TECHNICAL MEMORANDUM: REVIEW OF THE DRAFT DISCHARGE PERMIT AND APPLICATION, COPPER FLAT COPPER MINE

Sierra County NM

May 1, 2018

Prepared for: Turner Ranch Properties, LP, and New Mexico Environmental Law Center

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1.0 Executive Summary

New Mexico Copper Corporation (NMCC) has submitted an application for a discharge permit (Velasquez 2017, hereinafter DP Application) for the proposed Copper Flat Copper Mine (CFCM or Mine) to the New Mexico Environment Department (NMED). NMED has prepared Draft Discharge Permit DP-1840 for the Copper Flat Mine (hereinafter Draft Permit) and transmitted it to NMCC on February 2, 2018.

This technical memorandum reviews the DP Application, Appendices, associated documents and Draft Permit, with an emphasis on the following factors:

- The efficacy of liners under the tailings impoundments and various ponds
- The use of the andesite under the waste rock as a natural liner
- Tailings and process water management, including water balance and the residence time of water in the tailings
- Discharges from the pit lake to the surrounding groundwater
- Contaminant transport pathways to surface water and through the Ladder Ranch
- Stormwater diversions around waste and tailings
- The monitoring well system

The focus is on impacts to Turner Ranch Properties, LP's Ladder Ranch (Ladder Ranch or Ranch), which is shown in Figure 1, and how the permit violates the Copper Rule (NMAC 20.6.7).

Upon my review, the Draft Permit violates the Copper Rule in the following ways:

- The Draft Permit's maximum daily discharge volume is inadequate because it fails to include estimates of leakage from either the tailings storage facility (TSF) or underdrain pond, as described within these comments. The Draft Permit therefore violates the Copper Rule's requirement that applicants determine the maximum daily discharge volume. It also indicates that the discharge quantity identified in the Draft Permit is significantly underestimated. This factor is key to the Secretary's determination whether the Draft Permit poses a hazard to public health or undue risk to property.

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- The andesite bedrock beneath the proposed waste rock stockpiles is not an impermeable liner and therefore will not completely prevent all leaks to groundwater, thereby posing a hazard to public health and undue risk to property.

- The applicant's water balance calculations reveal a huge error regarding initial startup water and free tails water. Because of this error, the DP Application grossly underestimates the amount of fresh water the applicant will pump at the beginning of the project. This, therefore, violates the Copper Rule's requirement that the applicant submit an accurate water management plan. This factor is also key to the Secretary's determination whether the Draft Permit poses a hazard to public health or undue risk to property.

- The applicant failed to adequately analyze whether the Mine's open pit will be a hydrologic evaporative sink at all times, in violation of the Copper Rule's Section 20.6.7.33.D NMAC.

- Contaminants discharged from the Mine's waste rock stockpiles and TSF pursuant to the Draft Permit could reach surface water near the Mine, including the Rio Grande. This poses a hazard to public health and undue risk to property.

- Tailings run-off collected in unlined ditches could seep into groundwater, posing a hazard to public health and undue risk to property.

- The proposed groundwater monitoring well network is grossly insufficient to detect contamination moving from the Mine's pit lake, waste rock stockpiles or TSF. Even with contaminant dispersion, entire contaminant plumes could escape the Mine site undetected, thereby posing a hazard to public health and undue risk to property.

1.1 Impacts to Ladder Ranch

Ladder Ranch lies east and north of the proposed Mine, as shown in Figure 1. As will be discussed below in the memorandum, the groundwater flows west to east through the Mine site and onto the Ranch. Contaminant plumes would disperse laterally, so most contaminants released from the Mine would flow through or under the Ladder Ranch. Upon my review, the Draft Permit violates the Copper Rule on the Ranch in the following ways:

- The Greyback Arroyo lies just south of the Ranch property line, so any Mine-impacted surface water/stormwater flow that could jump the banks or cause changes in the arroyo plan could negatively impact the Ranch through contamination of springs. Potential contamination resulting from the Mine's discharges poses a hazard to public health and undue risk to property.

- Contaminants discharged from the Mine's waste rock stock piles and TSF pursuant to the Draft Permit could reach springs on the Ranch. Wells and springs on the Ranch could become contaminated by the Mine's discharges that exceed water quality standards set forth in Section 20.6.2.3103 NMAC, posing a hazard to public health and undue risk to property.

- The proposed groundwater monitoring well network is grossly insufficient to detect contamination moving from the Mine site onto the Ranch. The monitoring wells are spaced too widely and contaminant plumes could slip through undetected, thereby posing a hazard to public health and undue risk to property on the Ranch.

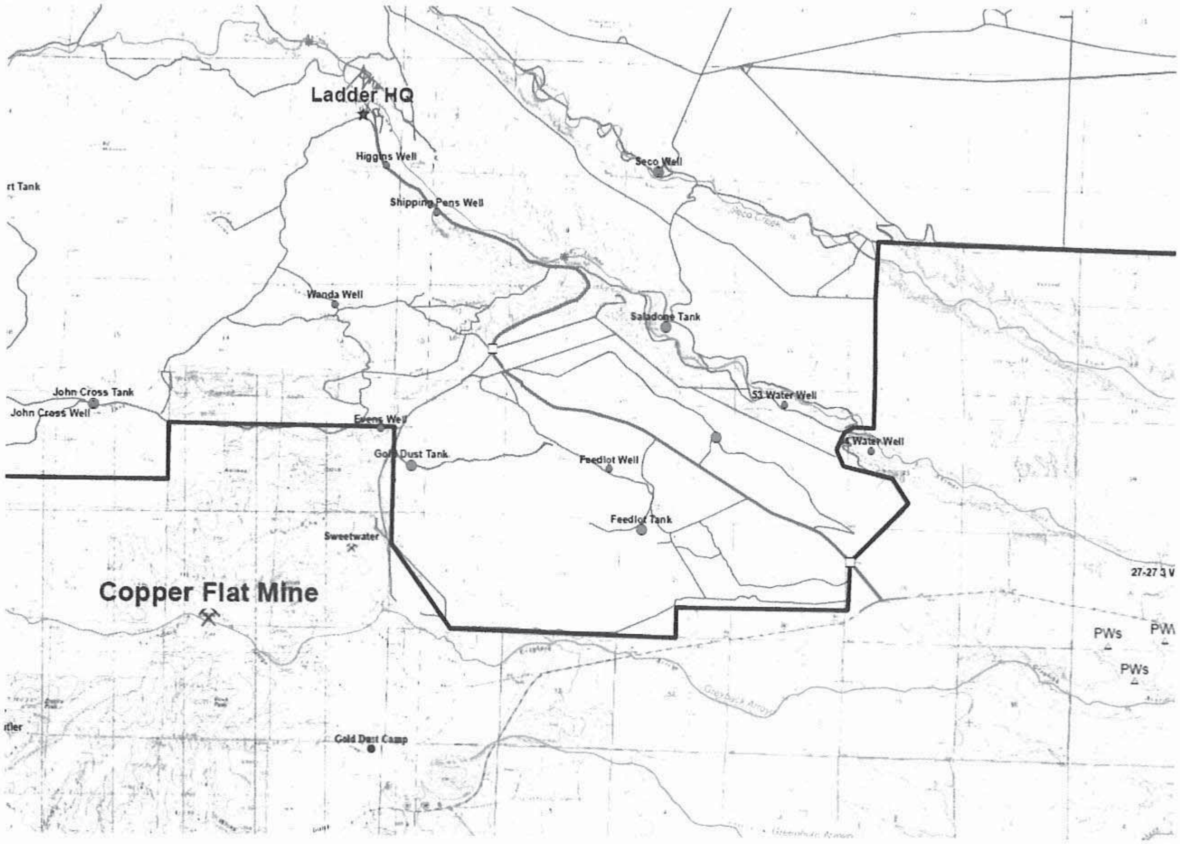

Figure 1: Map showing the Ladder Ranch, north of the dark property line, and the general location of the Copper Flat Mine.

2.0 Tailings Impoundment and Water Management Liners

The TSF would be constructed on the east portion of the Mine project site, downhill from and outside of the surface drainage area of the open pit and outside of the drawdown cone that will be caused by the pit dewatering (Jones and Finch 2017).

The TSF would ultimately contain 113 million tons of tailings waste from a facility producing ore at the rate of either 30,000 dry tons per day (tpd) (DP Application, p 1), 32,000 tpd (DP Application, p 41), or 38,000 tpd (Draft Permit, p 3). The maximum rate of slurry applied to the TSF would be 25,264,000 gallons per day (Draft Permit, p 3). The TSF would have an underdrain collection system, underdrain collection pond, and a water reclaim system (DP Application, p. 40). Much of the tailings water as captured in the underdrain or decanted from the surface would be reused for processing and dust suppression. Although the DP Application relies on the tailings underdrain to minimize leakage (Id.), the tailings underdrain would allow water to drain from the tailings and flow through the underdrain so that there would be a head of water on the underlying liner. Water would collect in depressions or sumps, which potentially would become a leakage source if the liner is not perfect as discussed below.

NMCC proposes as the primary means of protecting groundwater the use of engineered systems, primarily meaning liners under the TSF and various ponds. The proposed tailings liner would be 80 millimeter (mil) high-density polyethylene and 12-inch liner bedding material beneath the underdrain system and the underdrain collection pond would be a double-lined 60 mil HDPE liner (DP Application, p 41). However, the efficacy of the liners directly impacts the maximum daily discharge volume of the proposed Mine in the following way.

A leak is a discharge from the facility, according to Section 20.6.7.7.B(18) NMAC, and the Copper Rule specifies that the "maximum daily discharge volume" is the "total daily volume of *process water* ... or tailings ... authorized for discharge ..." (Section 20.6.7.7.B(35) NMAC, emphasis added). Process water includes any water within the copper mine facility that has contaminants exceeding standards specified in the Copper Rule, including leachate from waste rock or tailings impoundments (Section 20.6.7.7.B(50) NMAC). The Copper Rule requires that a DP Application determine the maximum daily discharge volume (Section 20.6.7.11.H.(1) and H.(3) NMAC) and that the Discharge Permit specify the discharge quantity.

However, DP Application section 20.6.7.11.H does not include estimates of leakage from either the TSF or the underdrain pond (DP Application, p 29). As noted, the DP Application and the Draft Permit simply assume that the engineering will completely protect groundwater. This is demonstrably not true (Beck et al 2009, Breitenbach and Smith 2006, Giraud and Bonaparte 1989). Even well-installed liners have pinhole leaks that allow leakage to enter the groundwater beneath the facility (the reference manual for the popular computer program for calculating flow through landfills (Schroeder et al 1994) provides estimates for the number of leaks in liners). Beck et al (2006) refers to geomembrane liners as causing "leakage avoided", meaning that improving the liner system simply avoids leakage, or reduces it, and that even in cases of excellent liner installation a liner still has leaks. Beck et al also provide data showing that liners with merely good installation can have leakage rates six times higher than liners with excellent installation for the same head over the liner.

Neither the DP Application nor the Draft Permit includes leakage estimates and therefore do not fulfill the Copper Rule's requirement that discharge quantities be estimated. NMED should therefore revise the Draft Permit to accurately reflect the maximum daily discharge volume.

The Ranch lies east and north of the proposed Mine, as shown in Figure 1. Groundwater flows west to east through the Mine site, and a contaminant leak from the TSF would disperse laterally - possibly resulting in contaminants reaching groundwater underneath the Ranch property. Additionally, wells and springs on the Ranch could become contaminated by discharges that exceed water quality standards set forth in Section 20.6.2.3103 NMAC. This potential contamination poses both a hazard to public health and an undue risk to property. Accordingly, approval of the draft permit, as written, would violate Section 20.6.7.10.J NMAC.

3.0 The Use of Andesite Bedrock Under the Waste Rock as a "Natural Liner"

NMCC claims the andesite bedrock underneath the proposed waste rock stockpiles[1] is an impermeable[2] liner that can substitute for an engineered geomembrane liner. It provides two arguments that the conductivity[3] (K) of the andesite is very low (Jones et al 2014, p 23). The first argument is that dewatering rates during the Mine's brief operations in 1982 and the evaporation rates from the existing pit lakes indicate there is very little groundwater inflow (through andesite) to the pit. The second argument is that Jones et al's completed pressure-injection tests demonstrate a low K. Neither of these arguments supports considering andesite as a substitute for a properly-installed impermeable liner. Additionally, while the numerical model simulated very little recharge into the andesite, this is not evidence of low permeability andesite because many things other than the formation K control recharge rates, including potentially fallacious modeling assumptions. The following paragraphs expand these three points.

3.1 Dewatering the Pit and Pit Lake Evaporation

The pumping rate for dewatering the pit while being mined in 1982 ranges from 22 to 50 gpm (Jones et al 2014, p 23). The pit lake which formed post-1982 has evaporated from between 16 and 45 gpm from a surface area which varied from 5 to 14 acres (Jones et al 2014, p 42). This rate reflects not only the transmissivity[4] of the formation connected to and providing water to the pit, but also the amount of recharge[5] reaching the pit. Due to faults limiting the area that may directly drain to the pit, the recharge may be limited by a small contributing area and by the precipitation.

Faults bound the andesite volcano which contains the ore body (Jones et al 2014, Figure 4.2 and 4.3). Recharge within these faults likely is the source of most of the flow into the pit, because the faults may be flow barriers[6]. Jones et al indicates that most groundwater in the Animas Graben[7] uphill from the Mine site either discharges to the surface in Warm Springs, uphill from the Animas Uplift[8], or it flows north or south to Percha Creek or Las Animas Creek (Jones et al 2014, p 24). Based on these observations, the groundwater entering the pit or pit lake must originate as recharge within the volcano fault system. Jones et al does not provide an estimate of the area of andesite within the volcano, but scaling from the map suggests it is about three miles square, or 5760 acres. Spreading the dewatering

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[1] Waste rock is rock that does not contain enough ore to process and stockpiles are where the waste is stored.
[2] Impermeable means that the formation is impervious to water flowing through it. In reality, nothing is truly impervious but rather it would allow only small amounts of water to enter.
[3] Conductivity is a measure of the ease with which water will flow through a formation.
[4] Transmissivity is a measure of the ease with which water will flow through an aquifer, and is the product of the conductivity and the thickness of the aquifer.
[5] Recharge is water that flows through the soil to reach the groundwater table.
[6] A flow barrier is a formation that prevents flow.
[7] A graben is a geologic formation that has been downthrust due to faulting.
[8] An uplift is a geologic formation that has been thrust upward due to faulting.

rate of 22 to 50 gpm over the area would yield from 0.07 to 0.17 in/y. However, there are indications there is much more groundwater in the volcano.

One indication is that there is no step drop[9] in the groundwater table at the point where the volcano meets the Palomas Basin east of the pit (Jones et al 2014, Figure 4.2). If the fault was a significant flow barrier, the water table would drop. This observation suggests that flow leaves the volcano area and there is more recharge than indicated by the pit dewatering rates.

A second indication is that the pit lake forms only a small drawdown cone[10] that could capture recharge from only a small portion of the andesite. This can be seen in the existing conditions groundwater contours (Jones et al 2014, Figure 5.21), which show flow arrows passing the capture zone of the pit and in the steady state[11] contours from the model calibration (Jones et al 2014, Figure 6.11). The simulated steady state 50-foot contours (Id.) show a small crenulation[12] at the pit indicating the pit captures some flow. The mapped pit lake contours indicate the drawdown is only about 25 feet (Jones et al 2014, Figure 5.21).

A third indication is the two springs shown within the crystalline bedrock surrounding the proposed pit (Jones et al 2014, Figure 4.4). Jones et al does not provide a flow estimate or even discuss them, but they clearly represent another discharge point for recharge occurring within the volcano.

3.2 Pressure Injection Test

The pressure injection test yielded K estimates in three boreholes, with three different levels in two of the boreholes. Jones et al (2011 Table 1) summarized the K estimates, ranging from effectively zero in one well that had some fracture-sealing issues to 0.14 ft/d, including 0.02, 0.085, 0.081 and 0.074 ft/d for various well levels. These estimates are mid-range, as shown in Freeze and Cherry (1979) Table 2.2, with the values being equivalent to those for silty sand or silt loess, or sandstone. The range includes fractured igneous and metamorphic rocks. Truly impermeable rocks, such as unfractured metamorphic rocks, have a K five orders of magnitude lower than the andesite being proposed as a liner herein.

The zones tested for permeability also were at least 64 feet below ground surface, with all but one exceeding 100 feet below ground surface (bgs). It is not known whether these levels were below the water table, since Jones et al provided no well log for them. Although the highest observed K is at the deepest range for borehole GWQ 11-24, the typical trend is for higher K to occur nearer the surface due to weathering which causes rock to fracture.

The other issue not considered when using the pressure injection tests to justify considering the andesite impermeable is scale – the waste rock will cover multiple acres whereas these tests are

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[9] A step drop is a point at which the water table changes steeply.
[10] Drawdown is the distance that the water table changes due to pumping or dewatering, and a cone is how the water table experiencing drawdown appears in three dimensions.
[11] Steady state is a condition when the inflow to a groundwater system equals the outflow, with there being no change in groundwater storage.
[12] A crenulation in a water table contour is where the contour line has a sharp bend due to a small trough in the water table.

relevant to only small volumes of the aquifer. Conductivity expressed over a large area is an average for that area, including fractures and unfractured media between the fractures. Most infiltration would occur through fractures, even though the fractures probably represent a small fraction of the andesite. If the waste rock covers fracture zones, it is likely that the seepage that makes it through the waste to the ground surface will flow across the ground surface and contact fracture zones. Seepage should not be considered as an average over the area of the waste rock stockpile, but as significant plumes of moisture entering the ground beneath the stockpile. It is therefore likely that K at the surface is even higher, contradicting the argument that andesite bedrock is sufficiently impermeable to serve as a liner.

3.3 Groundwater Model Recharge in to the Andesite

The groundwater model steady state calibration (Jones et al 2014, section 6.3) balances recharge with discharge to surrounding streams. The pinkish area in Figure 2 is the andesite and has recharge equal to 0.14 in/y; the area east of that is the Natomas basin which has no recharge. The rate corroborates the rate estimated above for offsetting the dewatering and evaporation rates. Because groundwater discharges other than to the pit lake, such as to springs, streams, and the Rio Grande downgradient from the Mine area, the calibrated recharge rate is clearly too low.

Simulated recharge is of meteoric water, rainfall and snowmelt, which occurs intermittently during specific events. Although the MODFLOW modeling is an empirical estimate and not a simulation of the physical process, it still represents a process that occurs only when water is available. Only 0.14 in/y is available because during the short-term events the water availability overwhelms the capacity of the ground surface to allow it to percolate so that that much of it runs off. A waste rock stockpile, prior to reclamation, would allow much of the meteoric water to enter and pass to the ground surface (the andesite) uniformly so that it would not runoff and would have full opportunity to enter the ground surface. The effective rate that water would reach the ground surface would exceed 0.14 in/y by many times and would do so much more uniformly with opportunities for seepage to enter the andesite lasting for much of the year.

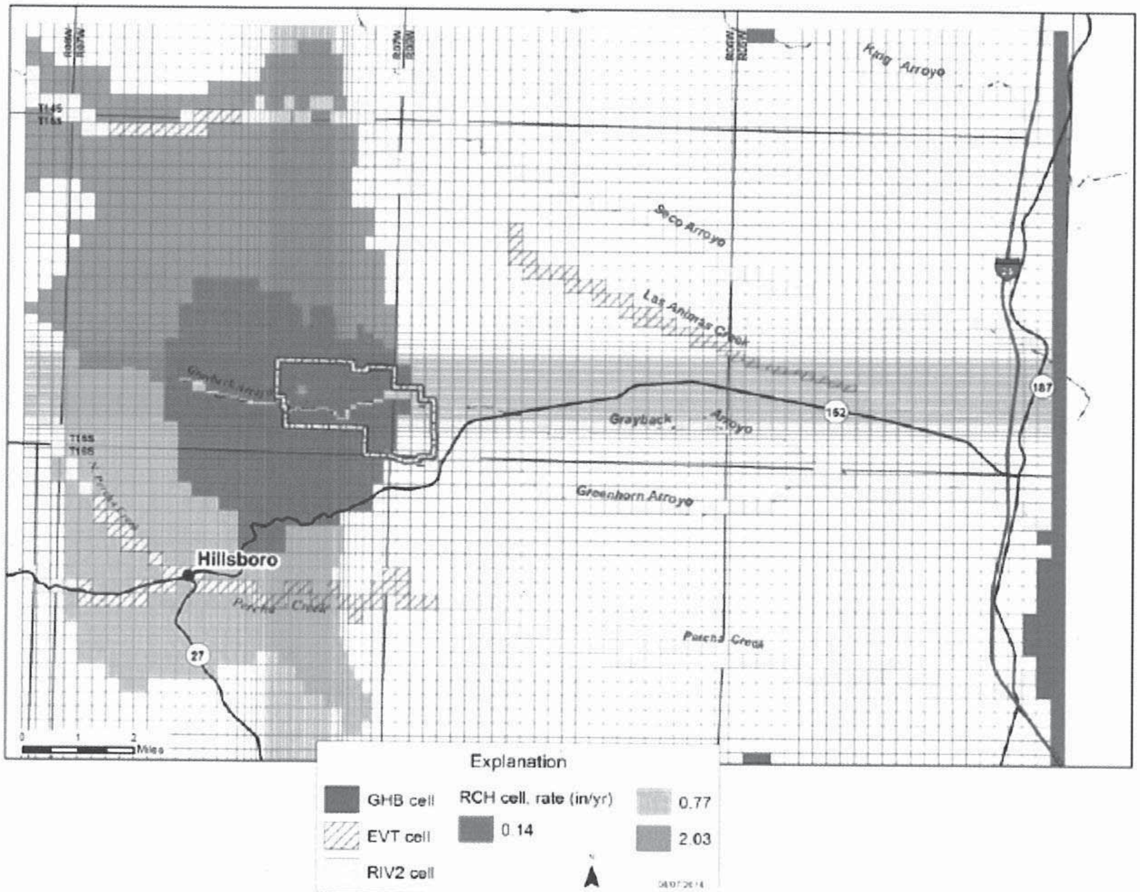

Figure 6.6. Natural boundary conditions.

Figure 2: Figure 6.6 from Jones et al (2014).

It is very likely that waste rock would cause more meteoric water to enter the ground. Andesite is not similar to a liner, because the average K is too high, it is fractured, and the waste rock would cause the water to reach the soil much more uniformly than it would without the waste rock. The DP Application (p 65) is not accurate where it states the permeability of the andesite is less than 10^{-6} cm/s; all of the estimates in Jones et al (2014) Table 5.2 exceed 10^{-5} cm/s. Therefore, Jones et al's modeling yielded conductivity values that contradict the andesite impermeability assumption in the DP Application.

4.0 Tailings and Process Water Management

NMCC summarizes the water balances for the mineral processing activities by stating that 13,000 gpm of water is necessary to operate the facility, 9200 gpm of which will originate from the TSF and 3800 gpm would be make-up water that is freshly pumped groundwater which supplements the other sources of water. The TSF water would be water pumped from the surface of the tails with a barge pump having a maximum capacity of 9200 gpm, and pumped from an underdrain collection pond at a design capacity up to 4000 gpm (DP Application p 73). NMCC would also use captured site stormwater, which NMCC describes as water that replaces water that would otherwise be pumped make-up water. DP Application Table 11J-2 shows total ore processing water totaling 21,242 af/y, with 15,504 and 5738 af/y being recycled and non-recycled water, respectively. If the facilities operated as proposed and the various pond liners do not leak, the primary lost water would be 4973 af/y that remains entrained[13] in the tailings and 752 af/y lost to evaporation (from the tails and various ponds). DP Application Appendix A describes the processing facilities in which Appendix G tabulates detailed water balance calculations (hereinafter, water balance refers to Appendix G of DP Application Appendix A).

The water balance tables show that average reclaim water (recycled water) is drainage from underflow tailings, and free water from the cyclone overflow slimes and cyclone overflow beach. The beach is the dry part of the tailings impoundment surface which NMCC estimates at about ¾ of the total impoundment; for example, the water balance shows after one month the pond and beach areas are 1,742,400 and 6,740,054 ft^2, respectively. Also, tailings discharge is 29.1% solids, and NMCC describes the cyclone feed as 31,992 tpd which requires 77,946 tpd of water, or 12,978 gpm (Table 2 of the water balance).

The water balance includes monthly volumes of water inflows, such as water inflow for the first month being 579,339,937 gallons of tailings water, 3,066,903 gallons of direct precipitation and 271,525 gallons of run-on. Of this, water losses include 135,827,440 gallons being entrained, and three evaporation fluxes[14]. The tailings water includes the majority, 433,345,798 gallons, being reclaimed from the TSF.

The water balance calculations reveal huge error – the table assumes steady state conditions and ignores the tailings water that remains in the saturated portion of the tails. Entrained water is that which wets the tailings, but water in the tailings pore spaces[15] will drain from the tailings. The underdrain captures this flow (or leaks it). The error is that the water balance calculations do not account for the free water that remains within the tailings, but rather shows a steady state condition, with all of the tailings water not entrained or evaporated being reclaimed. Water that remains in the tailings or evaporates cannot be reclaimed or reused.

The water balance also does not account for the water that initially would be added to the ore processing system[16]. Most of the 9708 gpm of "Water reclaimed from TSF" (Id.) for the first month, and certainly portions of the reclaim water for subsequent months, have not yet been added to the ore-processing and tailings circuit. The make-up water for the first month is 3270 gpm, but because there is initially no source of the reclaimed water, the first month, and many subsequent months or even years, would likely require additional make-up water. Steady state conditions would occur once the water recycled from the TSF reaches its full possible rate. Until the water balance reaches steady state, the

[13] Entrained water is water that goes to wetting the tailings and is not free to drain to the underdrain.
[14] Evaporation flux is the rate that water evaporates.
[15] Tailings pore spaces are the open volumes between tailings particle, or volume of tailings occupied by air or water.
[16] In this review, ore processing system includes processing, the discharge of tailings to the TSF, and the various features for recycling water, including the underdrain and the recant.

amount of recycled water presented in Table 3 of the water balance is underestimated and the make-up water must be much higher than predicted. In other words, the applicant will have to pump much more groundwater than acknowledged in the water balance just to commence the mine processing.

The DP Application description of the water balance, as presented in the water balance table of Appendix G of the DP Application, violates the Copper Rule requirement that an accurate water management plan be presented. Specifically, it violates Section 20.6.7.11.H(2) NMAC because the "identification of all sources of process water and tailings" is wrong. The Mine's DP Application clearly fails to account for initial start-up water and it fails to account for free tails water.

The Mine's impacts to groundwater from the pumping of the required amounts of groundwater for operations clearly have not been estimated at all and the actual impacts to groundwater-related resources have been grossly underestimated. Without this required analysis, the Secretary cannot accurately and definitively rule out whether the Draft Permit will pose a hazard to public health or an undue risk to property due to substantially lowered groundwater tables and associated lowering of hydrologically connected surface water. NMED must therefore require NMCC to revise its water balance calculations and associated water management plans.

5.0 Pit Lake Discharge to Surrounding Groundwater

If the pit lake is a flow through pit[17] after closure, the pit lake water quality must meet groundwater standards (Section 20.6.7.33.D(2) NMAC). If the pit lake is a hydrologic evaporative sink[18], the groundwater standards would not apply (Section 20.6.7.33.D(1) NMAC). The DP Application (p 165) states the final steady state water surface would be about 4895 ft above mean sea level (amsl). NMCC would do a rapid refill by adding about 2200 acre-feet to the pit within six months after closure. NMCC claims that groundwater downhill of the pit would be 5100 ft amsl, which is higher than the full pit lake level, and that would prevent pit lake water from escaping the zone around the pit and mixing with groundwater (Jones and Finch 2017).

The basis for NMCC's claim is the modeling of dewatering and pit lake development (Jones et al 2014, Jones and Finch 2017). The modeling relies on calibrated aquifer parameters[19], as shown in Jones et al (2014) Table 6.1. The andesite formation is the primary formation in the Animas Volcano zone of the Animas Uplift (Jones et al 2014, Figure 4.3), although quartz monzonite surrounds the pit and controls the hydraulics of flow around the pit (Jones et al 2014, Figure 4.3, Figure 6.3). Parameters for the andesite and quartz monzonite are the same throughout the model, so treating them as separate has no effect on the model results. The andesite and quartz monzonite are referred to as the pit formations hereinafter whenever both are implied.

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[17] A flow through pit is one in which groundwater enters the pit and then discharges from the pit.

[18] A hydrologic evaporative sink means that evaporation from the pit exceeds precipitation so that groundwater drains to the pit.

[19] Aquifer parameters are properties that define the aquifer and control how groundwater flows through it, including conductivity, transmissivity, and porosity. Transmissivity is the product of conductivity and thickness.

The modeling treats the pit formations as a homogeneous formation, with K equal to 0.002, 0.001, and 0.001 ft/d for layers 2, 3, and 4, respectively. Vertical anisotropy[20] is 0.01 for all three layers, which means that the vertical K is 1/100th of the K specified above. Layers 2, 3, and 4 are 1000, 2000, and 3000 feet thick, respectively. Simulations of pit dewatering and pit lake development all occur within layer 2 because it is 1000-feet thick and therefore encompasses the entire profile of the pit, which means dewatering is simulated as being drawn from one homogeneous formation. Modeling the pit formations in this way assures that the drawdown cone near the pit is very steep and does not expand from the pit quickly. Thus, at the end of mining, the simulated volume of unsaturated pit formation[21] between the pit wall and the saturated zone, or drawn-down water table, is small (Figure 3). As NMCC rapid fills the pit, water from the pit lake would enter that unsaturated formation. As shown on Figure 3, NMCC's simulated water table encircles the pit and prevents water from escaping. However, this simulated water table is inaccurate for various reasons discussed below, including the calibrated K being far too low and because the modeling ignores potential fracture zones.

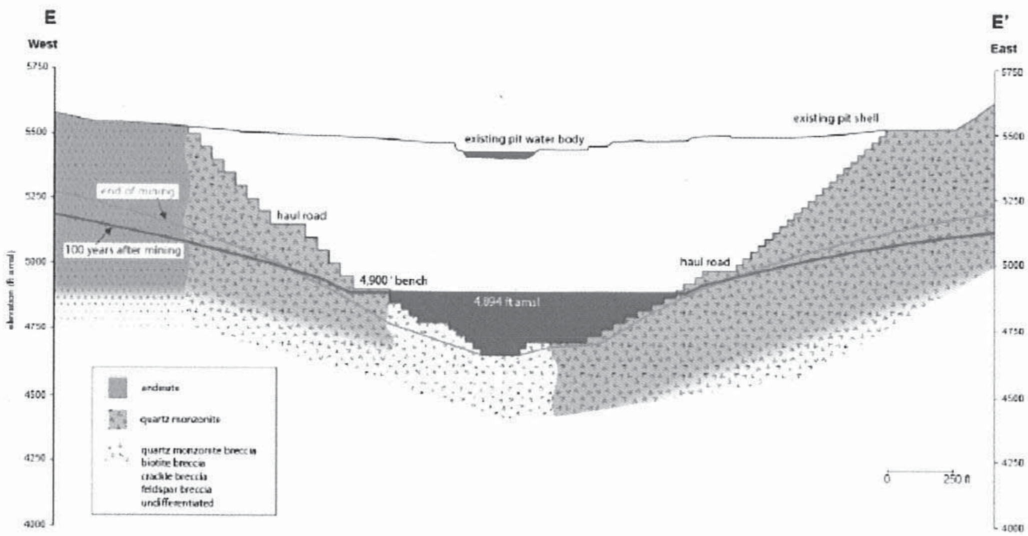

Figure 3.16. West-to-east hydrogeologic cross-section E-E' showing water-level profile across existing pit and proposed open pit after rapid fill.

Figure 3: Figure 3.16 from Jones and Finch (2017) showing the water table near pit at the end of mining and 100 years after the end of mining.

The first reason the simulated water table is inaccurate is that the calibrated andesite K is two orders of magnitude less than the measured values. Therefore, the water table drawdown forms a steep cone near the pit, as shown in NMCC's modeled results in Figure 3. If the K was higher, as measured, there

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[20] Anisotropy is a ratio of hydraulic conductivity values in different direction. If vertical conductivity is less than horizontal conductivity, the vertical anisotropy would be greater than 1.0 (Kh/Kv is vertical anisotropy).

[21] The unsaturated pit formation is the geologic formation surrounding an open pit than has been drained of groundwater. As the pit lake forms after mine dewatering ceases, groundwater will reenter some of the unsaturated pit formation.

would be much additional aquifer volume between the pit and the drawn-down water table. Additionally, the model parameterization ignores the results of the pressure injection tests, in that the testing found that K at depth was greater than in shallow areas, but the parameterization assumed the highest layer had the highest K. There is no basis for the Jones et al (2014) assumption of decreasing K at depth because they conducted no analyses of permeability at levels lower than 250 feet bgs.

The second reason the simulated water table is inaccurate is the failure to consider fractures. Layering in bedrock means the model could miss pathways in the bedrock that would connect the forming pit lake to the aquifer beyond the groundwater divide. By assuming a homogenous 1000-foot thick formation, Jones et al (2014) essentially ignored fracture zones in the model. However, the variability of K found in the pressure injection tests demonstrates that fractures are likely. These tests showed that K varied over an order of magnitude over just 150 feet. More and longer samples would undoubtedly reveal zones with even higher permeability. These pathways could allow contaminants to escape the drawdown cone so that most of the formation drains away from the pit rather than towards it. NMCC has presented no evidence that indicates there are no significant fracture pathways that would cause contaminants to escape the pit.

The third reason the simulated water table is inaccurate is the drawdown cone generated by dewatering in a formation with higher K would be much more spread out, and flatter, than the one shown in Figure 3. Drawdown caused by dewatering in a sloped groundwater table, west to east as occurs pre-mining at the Mine, forms a groundwater divide[22] east of the pit. This "capture zone" defines an area from which water will be drawn to the pit, or pit lake. The elevation of the groundwater divide depends on the K of the formation in which it is calculated, the recharge entering the formation near the pit, and the steepness of the original water surface through the pit. The groundwater divide in a more conductive pit formation would occur further downgradient from the pit and therefore would be lower because the pre-mining water table would be lower. The groundwater divide would also be lower if the pre-mining groundwater table was steeper. Higher recharge would increase the water flowing to the pit and needing to be dewatered, so for a given K it would raise the groundwater divide because a higher gradient would be required to cause the water to flow toward the pit.

The fourth reason the simulated water table is inaccurate is that fracture zones in the pit formations would cause the groundwater table near the pit to be irregular, and the divide could form further from the pit and at a lower elevation in a high K fracture zone. The groundwater divide in these zones would possibly be lower than the final pit lake elevation estimated by NMCC based on a homogeneous pit formation, so these zones provide possible pathways for water to escape the forming pit lake to reach downgradient groundwater.

NMCC has clearly not analyzed this potential nor presented evidence to support its assumption of no fracture zones. Analysis could be accomplished within the model by increasing the K by two orders of magnitude to reflect the measured values, and by creating potential zones with even higher K. However, due to the lack of mapping of these zones, they could be tested only theoretically.

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[22] A high point, or ridge, in a groundwater table.

Finally, Finch and Jones (2017) presented an analysis of how much rainfall would be necessary to cause the pit lake to rise high enough to escape their estimated 5100 ft groundwater divide. Rather than considering the rapid refill which could cause the pit lake to rise above the surrounding groundwater, they estimated it would require a 250-inch rainstorm to fill the pit lake to a level above surrounding groundwater (Finch and Jones 2017). The amount is ludicrous in an area with less than 20 inches of annual rainfall.

Without evidence or modeling as evidence, NMED must assume that pit lake water could escape the pit and contaminate surrounding groundwater during the proposed filling operations. NMED, however, could minimize potential contamination of groundwater from pit lake discharges by properly administering the pit lake as a flow-through pit during the rapid fill and until the groundwater level has recovered to make the pit lake a sink. The pit lake during rapid refill must be subject to water quality standards found at Section 20.6.2.3103 NMAC. NMED should therefore revise the Draft Permit to require that Section 20.6.2.3103 NMAC standards be met at the pit lake during refill operations, in accordance with Section 20.6.7.33.D(2) NMAC.

6.0 Groundwater Contaminants Reaching Surface Water

Contaminants escaping the waste rock/tailings facilities could reach surface water near the Mine site, including the Rio Grande. NMCC acknowledges that its production pumping and subsequent consumptive use could affect flows in the Rio Grande, so it follows that groundwater pathways from the Mine site to the river could contain contaminants. The potential of surface water contamination from the Mine's contaminated discharges would be even greater during closure because production pumping that might capture contaminants during operations will not be operating. Even though it is unlikely that contaminants would reach the production wells within the Mine's operation phase due to slow transport time, the risk of contaminants reaching the river remains over the long-term. Therefore, the Draft Permit as written poses a hazard to public health and undue risk to property from migrating contaminants reaching the Rio Grande and negatively impacting the river's water quality and ecosystem.

Additionally, as previously discussed, the Ranch lies east and north of the proposed Mine, as shown in Figure 1. Groundwater flows west to east through the Mine site, so pathways emanating from any point on the Mine site could cross the Ranch property as they flow eastward to the river or tributaries. Contaminants follow those pathways, and a plume would develop around the flow paths, meaning that dispersion to the north from the flow path would penetrate far into groundwater within the Ranch property. Wells and springs on the Ranch could become contaminated by the Mine's discharges, posing both a hazard to public health and an undue risk to property. Accordingly, approval of the Draft Permit, as written, would violate Section 20.6.7.10.J NMAC.

Failure to discuss these pathways also violates Sections 20.6.7.11.P(4) and (5) NMAC, which require the identification of potential pathways for migration of contaminants to surface water and the identification of surface waters that are gaining because of inflow of groundwater that may be affected by contaminants. The DP Application (p 153, 154) attempts to address potential pathways but mostly implies the liners or covers would prevent contaminants from entering the groundwater. The DP

Application fails by not considering the pathway that contaminants would follow from waste rock stockpiles, the tailings impoundment, or escaped contaminants from the pit to surface water, whether Percha Creek, Las Animas Creek, Greyback Arroyo, or the Rio Grande, and the effect to offsite properties including the Ranch. This pathway mapping should also be used to site additional groundwater monitoring locations to monitor if leaks are occurring.

NMCC could use its model to track pathways from the sources (TSF, waste rock stockpiles, pit) to their eventual sinks (the feature into which the contaminant would discharge). This could be accomplished with particle tracking using the existing model, although it would include the biases toward low K in the bedrock discussed above. Using reasonable seepage rates, the model could also be used to track contaminants and estimate contaminant plumes. It could also estimate relative contaminant concentrations for discharges into the rivers. NMED must therefore require NMCC to modify its model to adequately track contaminant pathways in order to satisfy Sections 20.6.7.11.P(4) and (5) NMAC.

7.0 Stormwater Diversions and Prevention of Infiltration to the Tailings and Waste rock.

Diverting stormwater away from the tailings impoundment, surge pond, underdrain collection pond, and process water reservoir is a method used for minimizing the potential for groundwater pollution that would occur if stormwater contacted these materials and seeped into the ground (DP Application, p 42). The tailings impoundment would mostly be protected from runoff through the Mine site from above by the routing of the Greyback Arroyo through the Mine site (DP Application, p 100). Runoff from the tailings dam would be collected in ditches which report to a lined conveyance ditch at the toe of the dam. The biggest threat to groundwater from runoff at the tailings impoundment is runoff leaking from the unlined ditches into and through the embankment and into the ground near the base of the TSF. These ditches would collect water and form a source for seepage into the embankment.

The DP Application also claims that run-off would be diverted away from waste rock stockpiles to minimize contact with waste rock through the use of unlined collection ditches. However, the figures are not sufficiently detailed to assess whether the proposed diversion would be successful. As with the tailings, these unlined collection ditches would concentrate run-off, creating sources of seepage that would percolate through the waste rock to the ground surface, eventually entering groundwater. Because the collection ditches are not lined (see cross-section C and D, Figures 9 and 11, DP Application Appendix B), seepage would occur through the bottom of the ditches. This additional seepage would add to the direct seepage through the waste rock stockpiles.

The DP Application and Draft Permit therefore fail to protect groundwater from the seepage of stormwater into the base of the tailings and waste rock stockpiles. They also fail to estimate the amount of discharge that would occur, in violation of the Copper Rule. It is clear, on the face of the DP Application and associated Draft Permit, that seepage from unlined stormwater collection ditches will pose a hazard to public health and undue risk to property by contaminating groundwater.

Again, Ladder Ranch lies east and north of the proposed Mine, as shown in Figure 1. Groundwater flows west to east through the Mine site, so most contaminants released from the Mine pursuant to the Draft Permit would flow through or under the Ranch. This includes seepage from unlined stormwater collection ditches. Wells and springs on the Ranch could therefore become contaminated by the Mine's discharges from unlined stormwater collection ditches. This potential contamination poses both a hazard to public health and an undue risk to property. Accordingly, approval of the Draft Permit, as written, would violate Section 20.6.7.10.J NMAC.

8.0 Groundwater Monitoring Well Network

The groundwater monitoring well network, described in DP Application Appendix E, is grossly insufficient to detect contamination moving from the forming pit lake, waste rock stockpiles or TSF, thereby resulting in a hazard to public health and undue risk to property. It does not meet the requirements for monitoring specified in the Copper Rule.

> A permittee shall monitor ground water quality as close as practicable around the perimeter and downgradient of each open pit, leach stockpile, waste rock stockpile, tailings impoundment, process water impoundment, and impacted stormwater impoundment The department may require additional wells around the perimeter of mine units that are underlain by areas where ground water flow directions are uncertain, including fracture flow systems, and around copper mine units that have the potential to cause ground water mounding. The department may require additional monitoring wells at any other unit of a copper mine facility that has the potential to cause an exceedance of applicable standards as additional permit conditions in accordance with Subsection I of 20.6.7.10 NMAC. **Monitoring wells shall be located pursuant to this section to detect an exceedance(s) or a trend towards exceedance(s) of the applicable standards at the earliest possible occurrence, so that investigation of the extent of contamination and actions to address the source of contamination may be implemented as soon as possible.** (NMAC 20.6.7.28.B, emphasis added)

As will be described, the monitoring wells are spaced too widely to even detect contaminant plumes emanating from the sources (such as the TSF, pit, and waste rock stock piles). Even with dispersion, the wide spacing would allow plumes to slip between monitoring wells undetected. NMED clearly has authority under the Copper Rule to require a greater and more appropriate number of monitoring wells at Copper Flat than the inadequate number the Draft Permit is proposing. Section 20.6.7.28.B NMAC. The following paragraphs will discuss monitoring at the waste rock stockpiles (WRSP) 2 & 3, the TSF, ponds, and the open pit and how NMCC's proposal is inadequate to detect contaminant migration.

8.1 Waste Rock Stock Piles

NMCC proposes four new monitoring wells around the perimeter of WRSP3 (#2 is upgradient from #3). Proposed wells PGWQ-4, PGWQ-7, PGWQ-8, and PGWQ-12 are located on the perimeter and spaced at from 1000 to 2000 feet, based on scaling from Figure 4 in Appendix E. PGWQ-12 is south of WRSP2. These four wells would only detect contaminants if there is a leak directly upgradient from them because a leak anywhere would slip between the wells undetected due to the well spacing. PGWQ-5, PGWQ-13, and PGWQ-20 will be additional monitoring wells farther down-gradient of the waste rock (Appendix E, p 13) along the runoff channel conveying upgradient water through the site. The water is probably not Mine-impacted, so percolating runoff would dilute any contaminants in these wells, rendering the wells much less useful for monitoring purposes. Also, PGWQ-13 and -20 are just north of the TSF, and any contaminant found there would have an indeterminate source – the waste rock, the TSF, or impacted storm water.

8.2 Tailings Storage Facility

There are essentially just four monitoring wells proposed for near the perimeter of the TSF – PGWQ-14, -15, -16, and -19 (Appendix E, p 14). All are replacement wells for existing monitoring wells that will be buried by the expanding TSF (Id.). The existing wells will be the monitoring wells initially. The new proposed wells are spaced at what scales at greater than 2000 feet. As for the waste rock stockpiles, these wells will detect contaminant only if their source is just upstream from the well.

8.3 Monitoring Wells Downgradient from Ponds

The DP Applications indicates there are additional monitoring wells proposed downgradient from different ponds, such as PGWQ-17 downgradient from the underdrain collection pond (Appendix E, Figure 4) or PGWQ-6 downgradient from a Mine-impacted stormwater impoundment[23]. The source of contaminants reaching these wells could be difficult to discern because of multiple sources upgradient from them. Monitoring wells downgradient from stormwater impoundments should be sampled during the normal sampling times and after each large storm event during which the impoundment filled with water. This would help detect changes due to stormwater seeping through the pond. NMED should revise the Draft Permit accordingly.

8.4 Addition of Monitoring Wells Around the Waste Rock Stockpiles and Tailings Storage Facility

NMCC should propose additional monitoring wells for the waste rock and tailings based on potential plume dispersion from leaks in the facilities, pursuant to its authority under Section 20.6.7.28.B NMAC. The spacing should be set so the chance that a plume could slip between the monitoring wells is small. This would be accomplished by using a detailed numerical transport model for the site. The regional model of Jones et al (2014) may not be detailed enough, but it could form the basis for a telescoped model grid[24] around the sources. The transport model should use reasonable dispersion parameters to simulate the growth of the plume. The maximum spacing between monitoring wells should be a little less than the width of the simulated plume, to be conservative. Without this type of modeling, the placement of the wells is simply random guesswork and there can be no confidence that groundwater contamination would be found, potentially resulting in a hazard to public health and undue risk to property.

8.5 Open Pit

The monitoring well network around the pit also appears to be grossly inadequate. NMCC proposed to use three existing monitoring wells upgradient of the pit and six monitoring wells, four existing and two new, around the pit perimeter. The wells appear to be designed more to monitor water level than to

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[23] A mine-impacted stormwater impoundment is one which contains stormwater that has contacted mine disturbed rock or soil.

[24] A telescoped model grid is one where the model is made much more detailed around a specific area.

monitor potential leaks. Appendix E Table 3 does not show the elevation of the screens, but some of the depths appear to not be deep enough to sample the water at the full depth of the pit. The monitoring well network must be designed to detect whether groundwater flows from the pit into surrounding groundwater.

NMED should use its authority under the Copper Rule to require additional monitoring around the Mine facilities, based on adequate modeling of how plumes would develop from different portions of the Mine as described above in section 8.4. NMED should require an inner and outer perimeter of monitoring wells that will sample the water table when the pit is at full drawdown. The focus should be on the east side of the pit, with about six monitoring wells on an inner perimeter and six on an outer perimeter. This would detect irregularities in the water table that would allow pit lake water mixing with groundwater.

9.0 Conclusion

The DP Application submitted by NMCC for a discharge permit for the proposed Copper Flat Copper Mine Draft Discharge Permit, DP-1840, is insufficient and the Draft Permit poses a hazard to public health and undue risk to property on the Ranch. The Draft Permit violates the Copper Rule in the following ways:

- The Draft Permit's maximum daily discharge volume is incorrect because it does not include estimates of leakage from either the TSF or Underdrain Pond. This violates the Copper Rule's requirement that applicants determine the maximum daily discharge volume. The discharge quantity identified in the Draft Permit is significantly underestimated. This factor is key to the Secretary's determination whether the Draft Permit poses a hazard to public health or undue risk to property.

- The andesite bedrock beneath the proposed waste rock stock piles does not substitute as an impermeable liner and therefore will not completely prevent all leaks to groundwater, thereby posing a hazard to public health and undue risk to property.

- The applicant's water balance calculations include a huge error regarding initial startup water and free tails water. Because of this error, the DP Application grossly underestimates the amount of fresh water the applicant will pump during the commencement and initial months of the project. This therefore violates the Copper Rule's requirement that the applicant submit an accurate water management plan. This factor is key to the Secretary's determination whether the Draft Permit poses a hazard to public health or undue risk to property.

- The applicant failed to adequately analyze whether the Mine's open pit will be a hydrologic evaporative sink at all times, in violation of the Copper Rule's Section 20.6.7.33.D NMAC.

- Contaminants discharged from the Mine's waste rock stock piles and TSF pursuant to the Draft Permit could reach surface water near the Mine, including the Rio Grande. This poses a hazard to public health and undue risk to property.

- Tailings run-off collected in unlined ditches could seep into groundwater, posing a hazard to public health and undue risk to property.

- The proposed groundwater monitoring well network is grossly insufficient to detect contamination moving from the Mine's pit lake, waste rock stock piles or TSF. Even with contaminant dispersion, entire contaminant plumes could escape the Mine Site undetected, posing a hazard to public health and undue risk to property.

Ladder Ranch lies east and north, partly downgradient, of the proposed Copper Flat Mine. Due to dispersion of the contaminants, many leaks emanating from the proposed Mine would flow through or under the Ranch. Upon my review, the Draft Permit violates the Copper Rule on the Ranch in the following ways:

- The Greyback Arroyo lies just south of the Ranch property line, so any Mine-impacted surface water/stormwater flow that could jump the banks or cause changes in the arroyo plan could negatively impact the Ranch through contamination of springs. Potential contamination resulting from the Mine's discharges poses a hazard to public health and undue risk to property.

- Contaminants discharged from the Mine's waste rock stock piles and TSF pursuant to the Draft Permit could reach springs on the Ranch. Wells and springs on the Ranch could become contaminated by the Mine's discharges that exceed water quality standards set forth in Section 20.6.2.3103 NMAC, posing a hazard to public health and undue risk to property.

- The proposed groundwater monitoring well network is grossly insufficient to detect contamination moving from the Mine site onto the Ranch. The monitoring wells are spaced too widely and contaminant plumes could slip through undetected, thereby posing a hazard to public health and undue risk to property on the Ranch.

10.0 References

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