in the future.

The HMMP (p.67) goes on to say, "Should channel incision become excessive… then repair actions will occur. These may include realigning the channel and creating a preferable channel gradient. If necessary, other longitudinal grade control options could be considered." "Realigning" the channel means reconstructing the channel in a new alignment, in effect starting over with the process of rebuilding the channel, with no reason to expect greater success the second time.

Thus the HMMP seems to want to have it both ways: to say that the channel would be dynamic and changing, but also that it would be "maintained" in an unrealistic, as-built condition to maximize mitigation credits.

Further reflecting this apparent confusion, the HMMP uses the term "maintenance" in contradictory ways. On pg.48, the HMMP defines "inspections" as "routine evaluations" such as "fence inspections, ensuring the property is free of litter, etc. Maintenance activities are typically completed as a result of inspections" and presumably would involve actions such as fence repair and removing litter. However, the context of the statements regarding maintenance, such as those on p.7 of WET (2017), "initial

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maintenance following the first few events after construction may be necessary" and "After the first few years…long-term maintenance is expected to decrease significantly," certainly imply interventions in the channel, such as channel realignment or installing riprap, that are far more substantial than picking up litter.

In describing the goal that Sonoita Creek would have the "freedom to evolve geomorphically," the HMMP (p.55) states, "Defining an acceptable level of channel morphology has always been a challenge, and nowhere is this challenge greater than in arid ephemeral systems." The concept of a "level of channel morphology" is not one recognized in the field of fluvial geomorphology, and the HMMP does not explain what it is attempting to say with this curious statement. However, the statement appears to be an attempt to excuse the contradictions and lack of clarity in the proposed channel reconstruction plan.

The contradictions in the HMMP and WET (2017) about the expectations for the reconstructed channels are important, because they reveal the riskiness of the proposed channel reconstruction, and the likelihood that the reconstructed channel would not maintain its designed configuration, and thus would not provide the acreage of habitat for which the project seeks to claim mitigation credit. The available evidence from the Sonoita Creek region and from similar reconstruction projects elsewhere strongly suggests that Sonoita Creek will cut a straighter channel through the artificially constructed meandering channel, and that this straighter channel is likely to incise. Thus, the large surface area of created habitat would not be maintained, and the expectation that frequent high flows would inundate the constructed floodplain adjacent to the channel is unlikely to be realized.

In sum, the HMMP and WET (2017) treatment of channel dynamics vs stability, how the artificial channel would be "maintained", and the failure to acknowledge the most likely outcome (Sonoita Creek cutting across the artificially constructed meander bends) reflect a misleading picture of the proposed project, and do not inspire confidence in the technically trained reviewer.

Misuse of Walnut Gulch as a Reference Reach

WET (2017) and the HMMP use Walnut Gulch (Tombstone, AZ) as a reference reach. Walnut Gulch was established as a USDA experimental watershed in the 1950s, to provide observations and measurements on runoff patterns in a semi-arid environment (Moran et al. 2008, Goodrich et al. 2004). Walnut Gulch drains hills with relatively low-relief, with no drainage area in higher-relief mountains. Its channel is essentially cut into these hills, with a relatively narrow floodplain in most reaches, and its surface flow is isolated from groundwater, which is at depth. By contrast, Sonoita Creek drains the higher-relief Santa Rita Mountains and the Canelo Hills, which supply flow and sediments in a very different pattern than would be expected in Walnut Gulch. Sonoita Creek in the proposed project areas flows across an alluvial valley floor, with generally shallow water tables, very different from the Walnut Gulch situation.

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In a section entitled "Comparison of Sonoita Creek to Walnut Gulch Experimental Watershed, WET (2017:13) argues that Walnut Gulch provides "hydrologic and geomorphic analogues to Sonoita Creek" and cites Exhibit 1, which shows strip maps of reaches of Walnut Gulch and Sonoita Creek. The text refers repeatedly to the reach of Walnut Gulch near Flume 6 (one of the measurement stations established for monitoring flow on the experimental watershed), asserting that "Walnut Gulch has numerous reaches exhibiting broad, shallow channel forms with significant braiding near to, and downstream of, Flume 6." (WET 2017:13) The implication is certainly that what we see in Exhibit 1 is illustrating the points made in the text, and indeed Exhibit 1 is annotated with circles to highlight "braided multi-channel areas", supporting the assertions of channel braiding in the text. The problem with this is that the reach shown in the Walnut Gulch map in Exhibit 1 is *not* the reach near Flume 6, but a reach beginning about 3 miles downstream, with a larger drainage area. The Exhibit 1 map is annotated with a label for Flume 7 (on a tributary drainage) at the extreme right, and for Flume 1 near the center of the map. Contrary to the statements in the text, inspection of aerial imagery of the reach of Walnut Gulch below Flume 6 (Figure 1b) shows that it is nearly all single-thread and very straight (Figures 1b and 2). Nonetheless, the reach of Walnut Gulch near Flume 6 was used by WET (2017) as a reference for channel dimensions for its channel design on Sonoita Creek. The implication that the Walnut Gulch reference reach provides support for a multi-thread or highly sinuous channel design on Sonoita Creek is misleading at best.

Figure 2. Photo looking upstream along the straight channel of Walnut Gulch towards Flume 6, visible in the distance. (photo by author, December 2017)

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WET (2017:13) also lists characteristics of Walnut Gulch at Flume 6 that it says are similar to Sonoita Creek (drainage area, channel gradient, and coarse sandy substrate). Only on the next page does it mention average rainfall values, which it reports as 12-14 inches/year for Walnut Gulch, and 18-20 inches/year for Sonoita Creek. These very large differences in rainfall went unmentioned in the argument for using Walnut Gulch as a reference reach, and undermine the argument that the sites are comparable.

Lack of Sediment Budget and Sediment Analysis

The proposed channel reconstruction is not based on any analysis of sediment supply, transport, or deposition. WET (2017: 6) asserts that Sonoita Creek is a "transport limited system with abundant sediment supply relative to the sediment transport capacity", but offers no basis for this assertion. As noted above, the HMMP (p.42) refers to "excessive sediment transport", without explaining what that is or would be.

Conclusion

The proposed mitigation project on Sonoita Creek involves a massive earth-moving project to create a new channel displaced a few hundred feet on the floodplain from the current channel, with much increased channel sinuosity, apparently to increase mitigation acreage credits. However, geomorphic principles and experience with similar artificial channel reconstructions elsewhere indicate that the constructed channel would not likely persist in its constructed form. There is a very high probability that (as in other such projects), the stream would cut across the constructed meanders, resulting in a shorter channel (more in keeping with the existing channel of Sonoita Creek).

The HMMP states that undisturbed parts of Sonoita Creek, which include its 'reference reach', have higher sinuosity than is actually the case, and states that its proposed design channel has a lower sinuosity than the design drawings show. A channel such as shown on these design drawings would very likely wash out as Sonoita Creek cuts across the meander bends during the first moderate flows (5-year return period or greater) following construction. The 'reference reaches' in Sonoita Creek and Walnut Gulch, cited as the basis for the channel design, are both essentially straight reaches, which do not provide support for the very high sinuosity proposed for the constructed channel.

As noted above, the proposed mitigation project would fill the existing channel of Sonoita Creek (which constitutes Waters of the US) without mitigation, and the assertion that the reconstructed channel would be ecologically superior has not been demonstrated. The new channel would destroy existing riparian habitat, and fill material generated from the excavation would be spoiled on existing riparian habitat, also without mitigation.

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References Cited

Elliott, J.G., and Capesius, J.P., 2009, Geomorphic changes resulting from floods in reconfigured gravel-bed river channels in Colorado, USA, in James, L.A., Rathburn, S.L., and Whittecar, G.R., eds., Management and Restoration of Fluvial Systems with Broad Historical Changes and Human Impacts: Geological Society of America Special Paper 451, p. 173–198, doi: 10.1130/2009.2451(12).

Florsheim JL, Mount JF, Chin A. 2008. Bank erosion as a desirable attribute of rivers. *Bioscience* 58(6): 519-529.

Goodrich, D. C., D. G. Williams, C.L. Unkrich, J. F. Hogan, R.L. Scott, K. R. Hultine, D. R. Pool, A. L. Coes, and S. Miller. 2004. Comparison of methods to estimate ephemeral channel recharge, Walnut Gulch, San Pedro River Basin, Arizona, in *Groundwater Recharge in a Desert Environment: The Southwestern United States*, Water Science and Appl. Ser., vol 9, JF Hogan, FM Phillips, and BR Scanlon eds, pp77-99, American Geophysical Union, Washington DC.

Kondolf GM. 2006. River restoration and meanders. Ecology and Society 11: http://www.ecologyandsociety.org/vol11/iss2/art42/

Kondolf, GM, and J Ashby. 2015. Technical memorandum: conceptual design for Sonoita Creek, AZ, technical review support. Submitted to the US EPA, task order EP-G149-00241.

Kondolf, GM, Smeltzer MW, Railsbeck SF. 2001. Design and performance of a channel reconstruction project in a coastal California gravel bed stream. *Environmental Management* 28: 761–766.

Miller J, Kochel RC, Lord M, Martin TT. 2006. Limitations of the use of in-steam structures in stream restoration projects in North Carolina. Geological Society of America Abstracts with Programs 39: 43. https://gsa.confex.com/gsa/2006AM/finalprogram/abstract_114527.htm

Moran, S.M., W.E. Emmerich, D.C. Goodrich, P. Heilman, C.D. Holifield Collins, T.O. Keefer, M.A. Nearing, M.H. Nichols, K.G. Renard, R.L. Scott, J.R. Smith, J.J. Stone, C.L. Unkrich, J. Wong. 2008. Preface to special section on Fifty Years of Research and Data Collection: U.S. Department of Agriculture Walnut Gulch Experimental Watershed. *Water Resources Research*, 44 (W05S01) 10.1029/2007WR006083

Roni, P, and T Beechie (eds). 2013. Stream and Watershed Restoration: a Guide to Restoring Riverine Processes and Habitats. John Wiley and Sons, New York.

Smith SM, Prestegaard KL. 2005. Hydraulic performance of a morphology-based stream channel design. Water Resources Research 41: DOI:10·1029/2004WR003926.3926.

ED_002020B_00033396-00014

WET (Water and Earth Technologies). 2014. Conceptual Design for Ephemeral Channel Adjacent to Sonoita Creek. Prepared for Rosemont Copper Company, Tucson, by WET, Fort Collins.

WET (Water and Earth Technologies). 2017. Final design of the Sonoita Creek mitigation project. Prepared for Rosemont Copper Company, Tucson, by WET, Fort Collins.

ED_002020B_00033396-00015