

14 October 2025

RECEIVED

OCT 23 2025

MINING & MINERALS DIVISION

Ms. Erin McCullough  
Division Director  
NM Mining and Minerals Div.  
1220 S. St. Francis Dr.  
Santa Fe, NM 87505

Dear Ms. McCullough

I am writing to you in regard to the recently submitted amended Mining Operation and Reclamation Plan put forth by the New Mexico Copper Corporation for Copper flat Mine, Permit S1027 RN. Please conduct a public hearing for the review of this application.

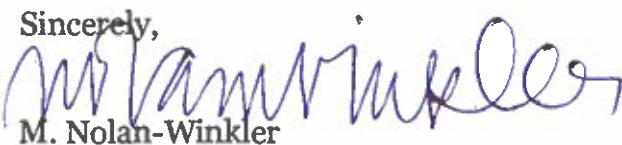
I am a resident of Hillsboro, NM and one of the town's members who have been in a suit against the reopening of Copper Flat mine for probably 7 years or more now. I am abashed and just sick and tired of NMCC's continued effort to reopen this old mine at the risk of polluting the air via our strong seasonal winds now by their wanting to create huge stacks of dry tailings. Polluting the water and/or air is not a good solution for the residents of our beautiful state.

I understand my being so tired of fighting this project with letters, time and money is no reason to stop them, but a public hearing would, at the very least, help those of us contesting the reopening of Copper Flat Mine some insight to the decision making by the state, BLM....

Also, I think the idea of 'rapid fill' of the pit with water from the ground is a horrendous waste of our precious water when they have all the waste rock piled around to us to fill the pit. Their closure plan needs to be revised. The amount of water rights NMCC owns will take 2.5 to years for the 'rapid fill' I've been told.

I would appreciate this matter be taken to the public for a discussion.

Sincerely,



M. Nolan-Winkler



Water IS Life

Erin McCullough  
Division Director  
New Mexico Mining and Minerals Division  
1220 South St. Francis Drive  
Santa Fe, NM 87505

Ms. McCullough:

I have been resident of the Hillsboro, New Mexico area since September 30, 2010 and 42 Cochise Trail on the Berrenda Ranches since July 15, 2013. I feel that I have come to appreciate the beauty and the fragility of the area over these fifteen plus years and before that beginning in April 2005 I first came to visit the Black Range.

I am writing now to request a public hearing on the amended Mine Operation and Reclamation Plan (MORP) filed with the New Mexico Mining and Minerals Division (NMMMD) at the end of September 2025 by the New Mexico Copper Corporation (NMCC). The MORP will be used by NMMMD to judge whether to issue a permit pursuant mine or not - and under what conditions - to the New Mexico Copper Corporation for Copper Flat Mine, Permit S1027 RN.

I am requesting markedly a review of the application for the following reasons:

(1) Dry stack processing is known to have consequences for air pollution depending on how the stacks are managed. In the NM environment, when we already have dust storms every spring, this issue needs examination and discussion. This has been a particularly windy season, particularly along Berrenda Road and throughout the Berrenda Ranch. Even more so than in Hillsboro. The wind is howling as I type this.

(2) The stacks are prone to destabilization and movement.

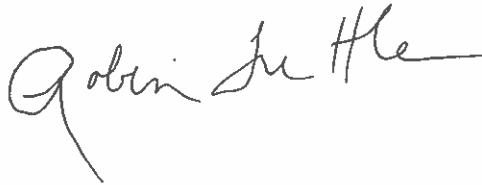
(3) Though dry stack processing uses less water, it consumes more electricity. Electricity costs have markedly increased. What is the effect upon the grid ?

(4) There is still a water problem: first, because it is not known if NMCC will have enough water rights for operation; and second, because it is still a lot of water, the use of which may affect local wells.

(5) "Rapid fill" of the pit with water from the ground is a waste of water when NMCC has waste rock available and piled nearby to fill the pit. The closure plan should be revised because with the amount of water rights NMCC owns, it will take 2.5 to 3 years for the "rapid fill."

Thank you for your attention to this request.

I am also interested in how the New Mexico Environmental Division (NMED) may consider the potential renewal of a waste water permit to the NMCC for Copper Flat Mine and would appreciate receiving a draft when it is submitted for review.

A handwritten signature in cursive script that reads "Robin Tuttle". The signature is written in dark ink and is positioned above the printed name.

Robin Tuttle



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**FW: [EXTERNAL] Copper Flat Mine S1027RN**

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**From** Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

**Date** Fri 11/14/2025 8:06 AM

**To** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

Public comment. Please file in the Copper Flat project folder.

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**From:** Max Yeh <maxwyeh@gmail.com>

**Sent:** Thursday, November 13, 2025 6:39 PM

**To:** Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

**Cc:** Allyson Siwik <grip@gilaresources.info>; Bob Cunningham <bcunni4668@aol.com>

**Subject:** [EXTERNAL] Copper Flat Mine S1027RN

You don't often get email from [maxwyeh@gmail.com](mailto:maxwyeh@gmail.com). [Learn why this is important](#)

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Dear Mr. Ennis,

I am truly sorry that the Copper Flat Mine case is back and opened on your desk. As you might expect, I have some comments I would like you to consider as you go through this updated application.

Although dry stacking will undoubtedly greatly reduce the amount of fresh water the project needs, water source and use are still problems with this project. The updated MORP assumes that the only change that needs consideration is the revised tailings treatment. That assumption is not true. The reduced amount of fresh water used entails important consequences that are unaddressed in either the original or updated MORP.

However, since the application begins (and ends) with dry stacking, let me begin my comments there and get to the water issues after.

I. The stability of the stacks depends on the physical qualities of the supporting ground, the internal physical characteristics of the tailings themselves, and the configuration of the stacks. WSP did detailed studies of all three elements. However, they considered their conclusions temporary because the data for them were insufficient. The study of the soil characteristics, for example, found that most of the various soil types underlying the whole structure was clay, which has very high expansive and contractive qualities, making the base unstable if water gets in. However, these characteristics at depth were based on core drills done by Quintana in 1979 and 1980 which often did not reach more than 40

or 45 feet depth. WSP recommended that for a full soil characteristic study and thus for a dedicated seismic study there should be data from 100 feet below the surface.

I urge MMD to consider WSP's recommendations as necessarily incorporated into the MORP.

**II.** Similarly temporary, WSP's conclusions in characterizing the tailings themselves (slippage, sheering and deformation) were dependent on Quintana tailings or laboratory generated tailings rather than actual production tailings. The shaping of the slopes in the stacking, being dependent on these characteristics, then, would have to be determined at the time of the stacking, undermining the certainty of the theoretical planning. This ongoing chore leads me to remember WSP's description of why dry stacking was previously rejected by NMCC: the lack of experienced personnel to carry out the complex demands of stacking. That problem is magnified when one considers the major objection to dry stacking, the control of dust.

The physical issues of structure may be less concerning than the problem of dust because of the chemical makeup of the tailings and because the prevalence of dust storms every spring locally. That issue is not addressed at all, except, perhaps, by the information that when the tailings are spread and compacted, they are still in a moist state. It is conceivable that given the right amount and production speed of the tailings, the right size of a bench being constructed, and the speed of spreading and compacting a layer of tailings, all coordinated, that there is never a tailings surface left open to dry into a dust problem before it is covered up with topsoil and seeded. But that would be an amazing feat of coordination. Can this company, which has never itself operated a mine, do that? [Even then, for seeds to grow into vegetation cover, as everyone knows, is somewhat a fantasy in this clime.]

If the miners cannot coordinate this feat in preparing and laying the tailings with reclamation, then it will need to depend on dust control watering to keep dust down, and that brings on the problem of water.

**III.** NMCC owns about 1,100 afy of groundwater rights. According to their Final Environmental Impact Statement (FEIS) on which their federal (BLM) mining permit is based, their 30,000 tons per day operation will need about 22,000 afy of water. That huge difference between supply and need, presumably, is made up by recycling water over and over, and very rapidly. Using the traditional wet process and pond to store tailings, they had estimated that 15,000 afy could be recycled. Using the drystack method could get them 5,000 afy more, but the real advantage of the dry stack is its speed, because squeezing the water out is a lot faster than waiting for solids in the pond to settle.

But these considerations are apart from the water used for dust control. Because dust control water is entirely evaporated, it cannot be part of the cycling and recycling process. In the FEIS (Table 2-29), they say they need 700 afy for dust control. Where is that water going to come from? It can't be pumped

out of their wells as part of their 1,100 afy water rights, since that would only leave 400 afy of water to cycle and recycle in their production, not possible even with dry stack tailings.

Neither the original MORP nor the present updated MORP says where this unrecyclable water comes from. But listed in the FEIS as sources of water are "stormwater" (300 afy) and the curious "moisture in the ore" (250 afy). See Table 2-30.

Stormwater is harvested in the present MORP in three different ways. The pit catches precipitation not only in itself but catches run-off from the quite large surrounding hills. The two waste rock piles shed their stormwater into three catchment ponds. The water that falls on the tailing cakes, the contact run-off, will be channeled into the seepage pond at the base of the tailings storage facility. These sources amount to a lot of water. In the FEIS it is counted as 300 afy but without the run-offs into the pit or from the tailings (which is 500 acres big). It could easily be 800 afy or more. Its removal from the area's total surface water flows can be significant, yet it has never figured in any hydrological study of impacts that I have seen.

The use of this water is problematic, legally speaking. NMCC has no rights to use surface water. It has designated this water as water that has contacted raw ore and thus is polluted. Environmentally, they are right not to allow it into the creek, but I don't know if you can gain the right to take water by polluting it. The Office of the State Engineer has to have something to say about this extra-legal taking, but it is not involved in the MMD decision on a mining permit. It was not involved in the BLM process that led to the federal permit to mine because it recused itself due to the pending litigation over NMCC's groundwater rights. I urge MMD to consult with the OSE on whether such a taking of surface water needs OSE permitting.

**IV.** The moisture in the ore may be another of these water grabs. I assume, without evidence, that the raw ore contains water because it is mined from below the groundwater level. The pit is already into groundwater, and as they mine, it will get larger and deeper. Groundwater will seep into the pit, and in order to mine, the water has to be constantly dewatered (a source of dust control water). My point is that, if this water is recycled (which is planned) and used in production, mining saturated ore is itself a form of water extraction. Technically speaking, this is production water that is depleting the aquifer. Again, this amount of groundwater depletion has never figured in any hydrological study of impacts. I would like to see, again, an OSE decision about this extra-legal method of taking water, and ask that MMD consult the OSE in making its permitting decision.

**V.** My last comment on the updated MORP is about reclamation of the pit, a subject almost ignored in the new application except to say that the "rapid fill" of the pit with groundwater will take over 2.5 years rather than the few months originally planned.

I have never liked this reclamation plan for three reasons. 1) the use of scarce groundwater to create a polluted lake that endangers beast and fowl does not seem to me beneficial to the public welfare as required by the NM Constitution; 2) the use of scarce groundwater instead of waste rock to partially fill the pit bottom makes no sense to me when storing waste rocks in piles is itself a problem, since every cubic yard of rock the mine dumps into the pit reduces water depleted from the aquifer by a cubic yard; and 3) the hydrologic sink is a myth (though approved by the courts) because the level of the pitlake is fluctuating all the time, both above and below the balance level, because of evaporation and precipitation; so that, polluted water will, in fact, enter the aquifer. Ideally, all the waste rock mining has generated should be put into the pit and then water added to create a kind of marshland which will sustain the kind of vegetation that neutralizes the pollution in the lake.

The fact that rapid fill is to take 2 ½ years before the pit walls are safely covered seems to me an opportunity for the NMED and the MMD to revisit their acceptance of the rapid fill reclamation of the pit. All the waste rock piles should be eliminated from the Reclamation Plan. The waste rock should be put into the pit, and water used to bring the pitlake into balance. If this process results in a kind of marshland, that would be an ideal reclamation project to plant marsh vegetation that neutralizes the pollution in the lake, as has been done in Australia.

**VI.** In summary, I ask MMD to consider:

- Requiring NMCC to incorporate WSP's recommendations regarding soil testing and seismic studies into the revised MORP.
- Weigh the question of the feasibility of the plan relative to personnel training in carrying out the complex plan.
- Consulting OSE for a determination of the permissibility of using polluted surface water without surface water rights.
- Consulting OSE for a determination of the legality of extracting groundwater without water rights by recycling water from saturated ore.
- Consulting OSE on the hydrological consequences of permanently removing 1,100 afy of groundwater and another 1,000 afy of surface water from the local watershed.
- Working with NMED to discuss with NMCC the possibility of a revised reclamation plan that removes all waste rock piles, reduces the amount of water needed to backfill the pit, and removes the threat of leaving a permanent polluted lake that drains the aquifer.

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Max

  
November 21, 2025

Erin McCullough  
Division Director  
New Mexico Mining and Minerals Division  
1220 South St. Francis Drive  
Santa Fe, NM 87505

Re: Mine Operation and Reclamation Plan for Copper Flat Mine, Sierra County, NM

Dear Ms. McCullough:

I'm writing to request that a public hearing be held on the amended Mine Operation and Reclamation Plan that New Mexico Copper recently submitted for the Copper Flat Mine in Sierra County. This is with respect to Permit S1027 RN. I hope that it's not too late for my request to be considered.

The topic is of great interest to the nearby residents, who would like an opportunity to voice their opinions and have them considered.

Many of my own concerns are related to water consumption at the mine, which I understand is under the jurisdiction of the New Mexico Environment Department and not the Mining and Minerals Division. However, the water consumption question is related to the reclamation plan, in that it may be possible for the mine pit to be backfilled with rock rather than with water — which, of course, is much scarcer than rock in this environment. Additionally, the risk that hazardous dust from the mine operation could affect air quality for neighboring communities needs to be addressed in any permit that might be issued.

Sincerely,

*Rebecca Hallgarth*

Rebecca Hallgarth

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**FW: [EXTERNAL] S1027RN**

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**From** Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

**Date** Tue 12/9/2025 8:13 AM

**To** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

Please add this to Copper Flat public comments.

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**From:** Max Yeh <maxwyeh@gmail.com>

**Sent:** Sunday, December 7, 2025 11:36 AM

**To:** Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

**Cc:** Allyson Siwik <grip@gilaresources.info>; Bob Cunningham <bcunni4668@aol.com>; Dustin Long (TEI-Ladder) <Dustin.Long@tedturner.com>; Carter Kruse (TEI - Montana) <Carter.Kruse@retranches.com>; Greg Daviet <director4@ebid-nm.org>; David Salopek <dpsalo@zianet.com>; Corey Durr <cdurr@blm.gov>; Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>; Serrano, Ryan, OSE <Ryan.Serrano@ose.nm.gov>; Tessa Davidson <ttd@tessadavidson.com>

**Subject:** [EXTERNAL] S1027RN

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Dear David,

Can you clarify for me the status of the 2020 agreement between MMD and NMCC? Is it still in effect? If it is, does it allow NMCC to apply for a permit just because of the change to dry stack tailings processing?

Although that agreement specifies acquiring water rights to 6,000+ afy and that amount is not now needed, the present plan still uses more water than the water rights they have. The conditions in that agreement on sufficient water rights are still not met. They do not have sufficient water rights to operate (dust control alone will take most of their adjudicated rights), and they do not have sufficient water rights to reclaim (2,200 afy), so it seems to me that if the agreement still holds, MMD is not obligated to consider the application.

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Max

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**FW: [EXTERNAL] Copper Flat Mine**

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**From** Ennis, David, EMNRD <david.ennis@emnrd.nm.gov>

**Date** Fri 1/16/2026 11:56 AM

**To** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

FYI. Please read the comments as they relate to the MORP and then file on the G drive for copper flat.

Thanks,  
DJ

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**From:** Max Yeh <maxwyeh@gmail.com>

**Sent:** Friday, January 16, 2026 11:44 AM

**To:** Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>

**Cc:** Serrano, Ryan, OSE <Ryan.Serrano@ose.nm.gov>

**Subject:** Re: [EXTERNAL] Copper Flat Mine

Good morning, Mr. Cathey,

I wonder if there has been any development about the issues I raised with the OSE concerning Copper Flat Mine's proposed use of water.

I also wonder if NMCC has applied or has indicated its intention of applying for a dewatering permit. Given that the OSE and NMCC are both on record that there is likelihood of impairment, I imagine that means that OSE will require both a plan of replacement and some further hydrological study. In either case, consideration of the Dewatering Act complicates the questions I raised earlier regarding water harvesting by distinguishing water harvesting in the pit from the other sources of harvested runoff.

My understanding of the Dewatering Act is that water pumped from the pit is not an appropriation (72-12A-5) and therefore cannot be used for mining purposes (except for the 30+ afy adjudicated groundwater rights) or for dust control (except for the 5 afy adjudicated groundwater rights). If that is correct, then is it also correct that the OSE does not have the authority to permit the use of water from the pit for dust control and processing as if the water produced by dewatering were an appropriation?

Considering that the pit water is a mixture of private and public waters and that it is a mixture of surface water and groundwater, I think the whole thing is a bag of problems which was created by designating the pit a well. It clearly is not a well in the sense that the hole in the ground does not exclusively access groundwater. Nor does it satisfy the NMED's requirements of a well. Is there a way of un-designating it that way for the OSE?

On Tue, Nov 18, 2025 at 8:59 AM Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)> wrote:

Mr. Yeh,

Thank you for the information regarding the Copper Flat Mine. Cheryl Thacker has retired, so please feel free to address your questions directly to me.

Many of the issues that you raise are new to me and will require some time for my staff and I to research and understand better. I will provide you with a more detailed response in a few weeks.

Best regards,

***Craig Cathey***

District IV Manager  
New Mexico Office of the State Engineer  
1680 Hickory Loop, Suite J  
Las Cruces, NM 88005  
Office (575) 524-6161  
Fax (575) 524-6160  
[www.ose.state.nm.us](http://www.ose.state.nm.us)

***find your well online using the New Mexico Water Rights Reporting System:***

<https://nmwrrs.ose.state.nm.us/nmwrrs/index.html>

***find your well online using GIS:***

[https://gis.ose.state.nm.us/gisapps/ose\\_pod\\_locations/](https://gis.ose.state.nm.us/gisapps/ose_pod_locations/)

***view notices for publication:***

<https://www.ose.state.nm.us/NFP/nfp.php>

***enter your meter readings:***

<https://www.ose.state.nm.us/Meter/>

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**From:** Max Yeh <[maxwyeh@gmail.com](mailto:maxwyeh@gmail.com)>  
**Sent:** Thursday, November 6, 2025 5:59 PM  
**To:** Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)>  
**Cc:** Serrano, Ryan, OSE <[Ryan.Serrano@ose.nm.gov](mailto:Ryan.Serrano@ose.nm.gov)>  
**Subject:** [EXTERNAL] Copper Flat Mine

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Dear Mr. Cathey,

I write you concerning the Copper Flat Mine in Sierra County. I understand that Cheryl Thacker retired last month, and since she had been instrumental in the OSE's many years of involvement with this project, I am uncertain to whom I should now address my questions.. I hope as supervisor of this district, you will be able to give me some direction.

Upon the SE's denial of the Tulla Resources's application to transfer water rights for use at Copper Flat, the mine's owner, NMCC, submitted an updated application for mining with MMD based on the

use of a dry stack tailings process which reduces the amount of fresh water need in its operation. At the same time, it has filed for a renewal of its waste water discharge permit from the NMED. I expect that it will also submit an alteration of its federal mining permit from the BLM. I think that the OSE must participate in these decisions because water rights and water use are central to the project.

The revised Mining Operation and Reclamation Plan is available on the MMD website. Having gone over it, I would like to ask OSE for some determination or comment on issues the MORP raises concerning water rights and water use. I attach a detailed explanation of these issues as a memorandum.

Briefly, the mine was adjudicated some 1,100 afy groundwater rights. It has no surface water rights. Yet, it plans to use double the amount of rights it has. The additional water comes from water harvesting (albeit, harvesting of water that has been in contact with mined minerals) and also from what seems an extra-legal way of extracting groundwater.

At the time of BLM's FEIS, I asked Ms. Thacker about using captured run-off water without having surface water rights, but at that time, the OSE was no longer involved in the BLM process since it had recused itself because of the pending litigation with NMCC over its water rights. The earlier DEIS, in which the OSE participated, did not propose water harvesting as a source of production water. Originally, NMCC's plan was to channel contact run-off water to the tailings pond, where it would simply evaporate. Ms. Thacker thought then that that was the normal process for handling contact run-off. However, the FEIS introduced catchment ponds at the various waste rock piles and using the contact run-off water for production.

NMCC's decision to use dry stack tailings and to proceed to mine with only a minimal amount of water rights, highlight its need for other water sources. The new 500 acre dry stack storage facility adds enormously to the amount of contact run-off, and capturing that run-off essentially doubles the amount of water available for production use.

I would like the Water Rights Division to have some kind of say in this use. Of course, contact run-off should not go into the stream, but one cannot simply allow polluting run-off to be a legal way to get the right to use surface water. This is especially true for uses like mining, where there is zero return after use.

The second issue, I want to lay before the OSE is the strange case of extracting groundwater by extracting water from saturated ore mined from below groundwater level. NMCC will extract this water from the ore in its processing and recycle it as more production water. Basically, the pit (which OSE classified as a well), which has no water rights for mining (5 afy for dust control and 30

something for evaporation) will supply the mine 250 afy of groundwater by taking the water by truck-fulls rather than pumping it out. Here, too, I ask that the OSE have a say.

A third water issue which seems to me to concern OSE is the reclamation plan which calls for the filling of the pit with groundwater (24/7 pumping of groundwater for 2.5 years). It does not seem to me a beneficial use of water to create an eventually polluted pond. Lawyers can easily find cases in which such peripheral use of water (not central to the production of copper) has been deemed non-beneficial by the courts. This waste is especially egregious because the mine will have tons of waste rock that can be used, at least partially, to fill the pit. Since the aim is simply to cover up the lower pit walls to prevent acid formation, every cubic yard of waste rock used is a cubic yard of groundwater saved while accomplishing the same end. Again, I request that OSE take a look at this issue as part of its review of water and water rights at Copper Flat.

Given the push by OSE/ISC in the last few years to address the issue of water supply in the state, it seems to me reasonable that the Water Rights Division in LC engage in overseeing the use of water and water rights at Copper Flat Mine. I ask this on behalf of the 100+ members of the Percha-Animas Watershed Association.

Thank you.

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Max

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Max

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**Re: [EXTERNAL] Copper Flat Mine, SI027RN**

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**From** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Date** Thu 2/12/2026 3:54 PM

**To** Max Yeh <maxwyeh@gmail.com>

Hello Max,

You're most welcome! Administratively complete is the lowest threshold for continuing into the technical review process and marks the beginning of the technical review. For us it just indicates that the applicant has provided documents that are sufficiently prepared to be technically reviewed. We will continue to receive comments up until the time of determination, which as you know, can be a long process.

That is a good question regarding the 2020 agreement with NMCC. This was before my time with MMD, and I will need to review our agreement with DJ and legal to see how that affects the updated permit application. I'll be in touch as I get more info. I look forward to continued discussions with you and others.

Thanks again,

Evan

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**From:** Max Yeh <maxwyeh@gmail.com>

**Sent:** Sunday, February 8, 2026 3:31 PM

**To:** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Subject:** Re: [EXTERNAL] Copper Flat Mine, SI027RN

Hi, Evan,

Thank you very much for correcting my mistake about the notice I received. I had been rereading the mining act and remembered vaguely that after the filing for a permit, the MMD sends a letter to the applicant that the application is complete, at which point the applicant publishes the notification that begins the hearing request period. I confused the administrative completion notice I got with that finding of completeness, and although I knew that several months ago there had been notice of application and a call for hearing requests, I thought I had better respond somehow to this new notification. Anyway, thank you for clearing that up for me.

So, tell me what the administratively complete designation means. It doesn't seem to end the staff's technical review since you are still taking comments, etc. Does it mean that staff is satisfied that all the facts are in the record so that beyond this point, the issue is simply discretionary?

What is the position MMD takes now relative to the terms of the agreement with NMCC of 2020? Of course the overall sufficiency of water has changed, but there was an item regarding the pit reclamation which specified the need for 2,200 afy water for the rapid fill. That number suggests NMCC counting on the transfer rights which the SE has now denied. In the amended application NMCC says that filling the pit will take 2.5 years, which is what it takes with the 1,100 afy water rights they have. Will MMD disregard that term of the agreement?

Thanks very much for your time answering my various questions. And, I apologize for not hearing my phone go off when you called. Being a creature from the dinosaur era, I've never been able to get my voicemail to work.

On Fri, Feb 6, 2026 at 2:05 PM Owen, Evan, EMNRD <[Evan.Owen@emnrd.nm.gov](mailto:Evan.Owen@emnrd.nm.gov)> wrote:

Hello Max,

Thank you for reaching out to me. I received your message shortly after I got back into the office after lunch. I called back twice but there was no way for me to leave a voicemail.

The timeline for the request for public hearing begins at the time of filing the application, in this case, filing the amended MORP, which we do view as a significant change to their plans. We received your and multiple other requests for public hearing and will hold a public hearing as we get further along into the technical review process. You will receive a letter from me in the next week or two acknowledging receipt of the request for public hearing, as well as stating that a public hearing will be granted at a later date to be determined. The public hearing will be properly noticed following NMC 19.10.9.904(B).

We are also happy to receive public comments at any time during this process, as we are aware of the public interest in this permit application.

I really appreciate you and others reaching out to me regarding this permit application. I am happy to chat on the phone more about our process or continue an email thread here.

Thank you again,

Evan

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**From:** Max Yeh <[maxwyeh@gmail.com](mailto:maxwyeh@gmail.com)>  
**Sent:** Friday, February 6, 2026 1:28 PM  
**To:** Owen, Evan, EMNRD <[Evan.Owen@emnrd.nm.gov](mailto:Evan.Owen@emnrd.nm.gov)>  
**Subject:** [EXTERNAL] Copper Flat Mine, SIO27RN

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Dear Mr. Owen,

I left a telephone message for you but decided to email you instead in order to have a written record.

I received by certified letter a notification from NMCC that the MMD has deemed its amended MORP administratively complete.

However, the letter did not mention the possibility or procedure for requesting a hearing. NMAC 19.10.9.902(E). Furthermore, it did not specify the date on which the 30-day period for hearing requests will expire.

I believe that because the changes to the project are significant, impacting not only the issue of the desirability of an unproven dry-stack method of storing tailings but affecting the amount of water, the legality of the projected water use, and the closure plan for the pit, an additional hearing on the project in its new form is warranted. NMAC 19.10.9.904(E).

Furthermore, some elements of the June 5, 2020, agreement between NMCC and the Director of MMD are unfulfilled, even allowing for changes in water use.

Please, let me know when the 30-day hearing request period runs. Also, let me know if my previous request for a hearing on the Amended MORP is still valid or if I should now resubmit my request.

Further, I would like to request that the 30-day hearing request period be extended to 60 days on the basis of the faulty public notification and on the number of people who have been following this case for decades. To whom shall I make such a request? Can it be made electronically?

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Max

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Max

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**Re: [EXTERNAL] Copper Flat Mine**

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**From** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Date** Wed 2/18/2026 10:25 AM

**To** Nolan Winkler <nolanwinklerartist@gmail.com>

Hello Nolan,

Thank you for taking the time to write to me with your concerns for the Copper Flat project. I appreciate this feedback, especially as the project has entered the technical review process for their amended MORP. This will be a lengthy process, but I will keep you informed with regards to a public hearing per your earlier written request. You will receive a formal letter from me in the next week or two indicating our plan to hold a public hearing at a date to be scheduled once the permit is further along the technical review process.

Sincerely,

Evan



**Evan J. Owen**

Reclamation Specialist

Mining and Minerals Division

NM Energy, Minerals, and Natural Resources Dept.

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(505) 490-0967

[evan.owen@emnrd.nm.gov](mailto:evan.owen@emnrd.nm.gov)

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**From:** Nolan Winkler <nolanwinklerartist@gmail.com>

**Sent:** Saturday, February 14, 2026 2:17 PM

**To:** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Subject:** [EXTERNAL] Copper Flat Mine

You don't often get email from nolanwinklerartist@gmail.com. [Learn why this is important](#)

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Now I'm told if the water usage and pollution isn't enough to stop the reopening this mine, now there is an electricity problem.

The amount of electricity Copper Flat will need for the use of filtered cake tailings I'm told is a LOT and that the mine is having difficulty finding that much electrical energy available. So now with both the

water and electricity problems confronting them that would then, if permitted, confront the people living in the area, isn't it simply time to say NO to this project?!

I would appreciate your undivided attention to these matters. I have lived in Hillsboro, NM since 1993 and am a participant in the first suit against Copper Flat Mine and I'm just tired of it all. It has gone on too long for those of us who live in and love the area.

A sincere thank you,  
Nolan Winkler  
Hillsboro, NM

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**[EXTERNAL] Technical issues at Copper Flat Mine**

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**From** Max Yeh <maxwyeh@gmail.com>

**Date** Sun 2/22/2026 10:26 PM

**To** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Cc** Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>; Corey Durr <cdurr@blm.gov>; Greg Daviet <director4@ebid-nm.org>; Carter Kruse (TEI - Montana) <carter.kruse@retranches.com>; David Salopek <dpsalo@zianet.com>; Bob Cunningham <bcunni4668@aol.com>; Dustin Long (TEI-Ladder) <dustin.long@tedturner.com>; allysonsiwik <allysonsiwik@gmail.com>; Kathy McKinney <kathymckinney@sbcglobal.net>; Tessa Davidson <ttd@tessadavidson.com>; Tea Davidson <tea@tessadavidson.com>

 2 attachments (150 KB)

Electrical power.pdf; Calculation of RunOff.pdf;

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Hi, Evan,

I'm sending you two technical comments on NMCC's mine application (SI027RN). Both need introductions.

The first is a calculation of electrical energy needed by the mine. Although MMD is not strictly charged with this issue, it is charged to look at significant environmental and social impacts even if they are downstream and cumulative impacts. Also, because, like water, the mine cannot do without it, having a sufficient energy source the use of which does not entail blackouts for the area (and beyond, since electrical service areas are very widespread) is a serious consideration. Whether the mine has a reliable, sufficient, and safe source of electricity should determine whether the mine should or should not operate. To date NMCC has no contract for the enormous energy it needs. Even if MMD does not use this issue as part of its permitting process. I think it should be well aware of the issue.

The second attached comment is a re-submit of something I wrote several years ago regarding the pit reclamation. I resubmit it because DBS&A's "Updated Probable Hydrologic Consequences Analysis, Copper Flat Project" confirmed by calculations, but in the earlier round they seemed to have been ignored.

In particular, the authors reference the 2018 PHC analysis of the effect of a 100 year precipitation event (3.29 inches in 24 hours) on the level of the pitlake. They say (p. 23) that such an event leads to a rise of "only 2 to 3 feet" in the pitlake. The authors clearly do not know the mine operation. A 3 foot rise in the pitlake is at the verge of flooding the 3 foot high ledge of BLM land, the non-inundation of which is crucial to the mine's claim that the waters of the pitlake are private, that they do not impinge on public land or public waters. See the end of my calculation where I calculate a 3.57" storm with the resulting rise of 3.0 feet.

The issue is critical. I do not think the 100 year storm is the appropriate standard for the following reasons:

1) Three inch storms are not unusual in New Mexico (that is why in my calculation I used data from a recent storm). They are certainly not unusual locally. Ranchers will testify to that. Furthermore, storms locally cluster creating storms that last often several days. This is why we have locally many and often flash flooding, when a series of storms saturates the soil causing enormous runoffs.

2) The standard of a 300 year storm, which is what I used for my calculation of the maximum rise in pit water, was used in the design of the tailings pond, as was proper. The reduction of standards in 2018, is unreasonable and unexplained. The tailings pond was a temporary structure to be reclaimed; in contrast, the pitlake will exist un-managed and in perpetuity. The pitlake deserves to be treated with greater, not lesser, care.

3) Given New Mexico's acceptance of climate warming and its year long study of the climate changes for the next 50 years, the use of the 100 year storm standard is uncalled for. We know with some certainty that storms in this area will be fewer but more intense. A standard of at least 100+ years must be expected by MMD.

If my calculation of a 300 year storm has any validity, the claim that the pitlake will be a hydrologic sink is nonsense. Water will move from time to time from the pit into groundwater. This fluctuation is acknowledged in the Update. The pitlake is not private water as it mingles and pollutes groundwater.

This is an essential point in considering groundwater pollution. That is why I resubmit this calculation for your consideration.

The original comment was sent to NMED as a comment on the original DP 1840. That is why all the references are from those files.

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Max

## Comment on Water Sufficiency, Part 1

The following calculation of Copper Flat Mine's water needs employing filtered tailings storage is derived from NMCC's own estimates of water use employing wet tailings storage as summarized in BLM's 2019 *Copper Flat Copper Mine, Final Environmental Impact Statement* (FEIS). I assume, as the applicant does, that the only change in operation is the water savings of the filtered tailings storage plan. I begin with the proposed 30,000 tpd ore throughput operation highlighted in the application before MMD. I also calculate water use in a 17,500 tpd proposal called in the FEIS the "Proposed Action" and in a hypothetical 15,000 tpd project, which was the plan of operation Quintana used when it mined Copper Flat for 3.5 months in 1982. Since processing water quantity would be the same no matter how the tailings are handled, I focus on the water needed to process the ore in each case before I consider other mining needs for water. In none of these operations are the approximately 1,100 AFY water rights that was adjudicated to NMCC's use enough to mine. In the first two cases, the water rights are insufficient to process the ore. Only with a 15,000 tpd throughput does NMCC have enough water to process the ore, but insufficient water to mine.

1. NMCC's estimates for water use in the 30,000 tpd throughput (called Alternative 2 in the FEIS):

Total water use **for mining** is estimated at 22,210 AFY.

Total water use **for ore processing** is 21,242 AFY.

Recycled water in processing is 15,504 AFY. Therefore, **72.9%** (15,504/21,242) of **process water is recycled** (the text says 72%).

Process water not recovered includes

4,973 AFY retained in the wet tailings,

752 AFY evaporated and

13 AFY retained in the concentrate.

Of these, evaporation and concentrate moisture are irretrievably lost from the system, amounting to 765 AFY.

Total fresh water need is 6,706 AFY. FEIS, v. 1, part 1, Table 2-29, p. 2-85

2. Filtered tailings stack storage improves upon these numbers. Assuming it increases recycled water from 73% to 90% of the process water (which is a high estimate since between 3% and 5% of the process water is not retrievable being evaporated or in the concentrate), it is still difficult to imagine that the increase of 17% is sufficient to drop the fresh water need from 6,700 AFY to the 1,100 AFY water rights the miners now have. The drop would only be possible if the rate of processing were vastly increased, but nothing in NMCC's revised application discusses that. We assume that processing 30,000 tons of ore takes the same amount of time (one day) no matter how the tailings are handled. [Note: The filter presses and conveyor system for the filtered cakes are designed to throughput 31,728 tpd; see my comment "Electrical Power Consumption at Copper Flat Mine," #3.] Given the same rate of processing, then, is that 17% increase enough for the proposed MORP?

3. If the revised MORP operates, the process will lose 10% of the process waters, assuming a 90% recapture. That means annual water lost in ore processing itself (ignoring other

consumptions of water like dust control) is 10% of 21,242 AFY or **2,124 AFY**, which far exceeds the water rights of 1,100 AFY available for replenishment. In this scenario, 1,359 AFY are left in the “dry” tailings (2,124 AFY – 765 AFY irretrievable evaporation and concentrate moisture). This estimate does not include dust control, sanitation, equipment washing or other consumptive uses and losses of water from the system. We do not see sufficient water savings, then, to allow the proposed operation for mining 30,000 tpd of ore.

[Note: All my calculations here deal with annual quantities rather than rates because NMCC presents its data this way, using arithmetic average calculations instead of integral and differential calculus which is proper for conceptualizing rates.]

4. If mining were scaled back from 30,000 tpd to 17,500 tpd (a filtered tailings version of the Proposed Action in the FEIS) the total ore processing water is estimated at 12,402 AFY. See FEIS, Table 2-10. The annual water loss using filtered tailings storage (under the 90% recovery assumption) would be **1,240 AFY**, closer to but still exceeding NMCC’s water rights, again, excluding all non-processing losses such as dust control etc. There is insufficient water to process 17,500 tpd of ore. The Proposed Action would recycle 1,116 AFY and leave 584 AFY in the dry tailings.

5. Adding the estimates for dust control and other consumptive uses and losses exacerbate these shortfalls. **For the 30,000 tpd scenario, total losses needed to be replaced would be 3,334 AFY and for 17,500 tpd, the water shortfall needed to be replenished would be 2,208 AFY.** These numbers are calculated for total non-recycled use by replacing the figures for “Water retained in tailings” in Table 2-29 and Table 2-10 (FEIS) by the calculated losses using filtered cake tailings storage in 3. and 4. above. But these quantities are significantly lower than proper because the use of dry tailings storage increases enormously the need for dust control waters. Even without the dry stacks to water, dust control and other non-recycled water use (**the non-process water need**) amount to **968 AFY**. Considering these non-processing water requirements, there simply isn’t enough water to mine.

6. NMCC claims that its groundwater pumping will be reduced to less than 1,050 AFY from a formerly projected pumping of 6,100 AFY. See MORP Update, p. 2; the 6,100 AFY results from subtracting captured surface water and groundwater extracted from the ore to reduce the 6,700 AFY need. [Note: Neither the FEIS nor the MORP Update address these extra-legal takings of water.] However, even this reduction of 5,050 AFY is insufficient. The mining operation includes water uses that are not recyclable: dust control, evaporation, sanitation, equipment cleaning, etc. Most these systemic losses are fixed. Those that vary with throughput vary very little. Thus, for the 30,000 tpd action, evaporative losses, dust control, moisture in the concentrate, and other unrecycled uses amount to **1,733 AFY**. For the 17,500 tpd action, they amount to **1,624 AFY**. See FEIS, Tables 2-10 and 2-29. Pumping 1,050 AFY will not offset these losses. It would be insufficient even in a 15,000 tpd operation.

7. If we assume that NMCC mines at 15,000 tpd throughput at the same rate of water usage (gallons of water per ton of ore) as in the 17,500 tpd scenario, then the total mining water use per day would be (682 gallons/ton) x (15,000 tpd) or 10,230,000 gallons per day. See FEIS,

Table 2-9. Annualized and converted to acre feet per year, **total mining water use is 11,459 AFY**. [Note: the labels in this table (and also the similar Table 2-28) are misleading. The first row does not represent “Average annual water use during ore processing” but the average total combined use of water for both processing and non-processing, and the second row does not represent the “Average water used to process 1 ton of material” but the total combined use of water for both processing and non-processing per ton of material processed.” I have more clearly distinguished between processing water and mining water which includes both processing water and non-processing water use.] Therefore,

$$\begin{aligned}\text{total ore processing water} &= (\text{total mining use}) - (\text{non-processing use}), \text{ or} \\ &= (11,459 \text{ AFY}) - (968 \text{ AFY}), \\ &\text{or } \mathbf{10,491 \text{ AFY}}.\end{aligned}$$

Non-processing use is dust control and other in FEIS, Table 2-10. They are fixed amounts no matter the throughput, but using filtered rather than wet tailings storage increases the water needed for dust control (offsetting some of the water gains in the filtering process). In the filtered tailings process, we assume 10% of the ore processing water must be replenished. Therefore, total freshwater need for the 15,000 tpd processing requires water rights for **1,049 AFY** of water, about the amount NMCC was adjudicated. While NMCC does have sufficient rights for ore processing at this production rate, it would not have any rights for the non-processing water needs and thus for mining.

8. The FEIS -- and also the present updated MORP -- references three sources of water besides its rights to groundwater. See FEIS, Table 30. These are captured stormwater, moisture in the ore, and pit dewatering. These sources have ambiguous legal status.

The mine dewatering act (NMSA 72-12A-5) specifically states (§A), “Mine dewatering is neither an appropriation of water nor waste, but is governed by the provisions of the Mine Dewatering Act. No water rights may be established solely by mine dewatering.” If dewatering is not an appropriation of water (a taking and a beneficial using in one’s own interest) and if it cannot establish a water right in itself, then the water produced by dewatering the pit cannot be used legally in ore processing, as NMCC plans. Dewatering does not grant NMCC rights of use.

Furthermore, in the basin adjudication of NMCC’s water rights in pitwaters, NMCC was granted 5.52 AFY for dust control and 34.65 AFY for evaporation. Change of purpose of use in these rights requires application and approval by the State Engineer.

The pit is registered as a well by the State Engineer (LRG 4652-S-17). Extraction of groundwater in a well and using it for ore processing is an appropriation of public waters (NMSA 72-12A-1 and 72-12A-18) for which NMCC has no rights except those adjudicated to it. Thus, the beneficial use of water extracted from saturated ore requires that the point of diversion of some of NMCC’s 1,100 AFY rights be transferred to the pit, requiring, again, application and State Engineer approval.

Stormwater collection and use from the pit is an appropriation of public water since the pitwater is groundwater, the pit being below the water table of the aquifer. Any runoff into the pit mixes with public water and becomes public, subject to the control of the State Engineer. Stormwater collected in the mine's various seepage ponds is also under state regulation. See the New Mexico Office of the State Engineer Rainwater/Snowmelt Harvesting Policy on its website:

11/24/2004 - The New Mexico Office of the State Engineer supports the wise and efficient use of the state's water resources; and, therefore, encourages the harvesting, collection and use of rainwater from residential and commercial roof surfaces for on-site landscape irrigation and other on-site domestic uses.

**The collection of water harvested in this manner should not reduce the amount of runoff that would have occurred from the site in its natural, pre-development state. Harvested rainwater may not be appropriated for any other uses.** [Note: my emphasis.]

NMCC's capture of runoff does significantly reduce the amount of runoff that would naturally occur at the minesite, and **the hydrological impact of that runoff has never been factored into the various water modelings for this mining project.**

9. Even with the **extra-legal sources of water** (amounting to **601 AFY**), NMCC does not have enough water for a 15,000 tp'd operation, since this source is insufficient to offset the non-processing water that is not recoverable.

10. **Conclusion:** These considerations suggest that the **basic principle of sufficient water rights for mining** established by the previous agreement between the state and NMCC **has not been satisfied by the reduction of water use espoused by the amended MORP application.** See *Director's Order Withdrawing Order issued March 31, 2020 and adopting Settlement Agreement*.

The **federal mining permit** issued by the BLM includes a similar stipulation, that NMCC obtain water rights approved by the OSE sufficient for its plan of operation before exercising the permit. See BLM, *Copper Flat Mine: Record of Decision*, August, 2019: **"Surface disturbance will not be allowed until sufficient water rights are acquired."** The FEIS even specifies that the mine's use of water will not impair other water rights, will not harm public welfare, and will conserve water. NMCC's application does not demonstrate two of these three conditions. In fact, the MORP states that its use of water will impair other rights and will negatively impact the state's obligations to the Rio Grande.

Max Yeh  
Percha-Animas Watershed Association  
February 26, 2026

## Comment on Filtered Tailings Stability

1. Since the whole cake stack tailings impoundment rests on an incline ground surface, what keeps the whole thing from sliding downhill? The incline is not very steep, but the weight of the tailings is very great,

If the dry stack were a solid object, the answer would depend on the coefficient of friction between the dry stack and the ground surface liner. The textured surface of the HDPE liner would increase that coefficient of friction over an untextured liner, but considering how low the coefficient of friction is for an untextured HDPE surface, that increase may not be significant.

However, the real situation is much more complicated than that, and the textured liner surface may or may not play a role in preventing sliding.

2. On the first level of complexity, we have a moist (not “dry”) pile of face-powder fine particles. The moisture, we are told and we assume, is sufficient to cause seepage that flows into the seepage pond and is recirculated. That seepage means that on the molecular level, the force of gravity on the water molecules is sufficient to overcome the force of attraction of water molecules to the surfaces of the tailings particles (adhesion). More than that, since the seepage presumably flows down the incline of the liner’s surface, the force vector along that incline, only a fraction of the vertical downward pull of gravity, is sufficient to overcome the attractive force between water and the particles’ surfaces. This great difference in forces explains what soil engineers call flow through unsaturated soil.

While the filtered cakes, when they are laid, have a certain percent water in them, the movement of water downwards – caused by gravity and through the unsaturated tailings – makes the moisture content less in the upper portions of the stacks and greater in the lower portions. In fact, since the stacks get thicker as the bottom of the stacks descends the incline on which the stacks sit (the top of the tailing stacks being kept level), one can hypothesize that moisture content of the stacks at the tailings/liner interface gets greater with each build-out.

It is sufficient to understand seepage in the “dry” stacks to say that water flows laterally at the tailings/liner interface; which is to say that along that interface the tailings are very wet.

What prevents the tailings particles from moving with the water, carried along by gravity and the attraction between tailings particles and moving water and the pressure of the flowing water itself? Only the ability of the tailings to resist deformation or its shear factor. But shear factor decreases with increasing water content. At some point in increasing water content, approaching saturation, it drops to zero. The question engineers must answer at Copper Flat Mine, then, is “what is the water content of the tailings at (or very near) the interface between tailings and liner where water is actually flowing?” I don’t see an answer.

Since the great weight of the tailings media increases the density of the tailings at the bottom of the stack, causing shrinkage (getting rid of air bubbles) and increasing rigidity and stability, thus off-setting the loss of shear resistance with increasing saturation, what is the resulting shear factor near the interface, and is it enough to prevent the whole thing from sliding? Or, has water so accumulated at the bottom of the stack that the shear factor has effectively gone to zero? Sliding at the liner is not necessarily sliding **on** the liner surface but sliding **just above** the surface where the saturated tailings have lost their integrity (thus the reason why the texture of the liner may play no role at all).

In a recent modeling of this problem in dry stacks, the investigators state, “it was observed that the potential failure surface is triggered when the soil reaches a saturation degree of about 65–70%.” That is a pretty low threshold. Further, they concluded that at this point of saturation “the soil behavior is practically independent of deposition rates, slope inclination and pile height”; although, “the factor of safety (FoS) decreases for faster deposition rates compared to slower ones.” The whole study is important for my point here, but see especially Figure 7 showing the distribution of various degrees of saturation within the stack during build-out; Figure 8 showing the distribution at different facial slopes; and Figure 9 showing the changing distribution of saturation after closure (out 320 years). See Ricardo Gallardo, *et al.*, “Modeling self-compaction and static stability of a copper filtered tailings pile under unsaturated conditions,” *Acta Geotechnica* (2024) 19:4297–4312, appended.

The Gallardo modeling demonstrates what hydrologists have long known: that water infiltration through the vadose layer (the unsaturated soil above the saturated aquifer) does not proceed linearly. Instead, water clumps together (like a large water drop) clinging to the soil particles until the drop grows massive enough for the force of gravity to overcome the adhesion to the soil. We cannot immediately apply this model to the future situation at Copper Flat because Gallardo modeled a level bottom to the stacks, whereas NMCC intends an inclined surface, which suggests the possibility of drainage.

The inclined liner introduces a further complexity. Water movement on the liner depends on the added factor of the attractive forces between water molecules and polyethylene molecules of the liner. Further, the vector of the force of gravity along the incline is quite small. Water may not drain out at all; in which case, Copper Flat’s filtered tailings stack may indeed look like Gallardo’s model with an extensive area of saturation near the liner and growing, long after mine closure (unattended, we may add). The inclined liner may mitigate the saturation problem, but it may also increase the risk of catastrophic sliding of the stack. We need a better study than NMCC has provided.

3. Further, how do severe storms, hundred-year or three-hundred-year storms, affect these calculations? The permanent stability of “dry” stacks depends on them remaining permanently dry, that is, unsaturated. While it may seem that New Mexico’s arid climate favors continual unsaturated conditions, the local climate at Copper Flat argues against it. Storms here have a tendency to cluster, which is why the area is prone to flash floods when the soil becomes saturated due to a series of localized storms. The local winter climate also is characterized by the constant alternation of freezing and melting temperatures causing a loosening of soil surfaces through repeated expansion and contraction. Winter here also brings snow, which promotes deeper infiltration of water into the soil and into the tailings.

“Subsequent re-saturation can also occur due to infiltration either from rainfall or springs. Downward migration of moisture simply through unsaturated soil moisture transfer mechanisms from upper layers or consolidation of the stack as it grows in height may also cause the lower layer of the stack to become saturated.” Sadegh Javadi *et al.*, “Filtered Tailings vs. Thickened Tailings—A Holistic View,” 2020. <https://atcwilliams.com/filtered-tailings-vs-thickened-tailings-a-holistic-view/>. ATC Williams is an Australian mining consultancy that has managed over 400 tailings projects around the world.

4. If we look at the cross-sections used for each stage of the build-out in WSP’s stability analysis (Amended MORP, Attachment 2, Appendix F, Figures 3-2 to 3-5), the blue lines -- “W” above and “1” below the liner -- seem to represent the phreatic surfaces resulting from the modeling of annual rainfall in the stacked tailings and in the ground beneath. See the discussion of water tables resulting from precipitation in Section 3.4.3. If this is so, then the upper blue line indicates the possibility of saturated

conditions along the liner surface, a much simplified and conceptual version of what Gallardo's study actually calculated and modeled. These areas of saturation also impinge on the face of the CSTF at each stage, possibly indicating areas of slope failure during build-out. Yet, the model assumes a drained condition for the tailings.

5. Slope failure, especially along the juncture of the stack face with the liner, seems a concern because the build-out goes downhill. If the build-out started at the lower edge of the CSFT, built against a footer dam, then throughout the building of the stacks water would flow away from the working face at the liner and one might expect less problems with slope collapse. In such a scenario, the downhill slope face would, one assumes, be compacted to form a barrier/dam to the whole CSTF.

6. But the real situation at Copper Flat Mine is even more complex than that. The moist tailings in the stacks contain a number of chemicals used specifically to change the attractive and repellent forces between different type molecules: 1) chemicals to promote bubble formation in the flotation process (surfactants that reduce the water molecule's mutual attraction and thus lowers the water's surface tension making the water molecules cling to the particles of copper); 2) chemicals to coagulate particles so they will settle out of the tailings slurry (coagulants); and 3) chemicals used for dust control that bind particles into a surface structure (flocclulants). While these chemicals may be innocuous in themselves, their actions on the tailings will certainly affect the shear factor of the wet, possibly saturated, tailings at the bottom of the "dry" stacks. We also don't know how these chemicals react with the ones natively in the mineral residues at Copper Flat (which are certainly toxic).

7. I don't know if these questions of stability can be modeled in the lab. I don't know even if the normal soil mechanics used to describe unsaturated soil stability (Soil Water Characteristic Curves, matric suction, volumetric strain, etc.) -- itself derived from classical soil mechanics which deals with saturated soil and which seem useful for preventing failure along the face of the stacks -- is applicable to the situation at the tailings/liner interface. If the CSTF is compacted to increase stability only at the surface or on the face, the internal, uncompacted tailings are still a problem.

8. The possibility of saturated conditions in the tailings stacks and/or along the tailings/liner interface points to an essential corollary to the saturation problem: whether the water content within the tailings or at the interface is sufficient to cause liquefaction during an earthquake; and an earthquake of what magnitude?

The analysis of earthquake stability in Appendix F fails to consider that the mine is located in a fault zone, that the pit is crossed by several faults that might extend under the CSTF, and that study of the faults in the pit shows signs of dislocation. See P.G. Dunn, "Geology of Copper Flat Porphyry Copper Deposit," in S.R. Titley, ed. *Advances in Geology of the Porphyry Copper Deposits, Southwest North America*, 1982. Given this factual situation, perhaps the study should use as a design criterion not the 1 in 2,475 years event, which the Global Industry Standard on Tailings Management (2020) recommends only during operation and closure while the mine is under active care but the 1 in 10,000 year criterion which the GISTM recommends for passive care after mine closure (certainly the case we want to consider). <https://globaltailingsreview.org/wp-content/uploads/2020/08/global-industry-standard-on-tailings-management.pdf>.

9. Then, there is a question of risk. If the pile moves, what happens? It may seem that such a failure is less far reaching spatially than a break in a dam holding back a liquid slurry. However, if a large volume of toxic chemicals (sulfuric acid, heavy metals, radioactive elements, etc.) infiltrates into groundwater, or what is more likely, flows directly into Dry Gulch creek, the spatial influence of that

failure would be quite extensive, reaching the Rio Grande and southwards. Do we need to model a catastrophic failure?

10. If you ask Google's AI for operating copper mines in the US using filtered "dry" stack tailings impoundments, you will find that there is none; although, I have been told that two underground mines in Alaska are using filtered tailings storage. There are some gold mines experimenting with this process, but one of the reasons the issues raised above are difficult to answer is the relative newness of the process. American miners have little experience with the safety issues of filtered "dry" stack, especially with a throughput as large as 30,000 tpd; so that, claims of best practice are entirely theoretical rather than empirical and practical.

11. WSP's stability study seems to avoid discussing the problems it itself recognizes. After analysis of failures in the filtered tailings and along the liner interface – it found that "[i]n all cases, the critically low failure surface was a block sliding failure along the liner interface." Yet, in spite of that finding, the stability analysis seems to avoid the interface problems outlined above. See Appendix F, p. 24 [Amended MORP, Attachment 2, pdf p. 566].

First, the tailings at the interface is assumed to be drained, that is, unsaturated. *Ibid*, Section 3.4.3, p. 20 [Amended MORP, Attachment 2, pdf p. 562]; so, saturation is completely assumed out of the question. Second, the friction at the liner interface is set at infinity, defining an "exclusion zone" which binds the tailings above the liner with the ground beneath it, excluding the possibility in this model of slippage failure. *Ibid*, Section 3.4.2, p. 20 [Amended MORP, Attachment 2, pdf p. 562].

The analysis NMCC presents is perhaps useful for consideration of internal collapse of the stacks and slope failures at the stack's face. However, its authors have reservations and suggestions. The ground composition under the stack has not been investigated at depth. The tailings stress tests are from 1980.

Most important for this comment, the WSP analysis does not address the critically low failure surface of a slide and how to protect against it. It's treatment of tailings saturation is minimal given the importance of the degree of saturation in stack failure. Even in its consideration of risks, stack movement that threatens groundwater and surface water quality is unmentioned. For downstreamers, people who live along Animas Creek, the irrigators of EBID, the pecan growers, the City of Las Cruces, the Town of Deming whose well is just south of NMCC's production well field, the issue of water quality is just as important as water itself.

Max Yeh  
March 1, 2026



# Modeling self-compaction and static stability of a copper filtered tailings pile under unsaturated conditions

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## Abstract

Filtered tailings piles have better mechanical stability than other tailings disposal alternatives because they operate in an unsaturated condition. However, very few studies have quantitatively assessed the contribution of partial saturation for both self-compaction and mechanical stability. In this article, we evaluate the mechanical stability of a filtered tailing pile, based on an analysis of self-consolidation by material deposition under unsaturated conditions, considering rates of 1 h, 1 day and 4 days. For this purpose, an experimental study was carried out which included oedometric and triaxial consolidation tests in both, saturated and unsaturated conditions. Based on these results, a constitutive soil model was calibrated using the Bishop's effective stress concept, considering the evolution of the effective saturation and including soil–water characteristic curve (SWCC) as a function of volumetric strains. The results show that the proposed modeling strategy provides a reasonable approximation of laboratory paths with a single set of parameters. Additionally, the same approach was applied to model the pile's construction process. In this case, it was observed that the potential failure surface is triggered when the soil reaches a saturation degree of about 65–70%. At and this value, the soil behavior is practically independent of deposition rates, slope inclination and pile height. However, the factor of safety (FoS) decreases for faster deposition rates compared to slower ones.

**Keywords** Filtered tailings · Self-consolidation · Slope stability · Unsaturated soils consolidation

## 1 Introduction

Traditionally, copper filtered tailings are considered dense [45] because they have a solids concentration greater than 77% [27, 53]. Consequently, the material is deposited in an unsaturated condition, and therefore, an improved mechanical stability is expected. The unsaturated condition

tends to increase the shear strength and stiffness of the deposit due to a suction effect [14, 26, 50]. However, not always verifiable because of the permeability reduction due to non-saturation [8, 12] and the pile height levels that are being reached. Therefore, the detailed study of the self-consolidation process, its consequences on the saturation of the material and the influence on the mechanical stability of the pile need to be addressed [48, 49, 56], especially in seismic countries that have decided to use this type of tailings in very tall piles.

In the past 20 years, several studies have been carried out on the self-weight consolidation of mine waste material under saturated and unsaturated conditions [10, 11, 28, 40, 44, 46, 54, 55, 59]. However, these studies have been performed on conventional tailings or mixtures of mine waste materials. Few studies have used experimental results to develop computational models close to real field conditions [11, 23, 39, 41], despite continuous improvement since 1990 with the Barcelona Basic Model (BBM) proposed by Alonso [3, 19, 22, 29–31, 35, 51] to reproduce

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unsaturated behavior. These improvements have been able to a better assess unsaturated soil behavior in terms of strain and strength. In particular, they have contributed to identify key variables such as (i) the coupling between the suction with the small strain behavior, (ii) the soil–water characteristic curve (SWCC) and its dependence on porosity and (iii) the unsaturated flow and its impact on strength and deformation properties. However, these approaches have been rarely used by mine waste engineers, probably because: (1) The constitutive models require parameters that are not easy to determine experimentally, (2) numerical modeling is time consuming and (3) there is a lack of in situ information.

In this study, we show that using a simple constitutive model with a single set of numerical parameters, in combination with an appropriate SWCC and Bishop's effective stress approach, we are able to satisfactorily reproduce 1D consolidation and drained triaxial tests' experimental paths. The proposed strategy consists of including in the model the coupling between the evolution of SWCC and the volumetric strain. After calibration, we apply the approach to model the sequential construction of a typical filtered tailings pile. A fully coupled flow-deformation analysis [25] is used, into a FEM model, to study the influence of interlayer deposition rates on its mechanical stability. For this purpose, we use the strength reduction method (SRM). This modeling strategy provides a mechanism to generate flow from upper to lower layers, which is highly dependent on the deposition rate. It is shown that the deposition rate affects the factor of safety and the potential failure surface location, which begins to be triggered above 62% saturation from the top of slope toward the base of the pile, which is fully saturated.

## 2 Material and experimental methods

The fresh tailings material was extracted from a copper sulfide concentrator plant located in northern Chile, with a production of about 18,000 tons of tailings per day. This material corresponds to a low plasticity silt (ML) according to the unified soil classification system [6], with a specific gravity of 2.97 [7] and a saturated permeability of  $5 \times 10^{-7}$  m/s from flexible wall permeability tests [5]. The samples were generated using the moist tamping method to achieve a dry density of  $16.5 \text{ kN/m}^3$ , which is the field expected density according to the company in charge of the geotechnical design. This dry density with a water content of 16% corresponds to a saturation degree of about 60%. The experimental plan consisted of saturated and unsaturated consolidation tests with water flow measurements, as well as saturated and suction-controlled drained triaxial tests. Additionally, the SWCC was obtained at several

densities. Consolidation tests were performed in cylindrical samples with diameter ( $D$ ) and height ( $H$ ) of 63 mm and 22, respectively, while samples of 50/100 mm ( $D/H$ ) were used for the triaxial tests. SWCC was constructed based on four different techniques: (i) tensiometers, (ii) filter paper, (iii) axis translation and (iv) the equilibrium vapor technique (see [22] for additional details). Figure 1 shows the particle size curve of the tested material and the obtained SWCC, including a fitting with the Van Genuchten model [20] according to the following equation:

$$S_r(\psi) = S_{\text{res}} + (S_{\text{sat}} - S_{\text{res}})[1 + (g_a|\Psi|)^{g_n}]^{g_c} \quad (1)$$

$$g_c = 1 - g_n/g_n \quad (2)$$

where  $S_r$  is the degree of saturation,  $S_{\text{res}}$  is the residual saturation,  $S_{\text{sat}}$  is the degree of saturation when pores are still filled with water,  $\Psi$  is the matric suction and  $g_a$ ,  $g_n$  and  $g_c$  are curve fitting parameters. The parameter  $g_n$  controls the rate of water extraction once the air-entry value (AEV) is exceeded, its value varies according to the density [7, 12]. In this paper, the value of  $S_{\text{res}}$  was fitted based on the experimental SWCC instead of using the experimental residual saturation, as suggested in [57].

During the loading, the matric suction and the degree of saturation evolve due to the compressibility of air and water flow from the specimen [17]. In consolidation tests, the volume changes were quantified measuring the expelled water, and the variation of the height at each load increases. In triaxial tests, total volume changes were measured by the double wall method during shearing [15, 34]. During the isotropic consolidation phase, the volume change was estimated through the gas law, using a digital air pressure/volume controller [1]. The matric suction applied to the samples in triaxial tests was defined from the SWCC as a function of the expected in situ water content. In consolidation tests, the matric suction was not applied since we want to quantify the water expelled at each load increment and the corresponding evolution of saturation and matric suction.

Strength parameters for the material in saturated and unsaturated conditions were estimated using the concept of total average net stress proposed by Wang et al. [52]:

$$\sigma_3 = \sigma_c - u_a \quad (3)$$

$$\sigma_1 = \sigma_c + q - u_a \quad (4)$$

$$p_{\text{net}} = \sigma_c + q - u_a + 2 \cdot (\sigma_c - u_a)/3 = q/3 + \sigma_c - u_a \quad (5)$$

where  $q$  is the deviatoric stress,  $p_{\text{net}}$  is the mean net stress,  $q_s$  is the final intercept of this projection with the  $q$ -axis,  $\sigma_3$  is the net confinement stress,  $\sigma_c$  is the cell pressure,  $u_a$  is the air pressure applied to sample and  $\sigma_1$  is the net principal stress.

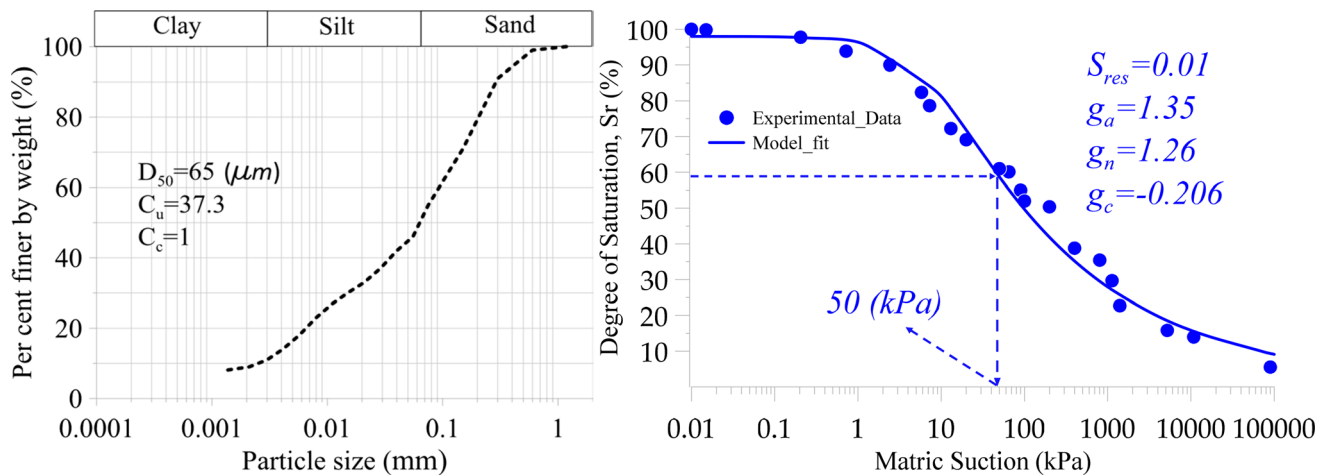


**Fig. 1** **a** Particle size distribution of the material tested. **b** Experimental and fitted SWCC

In order to consider the evolution of self-consolidation by self-weight, an artificial suction curve was calibrated based on three dry densities:  $16 \text{ kN/m}^3$ ,  $17.5 \text{ kN/m}^3$  and  $19 \text{ kN/m}^3$ . This strategy provides a mechanism to move from an unsaturated to a saturated condition, representing the effect of self-consolidation, including the field deposition and the corresponding density increase. For modeling, a fully coupled flow-deformation approach, including permeability evolution, was also considered. Deposition rates have an important role in this study and are evaluated in terms of the evolution of the saturation of each layer, including water flow between them.

### 3 Modeling strategy

In terms of modeling, a single set of parameters were calibrated for 1D consolidation and drained triaxial tests. The constitutive model selected to represent the transition from the unsaturated to the saturated condition corresponds to the hardening soil model [42] available in Plaxis<sup>®</sup> code [37]. Under unsaturated conditions, the software applies the Bishop and Blight [9] concept of effective stress, and therefore, the proper evolution of variables such as suction, effective saturation ( $S_{eff}$ ) and relative permeability becomes essential. The equations are as follows:

$$\sigma' = \sigma - p_{active} \quad (6)$$

$$p_{active} = S_{eff} \cdot p_w$$

$$S_{eff} = (S_r(\psi) - S_{res}) / (S_{sat} - S_{res}) \quad (8)$$

where  $p_{active}$  is the pore pressure acting on the soil skeleton,  $S_r$  is the degree of saturation of soil,  $S_{res}$  is the residual degree of saturation and  $p_w$  is the pore water pressure. Similarly, the evolution of  $p_w$  is driven by  $S_{eff}$  and Van Genuchten parameters. The formulation of the coupled

hydro-mechanical problem is represented by both the equilibrium and the continuity equations of the water–soil mixture. The displacements of the solid skeleton and the pore water pressure are the basic variables of the problem allowing an analysis of the simultaneous development of deformations, pore pressures and water flow in saturated and partially saturated soils as a function of time. The implementation available in the code is based on the works of Sheng et al. [43] and Gallipoli et al. [18], including an implicit stress integration scheme and the sub-stepping approach proposed by Pérez et al. [36].

The relative permeability also undergoes changes due to the effective saturation variation which is a result of its self-consolidation. The hydraulic conductivity dependence on suction is modeled as a function of effective saturation in Plaxis using Van Genuchten's parameters [24], but also introducing the following lower boundary value:

$$k_{rel}(S_r) = \max \left[ (S_{eff})^{g_l} \left( 1 - \left[ 1 - S_{eff}^{(g_n/g_n-1)} \right]^{(g_n-1/g_n)} \right)^2, 10^{-4} \right] \quad (9)$$

The mechanical and hydraulic boundary conditions were the same for the fully saturated and unsaturated tests. However, for the unsaturated tests, the initial saturation level should correspond to the expected value in the field and should coincide with the initial matric suction according to the SWCC used in the model. Figure 2 illustrates boundary conditions used to simulate elementary laboratory paths.

The consolidation test was reproduced for an increasing vertical stress from 10 to 3200 kPa. Two stages were considered for each vertical stress increase: a quick application of loading (1 s) and a consolidation stage where the excess of pore pressure dissipation takes place until the

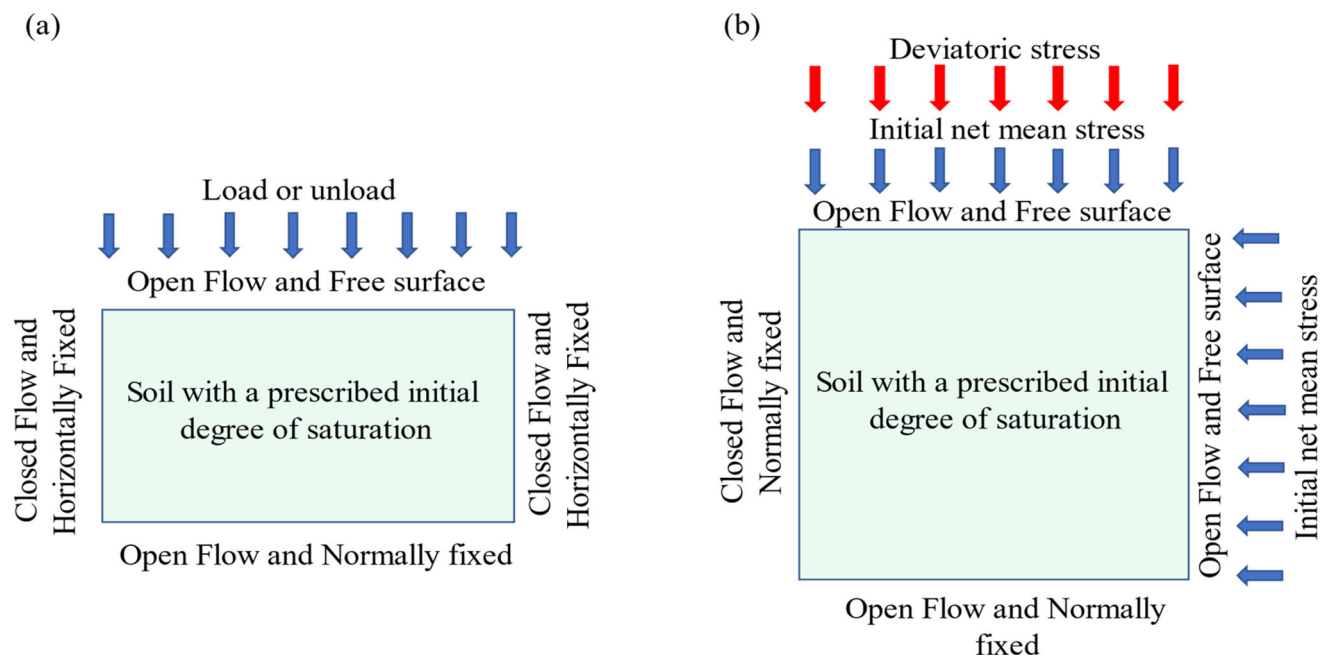


**Fig. 2** Axisymmetric model. **a** Hydraulic boundary conditions and loads used in the consolidation test. **b** Hydraulic boundary conditions and loads used in the triaxial test

value of 0.1 kPa is reached. After loading, the unloading process was also modeled. Regarding modeling of the triaxial test, the same soil parameters were used, including SWCC for the unsaturated case. A fully coupled flow-deformation analysis was used, adopting a perfectly drained condition. Nevertheless, matric suction was assumed constant during the shearing of triaxial tests by using the same shear rate of laboratory tests (0.0015 mm/min) in the model. The selection of material parameters for the constitutive model was performed jointly, for the saturated and unsaturated cases, trying to achieve the best simultaneous fit between both sets of experimental results using a single set of parameters.

Finally, we present an analysis of the slope stability by the strength reduction factor (SFR) method, adopting inclination angles of 1.73H:1 V, 1.3H:1 V and 1H:1 V (30°, 37.5° and 45°). These inclination angles of deposition were taken from the information available from the Karara Mine located in the mid-west of western Australia [24].

## 4 Experimental results and model calibrations

### 4.1 Effect of density and calibration of SWCC

Figure 3 shows the experimental suction curves for dry densities of 16.5 kN/m<sup>3</sup>, 17.5 kN/m<sup>3</sup> and 19 kN/m<sup>3</sup>. These curves were adjusted to allow the transition from looser-to-denser conditions in terms of the initial degree of

saturation, the matric suction and volumetric strain. These tests were performed after saturating the samples by immersion during 24 h, obtaining an initial saturation degree above 99%. This saturation degree was consistent with the initial measurement of the tensiometer, which was of about 0.4 kPa. Initial void ratio ( $e_0$ ) of those specimens after the saturation were 0.8, 0.697 and 0.563 for dry densities of 16.5 kN/m<sup>3</sup>, 17.5 kN/m<sup>3</sup> and 19 kN/m<sup>3</sup>, respectively. The SWCC used in the model was calibrated according to the initial saturation at which the material is deposited in situ, thus representing the initial matric suction level. Subsequently, this curve evolves in terms of saturation, due to the volumetric deformations experienced and the water flow. Matric suctions up to 100 kPa were obtained and measured continuously by means of tensiometers, using the evaporation method in the ku-pF apparatus manufactured by UGT®. Only adjustments for 16.5 kN/m<sup>3</sup> and 17.5 kN/m<sup>3</sup> are provided since the full saturation range was experimentally characterized only for these densities. The black line in Fig. 3 corresponds to the evolution of saturation and suction, as load increments are applied in the unsaturated consolidation test. A detailed description of this evolution is provided in the next subsection (see Fig. 4d). The influence of the density on the SWCC has already been studied by several authors, e.g., [2, 13, 32, 58]. These studies demonstrate the effect of porosity on the SWCC under drying conditions due to the evolution of density and the double porosity of some soils. This effect tends to disappear as the pore size becomes

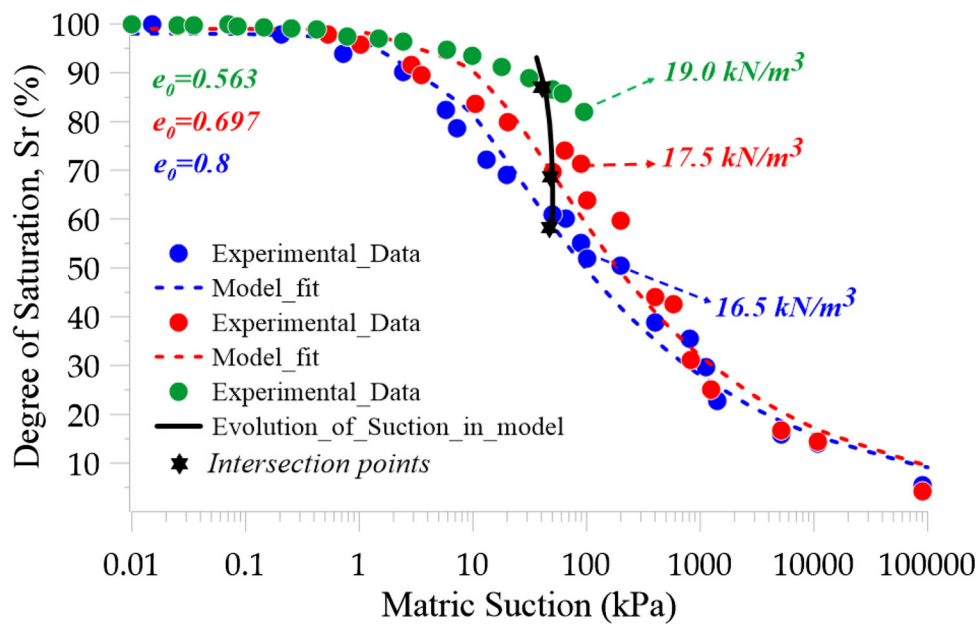


**Fig. 3** Adjusted and experimental suction curves in terms of material density

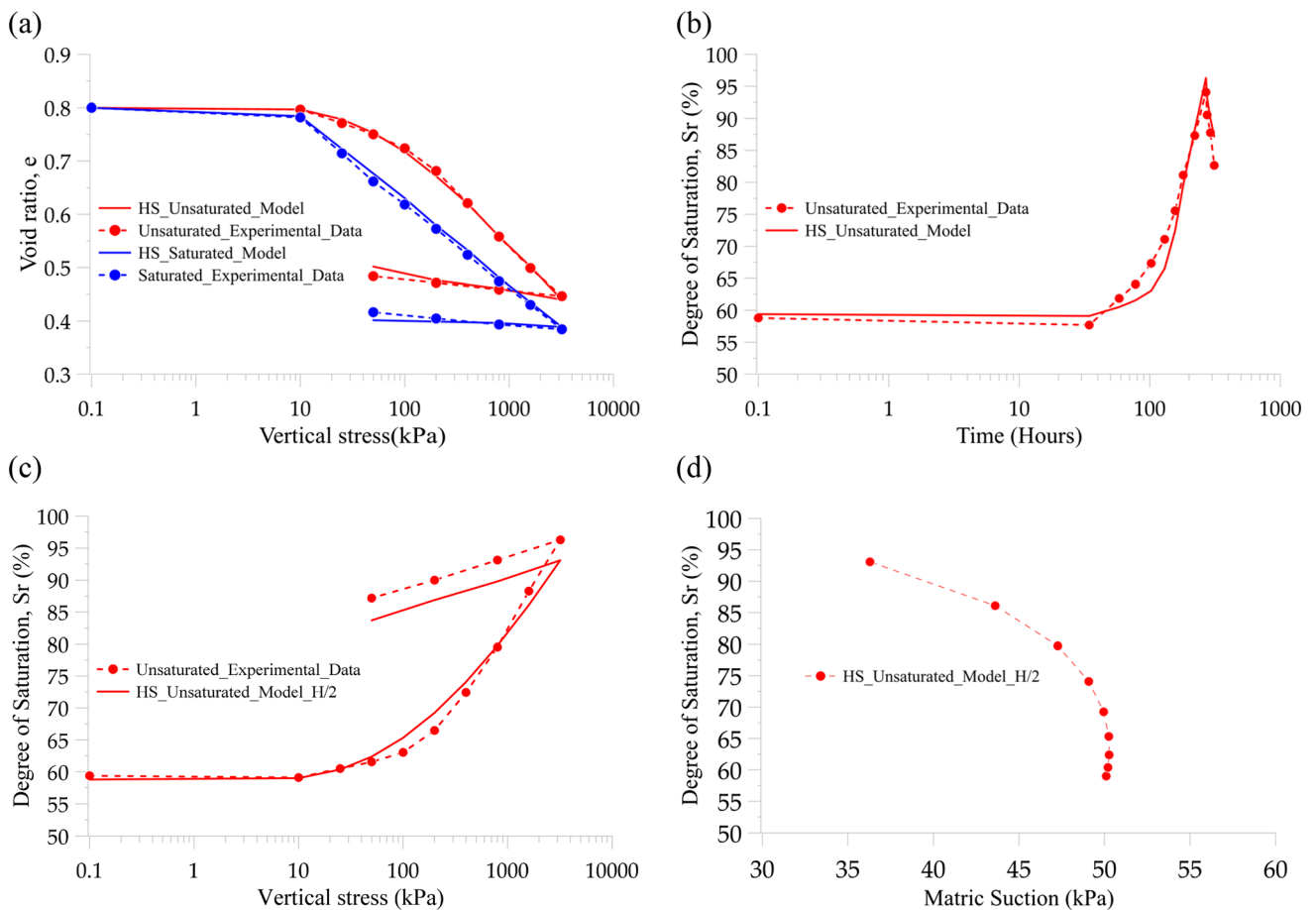


**Fig. 4** **a** Evolution of void ratio versus applied vertical stress. **b** Evolution of saturation versus elapsed time. **c** Evolution of saturation versus vertical applied stress. **d** Evolution of saturation degree versus matric suction

smaller and more uniform, i.e., as a result of density increment.

## 4.2 Consolidation test and model validation

Experimental results were obtained using an oedometer manufactured by GDS Instruments® on specimens (see sample description in Sect. 2), compacted by the moist tamping method. This device can apply air pressure to the specimen and perform consolidation tests at constant matric suction. For this research, load increments were applied, and the water expelled from the specimen at each load interval was measured. The water passes through a ceramic porous stone with a high air-entry value (1500 kPa), which avoids air flow. Details of the controlled suction tests can be found in [17], while here we present and discuss only the tests with free water flow. Figure 4 shows the experimental data as dots, while solid lines correspond to simulation responses. Although the initial void ratio is the same, suction stiffens the material reducing the volume changes for identical stress. During discharge, there is no obvious suction effect. The saturation evolution is presented in Fig. 4b and c, both as a function of the test duration and the applied vertical stress, respectively. It is observed that for the maximum vertical stress of 3.2 MPa, saturation reaches 95% and, when this load is reduced to 50 kPa, a final saturation of about 85% is obtained. These results indicate that the effect of void reduction or density increase outweighs the water expulsion as vertical stress increases. From a practical point of view, this means that the more confined lower layers of the tailings pile could become significantly more saturated, which could influence its mechanical stability. Figure 4a–c also shows the simulated path obtained according to the strategy presented in the previous section.

In general, the results in terms of void ratio and vertical stress are very close, but some differences could be noted regarding suction evolution. These differences appear at a vertical stress of 50 kPa but tend to reduce as the vertical stress increases. In Fig. 4, at 3.2 MPa, the trend reverses, and the simulated value is slightly lower than the experimental degree of saturation. This difference could imply that the simulation is not able to fully follow the evolution of the permeability during the test, which varies with both the saturation increment and the voids decrement. However, for the purposes of this study, the simulation results are satisfactory. In Fig. 4d, we show the evolution of the matric suction, and the saturation degree provided by the model. This value is not accessible in the test, as there is no direct control of the suction. This path is included in Fig. 3 to highlight the agreement with experimental SWCC for denser packings. It is verified that the void ratio–degree of saturation–matric suction combinations of the model are

reasonably consistent with the independent SWCC tests. Therefore, the model can reproduce reasonably well the simultaneous evolution of these three variables during unsaturated consolidation, starting from the SWCC associated with the sample preparation density.

## 4.3 Simulation of drained triaxial tests under full saturation and unsaturated conditions

The drained tests of specimens (see description in Sect. 2) in fully saturated and unsaturated soil at constant matric suction were carried out in a triaxial equipment with double chamber (inner and outer chamber) manufactured by GDS Instruments®. The specimens were compacted by the wet tamping method. In fully saturated condition, volume changes were measured through the back pressure controller and verified by the volume variation of the inner cell. For the unsaturated condition, volume changes were determined according to the gas law, as a function of the volume variation of the air pressure/volume controller of the equipment. Additional details can be found in [17]. Table 1 provides a summary of the characteristics and conditions of triaxial tests performed.

Figure 5 shows a comparison of the obtained experimental and simulated paths for the saturated case. It demonstrates that the behavior is contractive for all applied confining pressures, which is consistent with the density of the 80% of the standard Proctor [4]. The simulated path is reasonably close for all confinements, especially at 50 kPa. In terms of deviatoric stress, simulation is accurate at low axial strain ( $\epsilon_a < 4\%$ ) and at large deformations ( $\epsilon_a > 16\%$ ). However, the obtained volumetric strain derived from simulation shows some departures compared with the experimental response and is not sensitive to change of confinement. Comparing the simulations in Figs. 5 and 6, it is possible to conclude that the constitutive model can reproduce the experimental path with reasonably accuracy using a single set of parameters.

**Table 1** Details of the performed drained triaxial tests

| Condition   | Cell pressure (kPa) | Back pressure (kPa) | Air pressure (kPa) | Matric suction (kPa) | Initial net pressure (kPa) |
|-------------|---------------------|---------------------|--------------------|----------------------|----------------------------|
| Saturated   | 450                 | 400                 | 0                  | 0                    | 50                         |
|             | 500                 | 400                 | 0                  | 0                    | 100                        |
|             | 600                 | 400                 | 0                  | 0                    | 200                        |
| Unsaturated | 110                 | 10                  | 60                 | 50                   | 50                         |
|             | 160                 | 10                  | 60                 | 50                   | 100                        |
|             | 260                 | 10                  | 60                 | 50                   | 200                        |

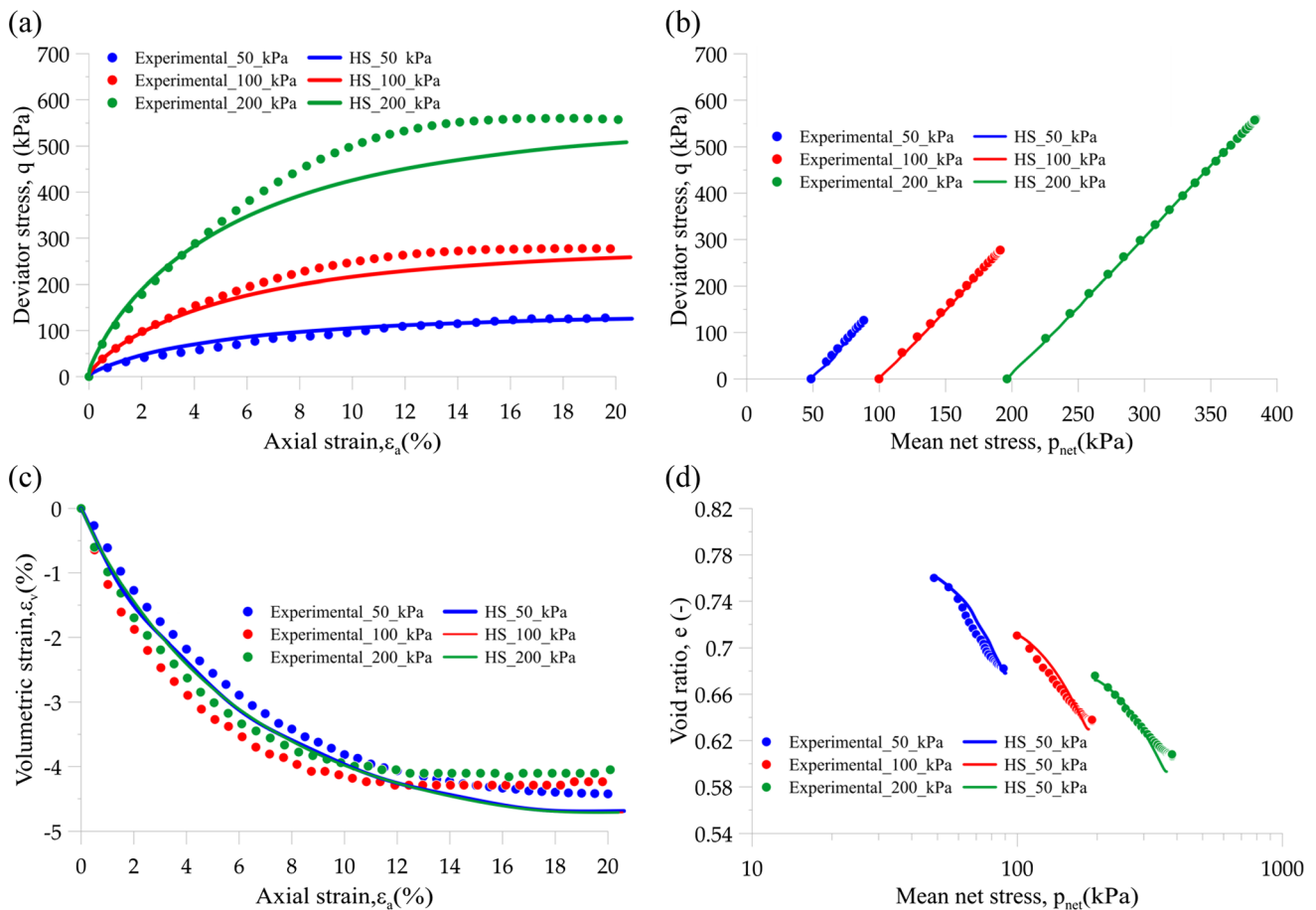


**Fig. 5** Triaxial drained saturated case. **a** Axial strain versus deviatoric stress, **b** stress path of mean net stress versus deviatoric stress, **c** axial strain versus volumetric strain and **d** mean net stress versus void ratio

Figure 6 shows the experimental and numerical results for the unsaturated path at constant matric suction. The experimental paths show contractive behavior for the whole confining pressures range, similar to saturated ones. Hence, 50 kPa of matric suction is not enough to trigger denser behavior. However, maximum volumetric strains are slightly lower than the saturated condition (4% vs 4.5%). Nevertheless, as the confinement increases, the volumetric behavior becomes closer to the saturated one. This implies that, when confining pressure increases, volumetric changes are also more significant because the material is closer to saturated condition due the air phase compression. Therefore, the effect of suction is more relevant for smaller confinements. It is important to note that an increase in saturation in the material samples, up to 8% during isotropic consolidation, is obtained for a fixed suction of 50 kPa and net confinement pressure from 50 to 200 kPa.

In terms of modeling, the fit is not as good as in the saturated case, but it is still reasonable. Greater differences can be noted at the intermediate range of deformations, but it was possible to properly reproduce initial stiffnesses and

large deformation values using the same set of parameters as in the saturated case. On the other hand, the simulated volumetric path is more compressible than the experimental case and almost independent of the confinement. Such a behavior is possibly the result of a constant air pressure in the model, and the fact that the effective stress, that controls the soil behavior, depends only on the evolution of the SWCC with matric suction as a function of the effective saturation.

It is concluded that by considering a single set of parameters and the SWCC corresponding to the sample preparation density, it is reasonably possible to reproduce the saturated and unsaturated consolidation laboratory paths, as well as the drained triaxial tests, in both, saturated and at constant suction of 50 kPa. In the range of stresses and matric suctions under study, the Bishop and Blight's effective stress concept, combined with the hydro-mechanical coupling in terms of effective saturation, allow the capture of the fundamental behavior aspects, including the evolution of SWCC with increasing density due to the increment of the confinement stress. A more accurate reproduction of the experimental trajectories could be

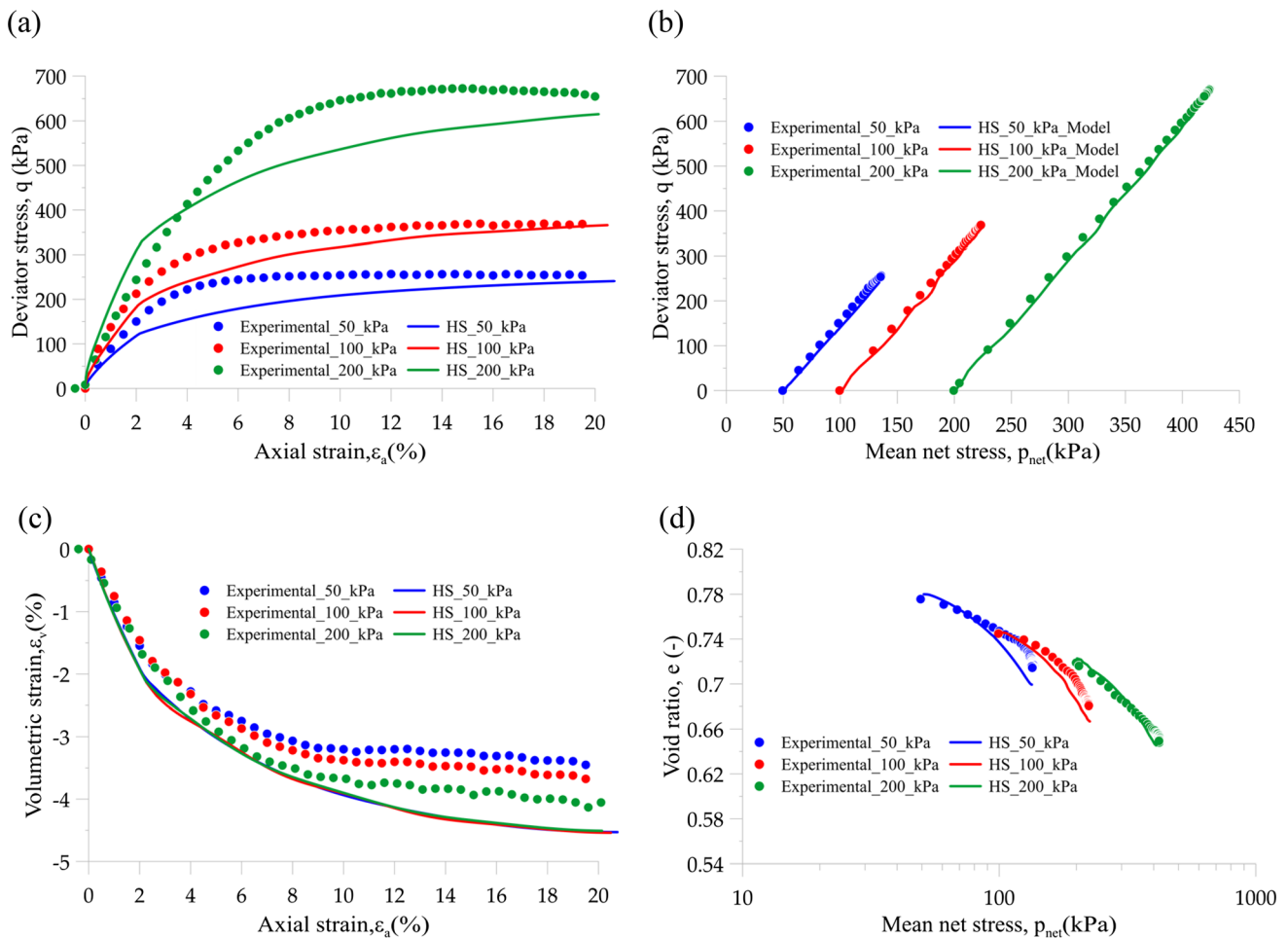


**Fig. 6** Triaxial drained unsaturated case. **a** Axial strain versus deviatoric stress, **b** net stress versus deviatoric stress, **c** axial strain versus volumetric strain and **d** mean net stress versus void ratio

achieved by individual calibration of the constitutive model for each confinement and suction level. However, this process would generate a large set of parameters that would be very difficult to handle in the model presented in the next section as the confinement and suction varies at each stage and step of the simulation. For this reason, we selected a single set of parameters representing a reasonable compromise between the effect of confinement and suction on the experimental paths. The parameters used for the HS model are provided in Table 2. This set of parameters and modeling approach will be applied in the following section to address the target problem of this paper, which is the stability of thickened tailings piles in unsaturated condition, including the effects of self-compaction.

**Table 2** Calibrated parameters

|                                      |                           |
|--------------------------------------|---------------------------|
| Dry density                          | 16.5 (kN/m <sup>3</sup> ) |
| $E_{50}^{ref}$ (kN/m <sup>2</sup> )  | 7500                      |
| $E_{oed}^{ref}$ (kN/m <sup>2</sup> ) | 3950                      |
| $E_{ur}^{ref}$ (kN/m <sup>2</sup> )  | 32,000                    |
| $p_{ref}$ (kN/m <sup>2</sup> )       | 200                       |
| $M$                                  | 1*                        |
| $c'$ (kN/m <sup>2</sup> )            | 0                         |
| $\phi^o$                             | 35.2                      |
| $\psi^o$                             | 2.5                       |
| $R_f$                                | 0.95                      |
| $v'_{ur}$                            | 0.17                      |
| $Ko^{nc}$                            | 0.423                     |
| $k_{saturated}$ (m/s)                | $5 \times 10^{-7}$        |
| Van Genuchten parameters             | See Fig. 1b               |

\*as suggested in [47]

## 5 Application: effect of the material deposition rate on slope stability and saturation degree evolution

In this section, the role of deposition rates is illustrated in terms of their impact in saturation due to induced volumetric strain by self-weight. Furthermore, the effect is quantified in terms of the factor of safety (FoS), the shape of the potential failure surface (PFS) and the saturation level at which the PFS begins to develop. To accomplish this task, the following modeling strategy was considered: (i) Each new layer of 1 m is added to the model with a saturation equivalent to the one expected in the field (16%); (ii) a fully coupled flow-deformation analysis is performed considering deposition rates of 1 h, 1 day and 4 days, (iii) flow between layers is allowed in the model and (iv) open flow and normally fixed conditions were imposed at the bottom of the model to simulate a stiff basal drain, and (v) flow is allowed over the slope face. A slope stability analysis by strength reduction method (SRM) [21] was performed up to 24 m of height considering slope angles of 1.73H:1 V, 1.3H:1 V and 1H:1 V (30°, 35° and 45°). SRM in Plaxis uses a friction angle, and cohesion reduction until failure is reached for a stable value of reduction. In the unsaturated case, suctions increase the effective stresses resulting in a higher strength of the soil. Since the method reduces the friction angle, the effect of suction is also reduced, but the resistance is still higher than an equivalent perfectly dry case ( $p_w = 0$ ). This method is only an approximation and could overpredict FoS values, but the aim of the application is to show the effect of water flow into the pile and the deposition rate on this stability indicator, rather than to reach a target FoS. The shape of the associated PFSs and the degree of saturation through them were analyzed for several deposition rates.

### 5.1 Evolution of saturation level with increasing pile height and material deposition rates

To illustrate some results of the model, Fig. 7 shows the evolution of saturation level as a function of the height for a slope of 45° and considering 4 days of deposition rate. This experiment corresponds to the worst case scenario in terms of self-weight loading, but it is the slowest deposition rate explored. For heights up to 8 m, the saturation level is in the range of about 60–80% in the pile, but the degree of saturation at the end of the construction base increases from 50 to 100%. Saturation is reached in a thin layer because of the increase in volumetric deformations and downward water flow from fresh layers. It can be observed that the saturation distribution within the pile is not smooth, but rather intercalation of layers with similar

saturation levels is generated, even reaching intermediate zones close to saturation. This is due to the interaction of the flow in each layer with the layers already deposited at the site, also consistent with some field observations [33]. As expected, for heights above 12 m, a thicker layer at the base of the pile begins to saturate because volume strains exceed the drainage capacity of the material. In addition, the central third of pile begins to reach saturation levels close to 80% and by 18 m, a clear increase in saturation (above 80%) can be noted. At 24-m height, a large portion of the pile is at 80% saturation; however, the saturation degree drops close to slope face. This implies that there is a discharge flow close to the face toward the base, affecting the overall stability of the pile.

On the other hand, Fig. 8 shows the degree of saturation distribution for a pile height of 24 m and three slopes (30°, 37.5° and 45°), as a function of two deposition rates (1 h–4 days). In general terms, the differences are minor, although some variations in the width of the driest zone close to the slope surface can be noted when the deposition angle changes. If the deposition rate changes from 1 h to 4 days, it is observed that the central third of the pile drains, increasing the saturation of the lower bottom of the pile in contact with the natural soil. Therefore, it is very important to consider a basal drainage system. It also shows that a slower deposition rate leads to a more continuous saturation distribution within the pile, reducing the influence of the layer thickness.

### 5.2 Long-term behavior of the pile

The results presented in the previous section refer to the end of the construction; however, these piles can in principle remain in perpetuity at the construction site. Therefore, it is pertinent to evaluate their long-term behavior. Figure 9 shows an example for a 45° slope case considering 4-day deposition rate. The simulation was extended to more than 300 years after the end of construction. Firstly, it is observed that the effective saturation becomes more homogeneous inside the reservoir, and the layer thickness considered for the simulation is no longer evident. Additionally, the evolution of saturation continues after the construction is completed, observing that after 10 years, a saturated layer of about 1 m has already formed at the base of the pile. Three hundred and twenty years later, the saturation level has reached almost half of the pile height. As at the same time, the top of the pile decreases its saturation level, while a long-term downward flow takes place.

Additionally, Fig. 10 shows the evolution of effective saturation and volumetric strain at control points shown in Fig. 9a. It can be observed that saturation continues to evolve many years after the end of construction, reaching

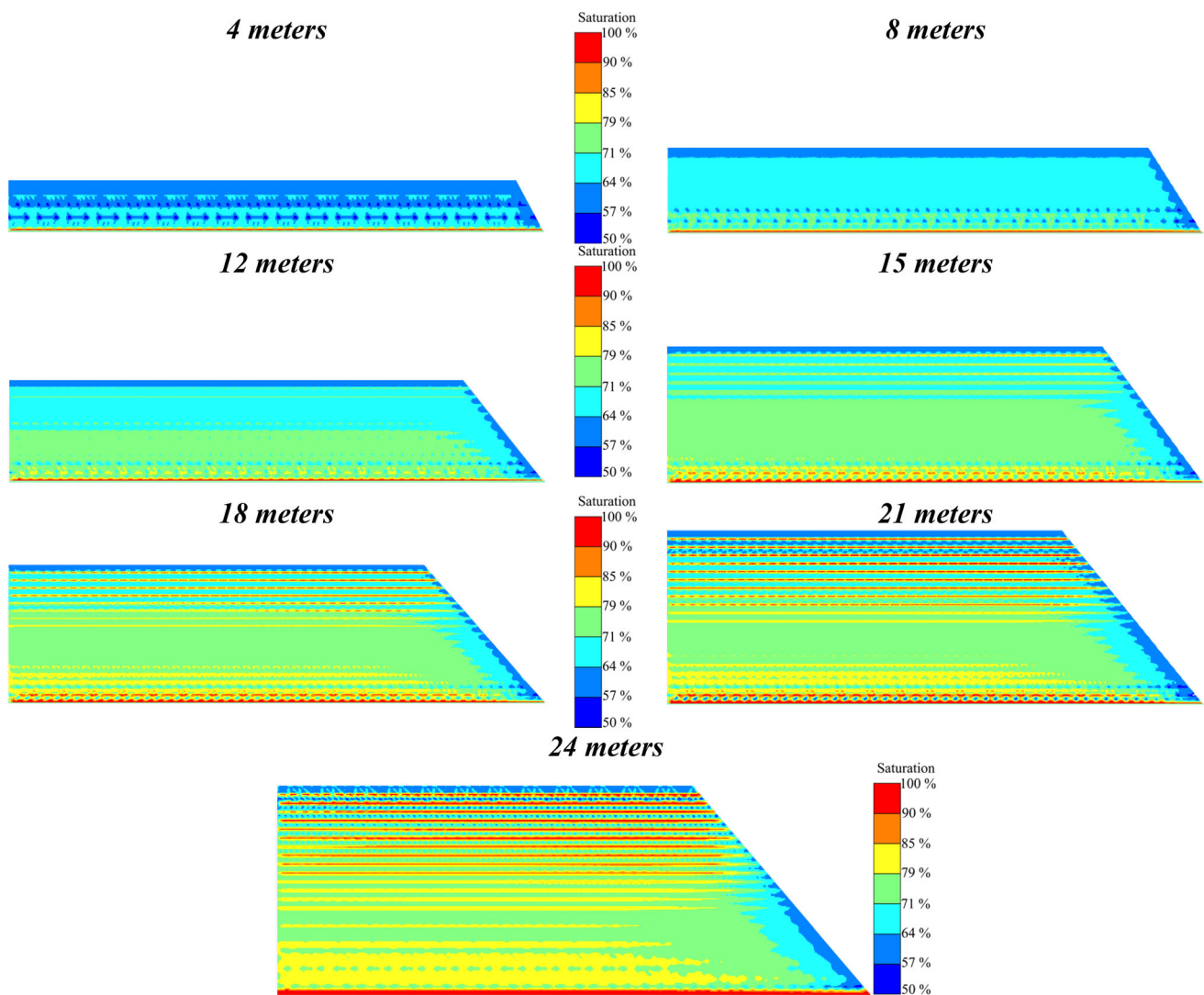


**Fig. 7** Effect of height evolution on the saturation degree distribution for case of 4 days and 45° slope during the construction

full saturation at the base, approximately 120 years after the end of the simulation of the construction process. It is also observed that the control points above 9 m in height continue to desaturate until the end of the simulation. At 9 m, the increase in saturation is slower because the drainage toward the lower layers is combined with the downward flow from upper layers. Regarding the volumetric strains at the same locations, it is observed that the variation is almost negligible, while the volume is kept nearly constant during the whole simulation. At the highest control point, a volume reduction is observed during the first 40 years due to desaturation, but after that period, the evolution also stops. It is important to note that the model predicts a very slight swelling of the lower layers when saturation is reached, suggesting that the lateral expansion

slightly exceeds the vertical compression close to the slope zone.

Although this long-term simulation can be conducted with the model developed in this work, it does not take into consideration any climatological effects that must play a relevant role for a long-term modeling, as well as yearly infiltration rates during rainy season or evaporation in warm periods. Additionally, the potential effect of waterproofing measures or basal drains performance becomes also relevant for a long-term assessment. An accurate simulation in such conditions would require the generation of winter/summer cycle scenarios over decades, which is beyond the scope of the present work and will be considered in the future phases of the research. For this reason, results of the following sections are presented at the end of construction time.

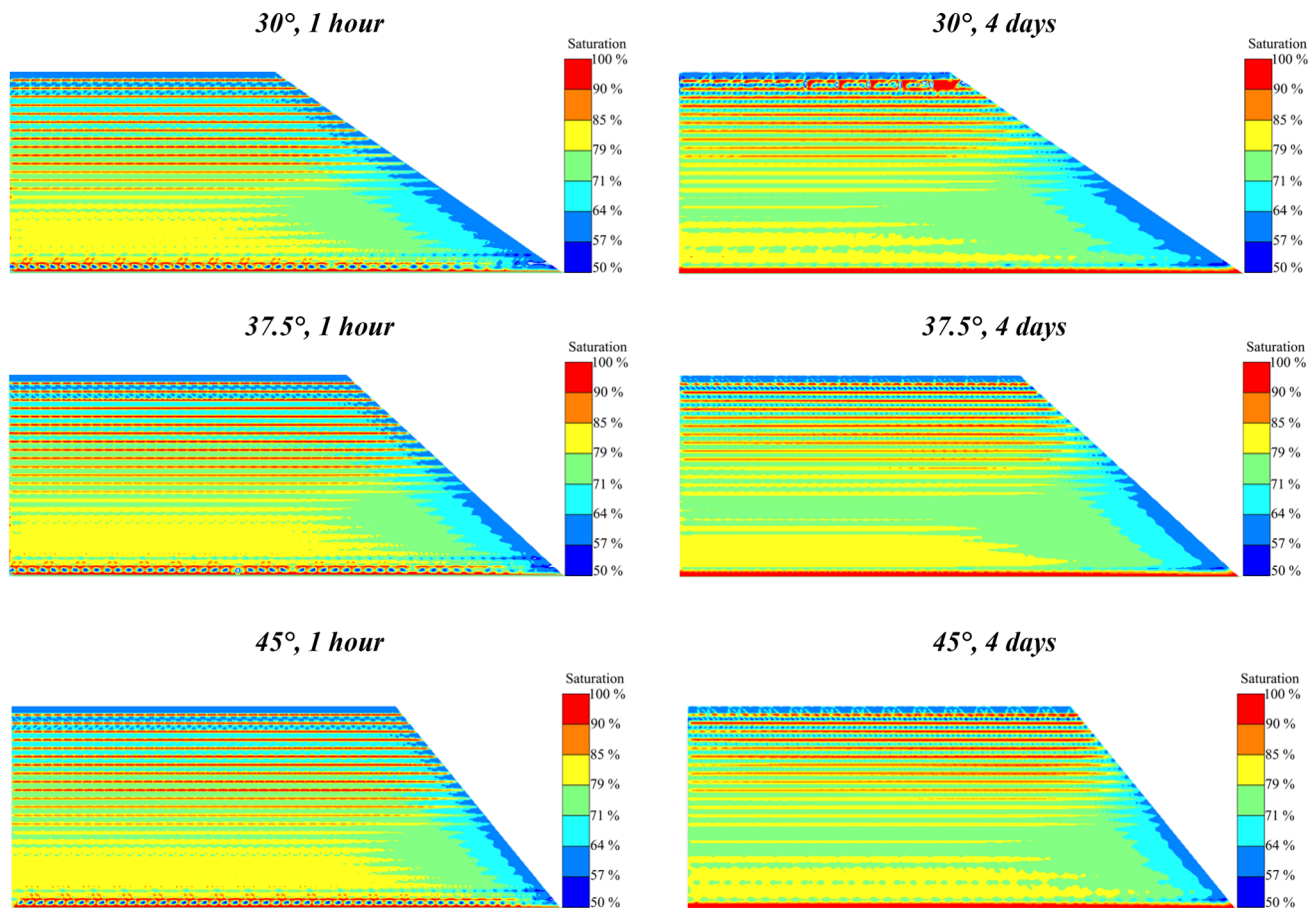


**Fig. 8** Effect of interlayer deposition rate on the distribution of degree of saturation inside the pile for different inclinations

### 5.3 Development of potential failure surfaces (PFS)

We use the strength reduction method (SRM) to study the impact of the deposition rate and the stability angle of the pile, for pile heights of 24 m. Figure 11 shows the potential failure surfaces (PFS) obtained from the application of SRM, while Fig. 12 shows the degree of saturation within each PFS in terms of a local coordinate, normalized through its extension ( $0 \leq \chi \leq 1$ ). All PFSs cross the base of the pile because nearly 100% saturation is reached at this level. Although the parameters used in the calibration have no cohesion, the PFS is approximately circular because the suction creates an apparent cohesion [16, 38, 52]. In the case of a 1-h deposition rate, the surface location is more erratic due to the heterogeneity of saturation distribution, while in 4 days case, a much well-defined surface is formed. All the PFS results of Fig. 12 have a saturation above 80% in their last quarter of extension ( $0.75 \leq \chi$ ). In general, the range of saturation in the upper half ( $\chi \leq 0.25$ ) of the PFS varies between 62 and 75%, but the greatest variability is concentrated in the third quarter ( $0.5 \leq \chi \leq 0.75$ ), where in some cases, saturation rises with

respect to the upper half, and in other cases, it is reduced due to downward water flow.

Regarding the position of the PFS, for deposition rates of 1 h, the PFS reaches the base at approximately 1.4 h from the toe of the slope, moving toward the slope surface as the angle increases. In these cases, the shape of the PFS is like an infinite slope fault. In contrast, the PFS associated with a 4-day deposition rate is like a circular fault. These PFSs are closer to the slope surface and reach the base at approximately 0.28 h from the toe of the slope. Analyzing the position of the PFS together with the profile in Fig. 12, it is concluded that the failure surface adjusts as the saturation distribution evolves, trying to reach the zone where saturation is closer to 100% where shear strength is minimum.

### 5.4 Effect of deposition rate on factor of safety (FoS)

Figure 13 shows the factor of safety (FoS) evolution as a function of height for each studied combination. As expected, FoS decreases as the pile slope increases. However, a slight increase in the FoS can be noted for a slower

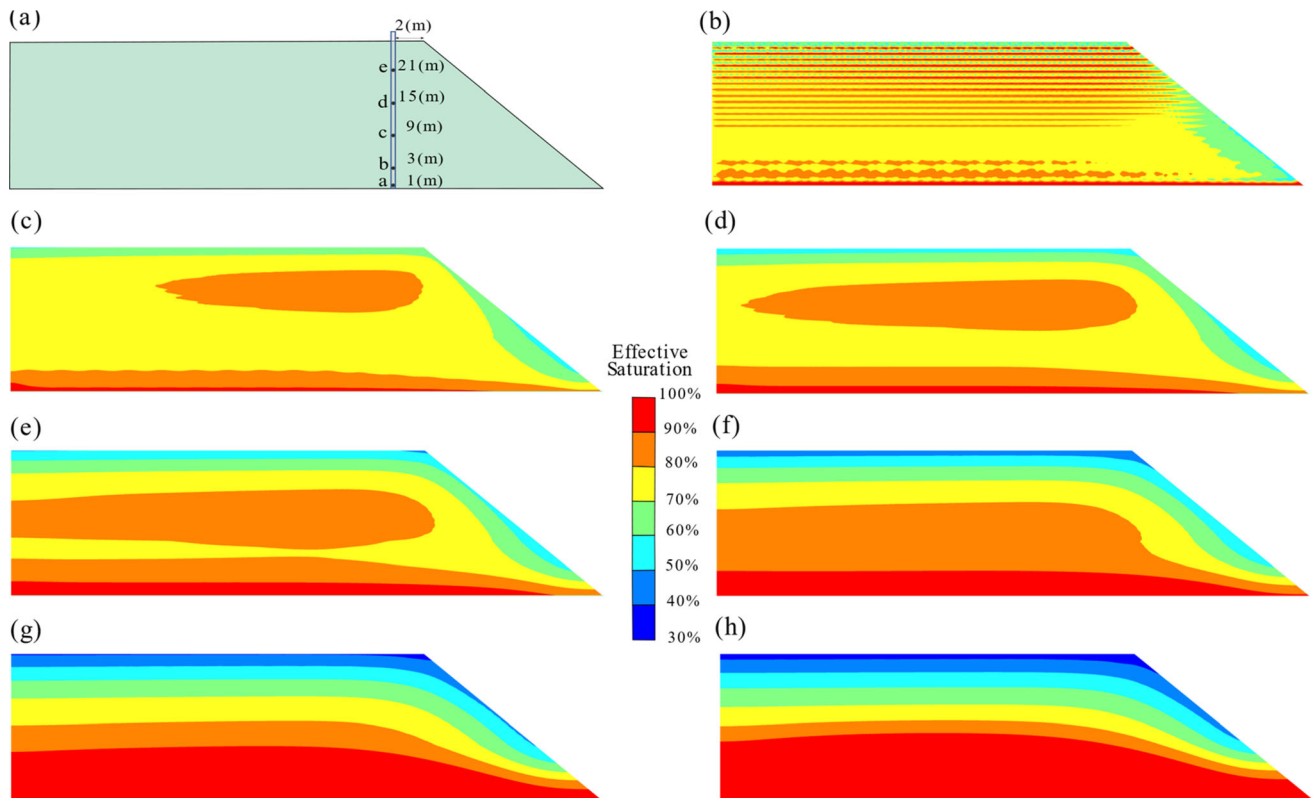


**Fig. 9** Effective saturation evolution for 45° slope and 4 days deposition rate. **a** Distribution of control points, **b** at the end of construction, **c** 10 years, **d** 30 years, **e** 60 years, **f** 120 years, **g** 220 years and **h** 320 years after construction

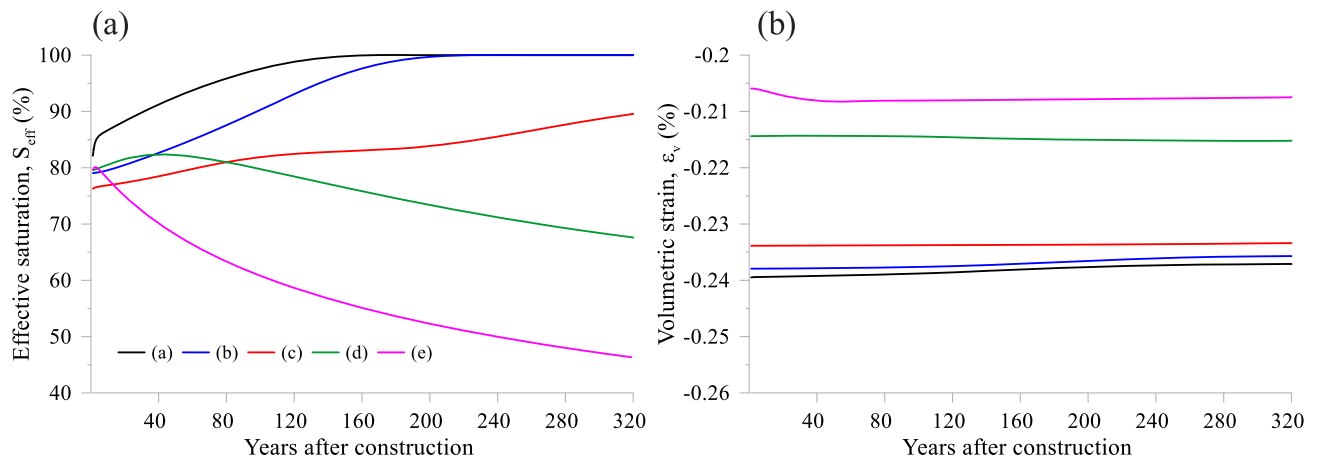


**Fig. 10** Evolution of **a** effective saturation and **b** volumetric strain at control points for 45° slope case and 4 days deposition rate

deposition rate. This is mainly due to the low permeability of the material under the unsaturated condition and the increment in volumetric strain by self-weight. For longer deposition rates, a more uniform distribution of saturation is achieved in response to water flow. On the other hand, using the deposition rate of 1 h and 4 days, the FoS increases as the slope steepness decreases. This is probably because: (i) A smaller soil portion is involved on the slope failure surface, and (ii) more time is required for a flow to

be established that tends to uniformize the saturation distribution within the pile. In contrast, differences in FoS between 1 and 4 days are negligible ( $< 0.7\%$ ). The 1.73H:1 V slope (30°) shows a reduction of the safety factor over 3 m, while the 1.3H:1 V and 1H:1 V slopes (37.5° and 45°) start to decrease from 6 and 12 m, respectively. At height above 6 m, the factor of safety begins to decrease more clearly with respect to the 1-h deposition rate. In conclusion, accelerated deposition rates

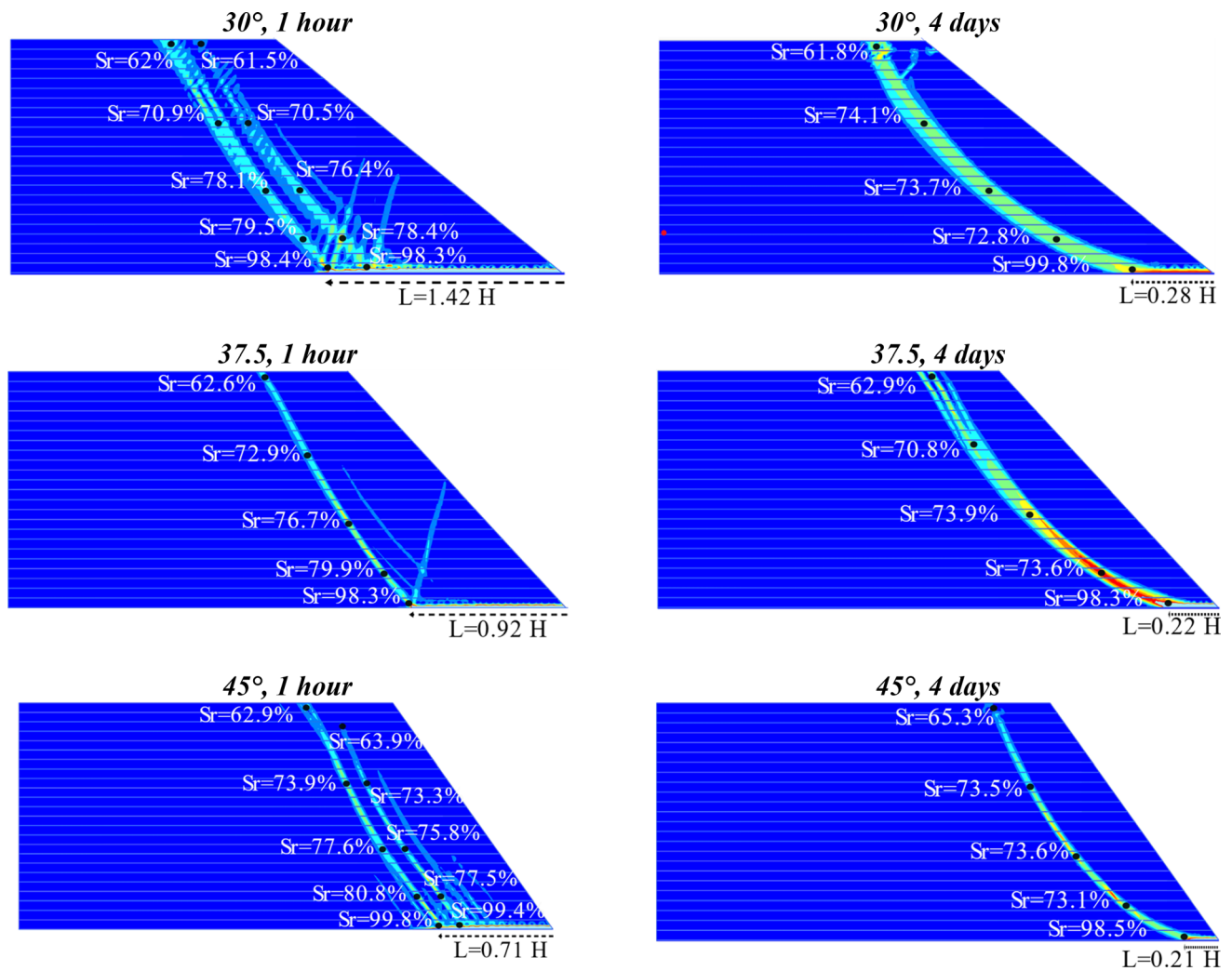


Fig. 11 Potential failure surface and degree of saturation within it

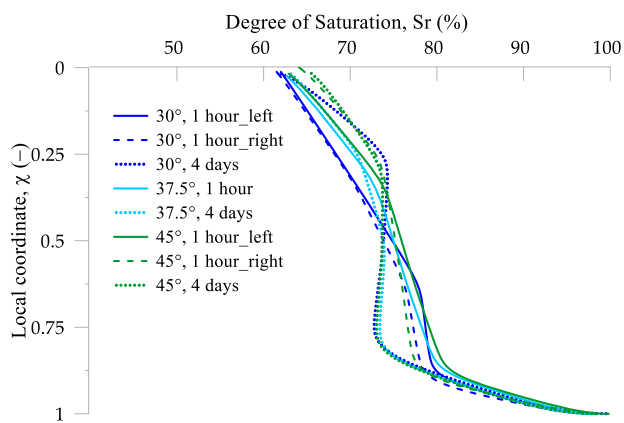


Fig. 12 Summary of the degree of saturation within the PFS for a height of 24 m, all slope angles and deposition rate of 1 h and 4 days

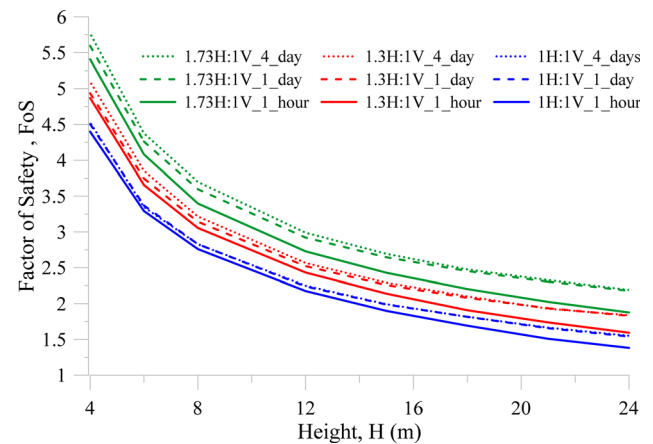


Fig. 13 Factor of safety as a function of slope inclination and interlayer deposition time

on lower slopes generate a slight decrease in the factor of safety.

## 6 Conclusions

With the proposed modeling strategy, it is possible to obtain a reasonable approximation of an elementary laboratory path with a single set of parameters. The pile construction model indicates that the potential failure surface is triggered when the soil reaches a saturation degree of about 65–70% and is almost independent of deposition rates and slope inclination for practical purposes. However, the FoS decreases for faster deposition rates compared to slower ones.

Regarding constitutive modeling calibration, the simulation of experimental results of the consolidation tests shows a satisfactory agreement when considering free drainage and evolution of suction. In contrast, the simulation of the triaxial tests at constant suction is satisfactory at axial strain levels below 1% and above 16%, while the quality of the fit decays at intermediate strain ranges. This allows a satisfactory representation of the initial stiffness of the material and the strength parameters at large deformation.

Regarding slope stability, the expected water content in the field allows reaching an angle of 1H:1 V (45°) and a height of up to 24 m with a safety factor of 1.54. Because saturation increases within the pile, the apparent cohesion is close to zero cohesion at the pile's base; this geometry can be explained by the contribution of suction due to the unsaturated condition of the material.

On the other hand, it was possible to model saturation evolution in the pile as a combination of the effect of self-consolidation and water flow inside the pile. It was found that the base of the model saturates since the volumetric strains exceed the drainage capacity of the material at unsaturated condition.

The factor of safety of the slopes increases as the deposition time between fresh layers increases, because a more uniform distribution of saturation is allowed. However, there is no significant effect on the factor of safety when the deposition time between layers increases from 1 to 4 days.

The potential failure surfaces appear in tailings when reaching a saturation of about 65–70%; hence, a real-time monitoring of saturation levels could be used as an early warning system for potential failure. In addition, given that the base reaches saturations close to 100%, the proper design of a basal drain is critical.

Finally, studying layer saturation due to self-compaction and adequately characterizing geotechnically new and improved deposition techniques, such as filtered tailings,

could mitigate the risks of mining operations and thus avoid catastrophic failures.

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**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## References

- Adams BA, Wulfschlag DG, Fredlund DG (1996) Air volume change measurement in unsaturated soil testing using a digital pressure-volume controller. *Geotech Test J* 19:12–21
- Ajdari M, Habibagahi G, Masroufi F (2013) The role of suction and degree of saturation on the hydro-mechanical response of a dual porosity silt-bentonite mixture. *Appl Clay Sci* 83–84:83–90
- Alonso EE, Gens A, Sosa A (1990) A constitutive model for partially saturated soils. *Geotechnique* 40:405–430
- ASTM (2012) Standard test methods for laboratory compaction characteristics of soil using modified effort. ASTM standard D1557-12. ASTM Int West Conshohocken, PA
- ASTM (2016) Standard test methods for measurement of hydraulic conductivity of saturated porous materials using a flexible wall permeameter. ASTM standard D5084-16. ASTM Int West Conshohocken, PA
- ASTM (2017) Standard practice for classification of soils for engineering purposes (unified soil classification system). ASTM standard D2487-17e1. ASTM Int West Conshohocken, PA
- ASTM (2014) Standard test methods for specific gravity of soil solids by water pycnometer. ASTM standard D854-14. ASTM Int West Conshohocken, PA
- Barbour SL (1998) Nineteenth Canadian geotechnical colloquium: the soil–water characteristic curve: a historical perspective. *Can Geotech J* 35:873–894
- Bishop AW, Blight G. (1963) Some aspects of effective stress in saturated and partly saturated soils. *Geotechnique* 13:177–197
- Bonin MD, Cabral AR, Nuth M (2019) Examination of the effects of solids content on thickened gold mine tailings sedimentation and self-weight consolidation. *Geotech Test J* 42:1493–1517
- Bonin MD, Nuth MN, Dagenais A-M, Cabral A (2014) Experimental study and numerical reproduction of self-weight consolidation behavior of thickened tailings. *J Geotech Geoenviron Eng* 140:1–10
- Cai G, Zhou A, Sheng D (2014) Permeability function for unsaturated soils with different initial densities. *Can Geotech J* 51:1456–1467
- Casini F, Vaunat J, Romero E, Desideri A (2012) Consequences on water retention properties of double-porosity features in a compacted silt. *Acta Geotech* 7:139–150
- Daliri F, Kim H, Simms P, Sivathayalan S (2011) Influence of desiccation and over consolidation on monotonic and cyclic shear response of thickened gold tailings. In: *Proceedings 14th Pan-American conference on soil mechanics and geotechnical engineering*, Toronto, Ontario, Canada, pp 1–8
- Estabragh AR, Javadi AR, Boot JC (2004) Effect of compaction pressure on consolidation behaviour of unsaturated silty soil. *Can Geotech J* 41:540–550

16. Fredlund DG, Morgenstern NR (1977) Stress state variables for unsaturated soils. *ASCE J Geotech Eng Div* 103:447–466
17. Gallardo-Sepúlveda R, Sáez E, Camacho-Tauta J (2022) Assessment of the self-compaction effect in filtered tailings disposal under unsaturated condition. *Minerals* 12:1–18
18. Gallipoli D, Gens A, Sharma R, Vaunat J (2003) An elasto-plastic model for unsaturated soil incorporating the effects of suction and degree of saturation on mechanical behaviour. *Geotechnique* 53:123–135
19. Gens A, Sánchez M, Sheng D (2006) On constitutive modelling of unsaturated soils. *Acta Geotech* 1:137–147
20. Van Genuchten MT (1980) A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Sci Soc Am J* 44:892–898
21. Griffiths DV, Lane PA (1999) Slope stability analysis by finite elements. *Geotechnique* 49:387–403
22. Hamid TB, Miller GA (2008) A constitutive model for unsaturated soil interfaces. *Int J Numer Anal Methods Geomech* 32:1693–1714
23. Heshmati AA, Motahari MR (2015) Modeling the dependency of suction stress characteristic curve on void ratio in unsaturated soils. *KSCE J Civ Eng* 19:91–97
24. Hore C, Luppnow D (2014) Karara Iron Ore TSF—design considerations for a unique large scale dry stack facility. In: *Proceedings of the 18th international conference on tailings and mine waste, Color USA*, pp 293–304
25. Khalili N, Khabbaz M.H, Valliappan S (2000) Effective stress based numerical model for hydro-mechanical analysis in unsaturated porous media. *Comput Mech* 26:174–184
26. Kimoto S, Oka F, Fukutsani J et al (2011) Monotonic and cyclic behavior of unsaturated sandy soil under drained and fully undrained conditions. *Soils Found* 51:663–681
27. Lara Montani J, Pornillos E, Munoz H (2013) Geotechnical–geochemical and operational considerations for the application of dry stacking tailings deposits-state of the art. In: *Proceedings of the 16th international seminar on paste and thickened tailings, Belo Horizonte, Brazil*, pp 249–260
28. Li J, Ou X (2018) Model test on self-weight consolidation of the red mud tailings placed in the karsts. *Geotech Geol Eng* 36:2839–2849
29. Lloret-Cabot M, Sánchez M, Wheeler SJ (2013) Formulation of a three-dimensional constitutive model for unsaturated soils incorporating mechanical–water retention couplings. *Int J Numer Anal Methods Geomech* 37:3008–3035
30. Morvan M, Wong H, Branque D (2009) An unsaturated soil model with minimal number of parameters based on bounding surface plasticity. *Int J Numer Anal Methods Geomech* 34:1512–1537
31. Ng CWW, Zhou C, Chiu CF (2020) Constitutive modelling of state-dependent behaviour of unsaturated soils: an overview. *Acta Geotech* 15:2705–2725
32. Niu L, Zhang A, Zhao J et al (2021) Study on soil–water characteristics of expansive soil under the dry-wet cycle and freeze-thaw cycle considering volumetric strain. *Advances in Civil Engineering* 2021:1–13
33. Oldecop LA, Rodari GJ (2021) Unsaturated mine tailings disposal. *Soils Rocks* 44:1–12
34. Patil UD, Hoyos LR, Puppala AJ (2016) Characterization of compacted silty sand using a double-walled triaxial cell with fully automated relative-humidity control. *Geotech Test J* 39:742–756
35. Pedroso DM, Farias MM (2011) Extended barcelona basic model for unsaturated soils under cyclic loadings. *Comput Geotech* 38:731–740
36. Pérez-Foguet A, Rodríguez-Ferran A, Huerta A (2001) Consistent tangent matrices for substepping schemes. *Comput Methods Appl Mech Eng* 190:4627–4647
37. PLAXIS, Brinkgreve RBJ (2022) Material model manual. Delft University of Technology & Plaxis B.V. Bentley, Delft, pp 1–274
38. Rahardjo H, Kim Y, Satyanaga A (2019) Role of unsaturated soil mechanics in geotechnical engineering. *Int J Geo Eng* 10:1–23
39. Rodríguez R, Sánchez M, Ledesma A, Lloret A (2007) Experimental and numerical analysis of desiccation of a mining waste. *Can Geotech J* 44:644–658
40. Saleh-Mbemba F, Aubertin M (2018) Characterization of self-weight consolidation of fine-grained mine tailings using moisture sensors. *Geotech Test J* 41:543–554
41. Sánchez JA, Beltra LN, Trujillo-Vela MG, Larrahondo JM (2020) Flows of liquefied filtered tailings: laboratory-scale physical and numerical modeling. *Int J Civ Eng* 18:393–404
42. Schanz T, Vermeer PA, Bonnier PG (1999) The hardening soil model: formulation and verification. In: *Beyond 2000 Computational Geotechnics Ten Years PLAXIS Int Proceedings Int Symposium Amsterdam*, pp 281–296
43. Sheng D, Smith DW, Sloan SW, Gens A (2003) Finite element formulation and algorithms for unsaturated soils. Part II: verification and application. *Int J Numer Anal Methods Geomech* 27:767–790
44. Shokouhi A, Zhang C, Williams DJ (2018) Settling, consolidation and desiccation behaviour of coal tailings slurry. *Min Technol Trans Inst Min Metall* 127:1–11
45. Simms P (2016) 2013 colloquium of the Canadian geotechnical society: geotechnical and geoenvironmental behaviour of high-density tailings. *Can Geotech J* 54:455–468
46. Sun LH, Weng ZQ, Liu SJ et al (2020) Compression and consolidation behaviors of lime-treated dredging slurry under vacuum pressure. *Eng Geol* 270:105573
47. Surarak C, Likitlersuang S, Wanatowski D et al (2012) Stiffness and strength parameters for hardening soil model of soft and stiff Bangkok clays. *Soils Found* 52:682–697
48. Ulrich B (2019) Practical thoughts regarding filtered tailings. In: *Proceedings of the 22th international conference on tailings and mine waste, Cape Town, South Africa*, pp 71–79
49. Ulrich B, Coffin J (2013) Considerations for tailings facility design and operation using filtered tailings summary of significant operating filtered tailings operations. In: *Proceedings of the 16th international seminar on paste and thickened tailings, Belo Horizonte, Brazil*, pp 201–210
50. Vanapalli SK, Fredlund DG, Pufahl DE, Clifton AW (1996) Model for the prediction of shear strength with respect to soil suction. *Can Geotech J* 33:379–392
51. Vaunat J, Romero E, Jommi C (2009) An elastoplastic hydromechanical model for unsaturated soils. In: *Proceedings of 17th International Conference of Soil Mech Geotech Eng Acad Pract Geotech Eng*, vol 5, pp 3403–3407
52. Wang Q, Pufahl DE, Fredlund DG (2002) A study of critical state on an unsaturated silty soil. *Can Geotech J* 39:213–218
53. Weatherwx TW, Kipara A (2010) Paste operations training at Barrick's Bulyanhulu Gold Mine. In: *Proceedings of the 14th international conference on paste and thickened tailings, Toronto, Canada*, pp 41–50
54. Wickland B, Wilson G (2005) Self-weight consolidation of mixtures of mine waste rock and tailings. *Can Geotech J* 42:327–339
55. Wickland BE, Wilson GW, Wijewickreme D (2010) Hydraulic conductivity and consolidation response of mixtures of mine waste rock and tailings. *Can Geotech J* 47:472–485
56. Wilson GW, Robertson AM (2015) The value of failure. *Geotech News* 33:24–28
57. Zhai Q, Rahardjo H, Satyanaga A (2017) Effects of residual suction and residual water content on the estimation of permeability function. *Geoderma* 303:165–177

58. Zhai Q, Rahardjo H, Satyanaga A et al (2019) Role of the pore-size distribution function on water flow in unsaturated soil. *J Zhejiang Univ Sci A* 20:10–20
59. Zheng J, Li L, Mbonimpa M, Pabst T (2018) An analytical solution of gibson's model for estimating the pore water pressures in accreting deposition of slurried material under one-dimensional self-weight consolidation. Part i: pervious base. *Indian Geotech J* 48:72–83

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## Comment on SI027NR: NMCC fails to understand New Mexico water rights

The DB Stephens' updated hydrological report (T. Neil Blandford and Farag Botros, *Updated Probable Hydrologic Consequences Analysis Copper Flat Project*, August 14, 2025), makes a somewhat unusual legal statement about the right to use water in New Mexico:

NMCC is entitled to fully exercise its existing water rights using the current points of diversion, and implicit to the exercise of these rights are the hydrologic effects attributable to NMCC's groundwater pumping. The hydrologic effects may include drawdown at wells of other ownership and the diminution of stream or spring flow. Consequently, not only are the updated PHCs substantially reduced relative to the 2018 PHCs, but NMCC is entitled to induce all hydrologic effects attributable to its groundwater pumping under the water rights summarized in Table 1-1. [p. 3; my emphasis]

It is true that, in exercising one's right to use water, a user might drawdown a neighboring well without harming that neighboring well. But certainly one may not do so to the extent that the drawdown harms the neighbor's right to exercise the full extent of his or her own right. That is to say that drawdowns are not in themselves injurious and an impairment of another's right. There is, the courts have often said, no bright line distinguishing harmless drawdown from an impairment, but each case must be decided on its own hydrologic facts. In the administration of water law in southern New Mexico, the State Engineer's office has followed the Morrison Guidelines on where that distinction occurs, but it is sufficient to say here that there is such a distinction, and one may not impair another's right to use water; even though, the court and the statutes do not recognize *per se* impairment. New Mexico water law protects water rights equitably, not just those of NMCC.

Thus it is improper to say, as NMCC's updated application for mining says, "NMCC is entitled to induce all hydrologic effects attributable to its groundwater pumping under the water rights summarized in Table 1-1" [my emphasis]. The update repeats this mistaken logic throughout, that NMCC's water rights trump the rights of other water users. Thus, "[b]ecause all pumping from the SFG aquifer in the updated water balance is from NMCC's existing, adjudicated LRG-4652 water rights, no effects on Rio Grande system flows are required to be offset," or "because pumping from the LRG-4652 well field is permitted under an existing adjudicated water right, all hydrologic effects on wells of other ownership are permitted to occur." [Both on p. 19.]

As a result of this strange concept of entitlement, the updated report fails to address the unlawful impairments that stem from NMCC's use of its water rights. For example, even though the authors recognize that pumping from wells at the mine site (which was not in the original plan) increased the impacts upon the aquifer there, they mention only the lack of neighboring wells to the east of the location and ignore the wells and springs to the north (on the Ladder Ranch) and wells to the west and south (on the Pitchfork Ranch, where one well will be seriously impaired according to NMCC's own analysis).

The MMD can gain a much fuller picture of these consequences from the Hearing Examiner's report from the administrative hearing held by the OSE on the transfer of water rights to NMCC's wells for use at Copper Flat Mine. There the issue of impairment is treated explicitly and in great detail. New geologic evidence is considered. New hydrologic models are analyzed. That report resulted in the State Engineer's rejection of the transfer based precisely on the harm it would cause to both specific water rights and to the state's general welfare. Unfortunately, the DB Stephens' update was issued a

week before the SE's decision and publication of the Hearing Examiner's report, and so it did not benefit from the new hydrologic evidence of impairment. The update is outdated.

See the Hearing Examiner's Report:

<https://api.realfile.rtsclients.com/PublicFiles/5f809ddfc9864dad89f9d03375144a14/a3304a88-9226-4245-8053-088e86c73e8f/2025-08-20%20Report%20%20Recommendation.pdf>.

In New Mexico, water rights are Constitutionally defined: Const., XVI, 1-3. They are not fee simple absolute property but conditionally granted, and among their attributes is their hierarchical ranking by priority ("Priority of appropriation shall give the better right"). Under a direct priority call or under Active Water Resource Management (AWRM), NMCC's water rights (most of whose priority is dated 1975) would be junior to both neighboring wells and to the Rio Grande's Compact waters and thus not be usable until prior rights are satisfied. In turn, NMCC's rights are protected from harm by the exercise of rights with more recent priorities. Given the present over-depletion in the Lower Rio Grande Basin, it is not clear that NMCC's water rights can be exercised or when they can be exercised.

That uncertainty is made even more uncertain by the fact that New Mexico water rights are rights only over New Mexico waters. They do not control Rio Grande Compact waters, which take precedence over all New Mexico water rights no matter how senior. If NMCC's water rights infringe upon Compact water, they cannot be exercised.

Thus, the practicability of NMCC's water rights is in doubt given the settlement of the *Texas v. New Mexico and Colorado* (as is its taking of extra-legal water beyond its rights). We do not know how this new depletion (though technically not a new appropriation) will be handled by the State Engineer relative to the closing of the LRG Basin, or relative to the required basin-wide operating plan that prioritizes Compact water delivery, or relative to the possible imposition of priority administration under AWRM if the present negotiations among major basin water users fail by October 1, 2026 to save enough water in the basin. The packet of New Mexico Settlement Agreements that support the yet to be approved Consent Decree can be found as attachments to this joint filing by the United States and New Mexico: [https://www.ca3.uscourts.gov/sites/ca3/files/Joint\\_Motion\\_Dismiss\\_082925.pdf](https://www.ca3.uscourts.gov/sites/ca3/files/Joint_Motion_Dismiss_082925.pdf).

## Comment on Water Sufficiency, Part 2

1. In Part 1, I have shown that NMCC's water rights of 1,100 AFY is insufficient for mining at a production rate of 30,000 tpd, as proposed by the updated MORP. It is insufficient as well for the 17,500 tpd plan which was proposed to the BLM as the base plan and for a 15,000 tpd mimicking the failed 1982 Copper Flat Mine project (which, by the way, planned to use 2,400 AFY of water). At what production rate, then, can the system described in the updated MORP operate, that is, the same ore processing system as in alternative 2 of the FEIS except for the use of a filtered tailings storage?

2. Using the same arithmetic method of calculation as in Part 1, a 10,000 tpd action that uses (FEIS, Table 2-28) 661 gallons of water to mine a ton of ore would use

$(661 \text{ g/d})(10000 \text{ t/d})(365 \text{ d/y})/(325,851 \text{ g/AF}) = \mathbf{7404 \text{ AFY total mining water use;}}$   
(total mining water use) – (non-processing water use) = total processing water use;  
 $(7404 \text{ AFY}) - (968 \text{ AFY}) = \mathbf{6436 \text{ AFY total processing water use;}}$   
10% of processing water lost to system = **644 AFY**;  
(processing water lost annually) + (non-processing water lost annually) = make up water  
 $(644 \text{ AFY}) + (968 \text{ AFY}) = \mathbf{1612 \text{ AFY make up water needed.}}$

NMCC would have 1,100 AFY of legally usable groundwater and, presumably, 601 AFY extra-legal surface and groundwater for a total supply of **1701 AFY**. Therefore, if the OSE decides that the extra-legal taking of public water is justified, NMCC can mine at a 10,000 tpd rate of production. Without that extra-legal water, NMCC could not mine even at that low throughput.

3. Since NMCC's numbers are the basis of my calculation, we must assume that NMCC knows what its available water supply can and cannot do. Why, then, has it applied for an essentially undoable project?

It clearly cannot intend to mine Copper Flat in the manner described in the MORP.

NMCC does not have the water to do so. It does not have the electrical power at the time of application to do so. See my comment on electrical power needs. Most important, it does not have the financial capacity at this time to do so.

4. In its last financial statement filed with the venture part of the Toronto Stock Exchange ([\*Themac Resources Group Ltd. Condensed Consolidated Interim Financial Statement, March 31, 2025\*](#)), NMCC's parent company declared assets of \$95 Million (CAD) and liabilities of \$192 Million (CAD) resulting in a negative working capital of \$97 Million (CAD) or about negative \$71 Million (USD).

With that kind of indebtedness, it would seem difficult for NMCC to find the \$364 Million (USD) which in 2019 it declared in the FEIS to be the cost of constructing Copper Flat Mine (not counting the additional construction of a huge filter factory for the revised tailings storage process). Any investor would have to consider that this marginal mine operating at best at a

production rate of 10,000 tpd would have an operating life close to 40 years. With intermittent closures resulting from the volatility of copper prices, the investment may wait a century for full return.

The filtered tailings operation not only adds enormously to the construction costs but also to the operating costs since it requires the added equipment for spreading and compacting the filtered cakes, the added labor costs of spreaders and water diversion managers, and the added engineers to constantly monitor the tailings and the stacks. And, of course, the added energy costs, which I've already estimate boosts the electric bill by a quarter or a third. These costs have to be offset by the income stream provided by selling copper, an income stream reduced (at best) to 1/3 that of the planned 30,000 tpd production. Is this project feasible?

5. During the consideration of NMCC's original application, I submitted to the Director of MMD an argument that the application should be denied on the grounds that the application was frivolous and the state should not be party to what was essentially a business ploy to enhance the value of Copper Flat Mine. This examination of NMCC's present lack of resources for reopening Copper Flat Mine makes that intent even clearer.

6. The insubstantiality of NMCC's application results from NMCC's failure to find sufficient water to mine pursuant to its 2020 Agreement with MMD. In 2021, NMCC's owner, Tulla Resources, leased 2,400 AFY water rights and applied to the State Engineer to transfer the rights to its production wells for use at Copper Flat Mine. The application was protested, and an OSE hearing held. See the files for the hearing on the OSE Hearing Unit website under 2021-025 Tulla Resources Group PTY LTD & Santa Teresa Capital, LLC - OSE File. No. LRG-3150-E into LRG-17825 at [https://www.ose.nm.gov/HU/select\\_proceedings.php](https://www.ose.nm.gov/HU/select_proceedings.php).

When the State Engineer denied NMCC's application to transfer leased water rights to its production wells in August, 2025, Copper Flat Mine became worthless as a mine since there was insufficient water rights for operation and any additional water rights could not be transferred for use at the mine. The hearing determined that even pumping the leased 2,400AFY at its production wells would have entailed significant harm to other water rights including rights in the Rio Grande and harm to the general welfare of the state. No mining could ensue at Copper Flat Mine under the original MORP. Deciding to use the previously rejected filtered tailings alternative (see FEIS, p. ES-7) seems an attempt to restore the mine's value.

Before the SE's decision (August, 2025), NMCC was already aware of the probable outcome to OSE's protest hearing on its transfer application. All final briefs were submitted by March, 2024, and the arguments against approval of the application were overwhelming. All protestants including the ISC, EBID, Camino Real Regional Utilities Authority, the Sierra Club, GRIP, Turner Ranch Properties, neighboring well users at both the transfer-from site and the transfer-to site, and the OSE's own Water Rights Division argued against granting the application. See the OSE Hearing Unit case files.

However, the outcome of the November, 2024, presidential election seemed to have given NMCC hope that the market value of Copper Flat Mine could be salvaged given President Trump's previous favoring of copper mining during his first term in office. A month after the elections, Themac Resources' governing board established a special committee to investigate the possibility of the company going private. See the whole narrative of Tulla Resources buying all of Themac's shares not already in its possession in order to change the company from a public to a private company in the Circular which the board sent to its shareholders prior to the shareholder meeting to authorize the change:

<https://www.sedarplus.ca/csa-party/records/document.html?id=9280dd036bbe78ad3b6d45d46e2d809013131e0b7ca37bf2e0ef5f5da59775f>.

The board declared Themac's dire, imminent insolvency as reason for going private. Themac was threatened by its subsidiary NMCC's enormous debt to Tulla Resources; it had limited alternatives for funding; there was little prospect of any liquidity relief; and it faced difficulties with permitting. Absorbing Themac into Tulla as a private company was a desperate effort to preserve Themac from insolvency.

As a business decision, protecting Themac from insolvency benefited Tulla Resources. Tulla Resources already owned 75% of Themac shares, and thus owned NMCC, its own debtor. Since the loan Tulla had given Themac carried an interest of 20% that was never paid, the annual unpaid debt was quite large (see the details in the financial statements filed quarterly with SEDAR). It now dwarfs the loan itself. That unpaid debt could be used for annual tax deductions by Tulla. Themac's bankruptcy would have ended that benefit.

Themac's continuing existence requires keeping the mining project going for two reasons. First, Themac's only real assets were the 1,100 AFY of adjudicated water rights (worth about \$9 Million using the estimated cost of New Mexico's buyback costs in the Lower Rio Grande Litigation Settlement). Having gone through a lengthy litigation turning on the issue of abandonment, Themac was acutely aware that in order to maintain validity in water rights in New Mexico those rights had to be exercised or, barring water use, there had to be evidence of the attempt to use water. Applying for a mining permit would be *prima facie* evidence of the intent to mine, keeping both forfeiture and abandonment at bay.

Second, the pursuit of permits is a means of valorizing the project, that is, to restore market value to the mine. Using a filtered tailing process was the only way to salvage the mine's value as a mine. Water savings are certainly a public relations hit, but there was no proof of its viability. The applications to the MMD and to the NMED, if successful, would demonstrate publicly that the lost value was recoverable. Permits in hand would allow both marketability and access to investments. As a business decision, the application to the MMD might be problematic, but there was nothing to risk.

Tulla's absorption of Themac, and thus of NMCC, also resolves a permitting difficulty. With Themac's enormous debt the bonding for a reclamation assurance was practically impossible to find. The corporate rearrangement seems to have solved that dilemma.

7. It is possible, speculatively, that the application before MMD results from business rather than mining considerations. It may even be possible that the change to filtered tailings storage was merely to bolster public relations, since it seems clear that there is insufficient water for mining even with its water savings. If that were true, the MMD should carefully ascertain whether the proposal is feasible in all aspects and if the applicant is willing and capable of carrying out its plan of operation. What, for example, is the price of copper that would allow mine operation and at what output? Does the mine have sufficient water rights for that production?

8. While New Mexico recognizes the value of mineral extraction, that value is realized only if there is actual mining. If an application for mining is only a gleam-in-the-eye hope, the state is not obligated to permit a failed project. The state ought not allow its permit to be used to enhance the marketability of a failed project to the detriment of possible investors in mineral projects throughout the state. Nor should the state further an attempt to preserve unused and unusable water rights which have only been used for 3 months 44 years ago, especially at a time when the state must retire 18,200 AFY of rights in this water basin to satisfy the Lower Rio Grande Litigation Settlement.

If NMCC had the water, the means, and the will to mine quickly to minimize market volatility, then one might consider the balance between the benefits and the harms to the public worthwhile (though NMCC admits that mining entails impairment of other water rights), but NMCC does not have that capacity, and it gives no indication that it will be able to find such resources. The MMD may not want to treat the updated MORP as a *bona fide* application to mine.

Max Yeh  
Percha-Animas Watershed Association  
March 6, 2026

## Addendum to Comment on Filtered Tailings Stability

According to Roxia, a Finnish company which consults, designs, delivers and services filtering equipment for filtered tailings in mining, the normal water content of the filtered cakes created under pressure lies between 12% and 20% by weight. See <https://roxia.com/what-is-tailings-filtration-and-why-is-it-critical-in-modern-mining/#:~:text=Filter%20press%20technology%20represents%20the,content%2C%20and%20overall%20system%20efficiency>.

In the Gallardo article I attached to my Comment on Filtered Tailings Stability, the copper mine tailings that the team used was compacted to a field expected dry density with a 16% water content “which corresponds to a saturation degree of about 60%” (p. 4298). We may expect that Copper Flat Mine’s tailings will have a similar water content. However, Gallardo’s team found that “[t]he potential failure surfaces appear in tailings when reaching a saturation of about 65–70%” (p. 4310). This means that the filtered cakes may be very near saturation when they are stacked. Subsequent water movement in the stacks are very likely to create large parts of the tailings stacks that are failure prone.

It is more certain that at the liner and just above it, the tailings are saturated creating a risk of sliding. But the fact that the filtered cakes have initially enough water content to make them close to failure makes a facial slope failure also more possible: “It is shown that the deposition rate affects the factor of safety and the potential failure surface location, which begins to be triggered above 62% saturation from the top of slope toward the base of the pile, which is fully saturated” (p. 4298).

On the stability of the facial slope see V.H. Le and Carlos Ovalle, “Stability of filtered tailings storage facilities,” *Montreal, Research Institute on Mines and the ...*, 2024, [https://www.researchgate.net/profile/Carlos-Ovalle-3/publication/384104667\\_Stability\\_of\\_filtered\\_tailings\\_storage\\_facilities/links/66eabbbf97a75a4b483190c6/Stability-of-filtered-tailings-storage-facilities.pdf](https://www.researchgate.net/profile/Carlos-Ovalle-3/publication/384104667_Stability_of_filtered_tailings_storage_facilities/links/66eabbbf97a75a4b483190c6/Stability-of-filtered-tailings-storage-facilities.pdf). The study focuses on facial slope stability relative to slope angle, saturation, and the use of waste rock to increase stability (apparently with little effect).

The major problem with NMCC’s planned stacks, given their riskiness, is their size. The Greens Creek silver mine in Alaska has a throughput of only 2,400 tpd, and it spreads its filtered tailings over 100 acres. Its stacks cannot be anywhere near the height of the proposed impoundment at Copper Flat.

NMCC says that using filtered tailings stacks removes the need for a dam. In fact, the whole impoundment is a dam built of fine sand. Its whole structure needs to be judged as if it were a dam because the dynamics of failure are precisely that of earthen dam failures. Perhaps MMD should ask the engineers in the dam division of OSE for an opinion.

Max Yeh  
Percha-Animas Watershed Association  
March 7, 2026

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**[EXTERNAL] Copper Flat Mine DP-1840**

---

**From** Max Yeh <maxwyeh@gmail.com>

**Date** Sat 3/7/2026 2:27 PM

**To** Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>

**Cc** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Corey Durr <cdurr@blm.gov>

 1 attachment (2 MB)

Greens Creek Mine Env. Permit Fact Sheet.pdf;

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Hi, Jordan,

It is my impression, because I haven't gone through the renewal application again, that we don't know the mix of chemicals in the recycled water. This is of some concern because I just read a fact sheet from the Alaska environmental agency on their permitting of the Greens Creek Mine, which is one of two Alaska mines that uses dry stack tailings. The silver and other metals mine uses the flotation method to concentrate the ore, just as NMCC intends. Their mixture includes copper sulfide, alcohol based frothers, xanthate, lime, sodium cyanide, zinc sulfate, sulfuric acid, sodium isopropyl dithiophosphate, 3418 A promoter, SD 200 depressant, metabisulfite, and carbon dioxide. Quite a list that reminded me how complex the chemical issue was.

The problem at Copper Flat is that potentially whatever chemicals they use for flotation, these will be mixed with the flocculants and the coagulants used to extract production waters. Potentially, and very likely, the result of the mixture will not be reusable for flotation where you don't want the particles to clump together. At Greens Creek Mine, the system has to be purged regularly to clear out the chemicals. The purged water then has to be treated before disposal. At Greens Creek, that is not a problem since they are treating all contact runoff water, waste rock seepage, etc. before releasing. At Copper Flat they want to recycle all the water which then adds the heavy metals, arsenic, cyanide, etc. to the flotation and other processing chemicals. If NMCC in fact has to purge, what are they going to do with the purge water?

I mentioned the problem of chemicals in my comment on the stability of the dry stacks, but it is perhaps more important as a discharge issue if there is no consideration of it at all in the design of the process.

I think the place to start is to find out which chemicals will be in the recycled water. I suspect they do not even know themselves. It begs reason to think that you can keep putting chemicals whose purpose counters each other repeatedly along with runoff and waste rock seepage water all together and still think the chemicals are going to work independently, especially since the brew is going to get more and more concentrated with the evaporation of the water. It's hard to imagine the brew as suitable process water, and it would be hard to imagine not needing purging.

I hope you have a good chemist on hand, because this could be a major design failure relative to the discharge permit.

The Greens Creek Mine and the Pogo Mine are the only mines I know of actually producing with dry stack tailings. They are tiny compared to NMCC's project. Both process about 2,400 tons of ore per day. NMCC's 30,000 tpd is humongously larger. It has no precedent in the US. I don't think they know what they are doing. From the very beginning of the permitting process, NMCC has depended on the regulators to do their

engineering for them. Fifteen years ago, NMCC applied for test drilling permits from the NMED with a one page application. They had to be instructed what constituted the issues such an application had to consider. It's been that way ever since.

I attach the info sheet about the Greens Creek Mine.

--

Max



**ALASKA POLLUTANT DISCHARGE ELIMINATION SYSTEM  
PERMIT FACT SHEET**

Permit Number: AK0043206

**Hecla Greens Creek Mining Company**

**DEPARTMENT OF ENVIRONMENTAL CONSERVATION**

**Wastewater Discharge Authorization Program**

**555 Cordova Street**

**Anchorage, AK 99501**

Technical Contact: David Khan, PE  
Alaska Department of Environmental Conservation  
Division of Water  
Wastewater Discharge Authorization Program  
P.O. Box 111800  
Juneau, Alaska 99811-1800  
(907) 465-6855  
[david.khan@alaska.gov](mailto:david.khan@alaska.gov)

An Alaska Pollutant Discharge Elimination System (APDES) permit is reissued to

**HECLA GREENS CREEK MINING COMPANY**

For wastewater discharges from

Greens Creek Mine  
P.O. Box 32199  
Juneau, AK 99803

The Alaska Department of Environmental Conservation (Department or DEC) reissues APDES individual permit AK0043206 to Hecla Greens Creek Mining Company (HGCMC). The permit authorizes and sets conditions on the discharge of pollutants from this facility to waters of the United States. In order to ensure protection of water quality and human health, the permit places limits on the types and amounts of pollutants that can be discharged from the facility and outlines best management practices to which the facility must adhere.

This fact sheet explains the nature of permitted discharges from Greens Creek Mine facilities to Hawk Inlet, Greens Creek, and Zinc Creek and the development of the permit including:

- information on public comment, public hearing, and appeal procedures,

August 16, 2023

- effluent limitations and other conditions,
- technical material supporting the permit conditions, and
- monitoring requirements.

### **Appeals Process**

The Department will transmit the permit, final fact sheet, and the Response to Comments to anyone who provided comments during the public comment period.

A person authorized under a provision of 18 AAC 15 may request an informal review of a contested decision by the Division Director in accordance with 18 AAC 15.185 and/or an adjudicatory hearing in accordance with 18 AAC 15.195 – 18 AAC 15.340. See DEC’s “Appeal a DEC Decision” web page <https://dec.alaska.gov/commish/review-guidance/> for access to the required forms and guidance on the appeal process. Please provide a courtesy copy of the adjudicatory hearing request in an electronic format to the parties required to be served under 18 AAC 15.200.

### **Documents are Available**

The permit, fact sheet, application, and related documents can be obtained by visiting or contacting the Department between 8:00 a.m. and 4:30 p.m. Monday through Friday at the addresses below. The permit, fact sheet, application, and other information are located on the Department’s Wastewater Discharge Authorization Program website: <http://dec.alaska.gov/water/wastewater/>.

|                                                                                                                                                                       |                                                                                                                                                                    |                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Alaska Department of<br>Environmental Conservation<br>Wastewater Discharge<br>Authorization Program<br>610 University Avenue<br>Fairbanks, AK 99709<br>(907) 451-2136 | Alaska Department of<br>Environmental Conservation<br>Wastewater Discharge<br>Authorization Program<br>555 Cordova Street<br>Anchorage, AK 99501<br>(907) 269-4028 | Alaska Department of<br>Environmental Conservation<br>Wastewater Discharge<br>Authorization Program<br>410 Willoughby Avenue, Suite 303<br>Juneau, AK 99811<br>(907) 465-6855 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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## 1.0 APPLICANT

This fact sheet provides information on the Alaska Pollutant Discharge Elimination System (APDES) permit for the following entity:

|                      |                                           |
|----------------------|-------------------------------------------|
| Permittee:           | Hecla Greens Creek Mining Company (HGCMC) |
| Facility             | Greens Creek Mine                         |
| APDES Permit Number: | AK0043206                                 |
| Facility Location:   | 18 miles southwest of Juneau, Alaska      |
| Mailing Address:     | PO Box 32199, Juneau, AK 99803            |
| Facility Contact:    | Martin Stearns                            |

The maps in Figure 1, Figure 2 , Figure 3, and Figure 4 of the fact sheet show the mine, treatment plant, discharge, monitoring locations, and proposed new outfalls 002A and SW-012.

## 2.0 FACILITY INFORMATION

Hecla Greens Creek Mine (HGCMC) is an underground polymetallic mine producing approximately 2,200 to 2,400 tons of ore per day. This ore is milled through an on-site grinding circuit and flotation concentrator, with some precious metal first extracted by gravity. Concentrates are then shipped internationally to smelters for refinement. Tailings from the concentrator and waste rock from mining are either returned to the underground workings or placed in a permitted storage area.

The HGCMC mine facilities encompass approximately 273 acres located in the Admiralty Island National Monument. The Admiralty Island National Monument is managed by the U.S. Forest Service and is located in the Greens Creek, Zinc Creek, Cannery Creek and Tributary Creek drainages. These creeks flow into Hawk Inlet. Major site facilities include the underground mine, waste rock storage areas, mill, dry tailings disposal site, port facilities (Hawk Inlet terminal facilities), and roads connecting these components. The location of the major facility components are shown in Figure 1.

### 2.1 Mining, Milling, and Tailings Disposal Processes

The ore is mined via underground methods. Waste rock removed from the mine is permanently disposed of in waste rock site 23 and dry tailings disposal site. At the mill, the ore is ground and processed by flotation to produce concentrates containing primarily lead and zinc with smaller portions of silver and gold. The following reagents are added to the flotation process: copper sulfate, alcohol-based frothers, xanthate, lime, sodium cyanide, zinc sulfate, sulfuric acid, sodium isopropyl dithiophosphate, 3418A promoter, SD200 depressant, metabisulfite, and carbon dioxide. The flotation concentrates are thickened, filter pressed, and then, trucked to the Hawk Inlet terminal for shipment off-site.

The tailings from the flotation process are thickened and filter pressed. Approximately half of the tailings are backfilled into the underground mine. The remainder are covered and transported to the dry stack tailings disposal site.

The dry stack tailings disposal site is located in the upper reaches of Tributary Creek drainage. Currently, the total area of the site is approximately 100 acres. The dry tailings disposal site consists of a dry stack tailings pile and runoff surge pond (tailings facility) adjacently situated. In 2003, an Environmental Impact Statement (EIS) for expansion of the tailings facility was finalized by the U.S. Forest Service and followed by approval to expand the tailings facility to approximately 85 acres, and on August 30, 2013, an EIS for another expansion of the tailings facility was completed. Afterward, the US Forest Service approved plans to expand the tailings disposal facility by about 18 acres.

## 2.2 Description of Discharges

Previous Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) permits issued to the permittee authorized the discharge of treated wastewater from outfalls 001 and 002 into Hawk Inlet and from ten storm water outfalls. Figure 1 depicts the locations of those outfalls. The sources of wastewater contributing to each outfall are described below.

Outfall 001: Previous permits allowed a discharge of treated domestic wastewater from outfall 001 to Hawk Inlet. In 2000, the Permittee directed the flows from outfall 001 to outfall 002 and abandoned outfall 001. Outfall 001 is no longer in use and excluded from this permit.

Outfall 002: Mine water and mill wastewaters and storm water are treated and discharged through outfall 002 into Hawk Inlet. The specific sources of wastewater and waste streams contributing to outfall 002 are listed below.

1. Mine water - Wastewater from the underground mine is (1) treated in the wastewater treatment plants (WWTP/400 gallon per minute (gpm) or 800 gpm) at the 920 Area and pumped to Tank 7 prior to discharge or (2) pumped to Pond 7/10 system and then to the Tailing Storage Facility (TSF) WWTP for treatment prior to discharge via Tank 7.
2. Mill wastewater - Most of the process water collected from the mill through tailings and concentrate thickening and filtration is recycled for reuse in the milling process. However, a portion of the process water is continually purged from the system to maintain water chemistry suitable for proper flotation performance. Prior to recycling the water is treated at the mill in the 920 Area WWTPs. The portion of treated water purged from the system is (1) pumped to Tank 7 prior to discharge or (2) pumped to Pond 7/10 system and then to TSF WWTP for treatment prior to discharge via Tank 7.
3. Sanitary wastes from the mine and mill area (920 Area) and Hawk Inlet terminal areas are treated and disinfected in a sequencing batch reactor (SBR) package plant in which the SBRs are designed to treat to secondary treatment standards. Treated sanitary wastewater from the Hawk Inlet terminal area is pumped to the TSF WWTP for additional treatment and then to Tank 7 and discharged through outfall 002. Treated

sanitary wastewater from the 920 Area will be (1) treated at the 920 Area WWTPs and pumped to Tank 7 prior to discharge or (2) pumped to Pond 7/10 system and sent to the TSF WWTP for treatment prior to discharge via Tank 7 and then outfall 002. The average effluent flow rate for the 920 Area and Hawk Inlet SBRs are about 7,200 and 5,800 gallon per day (gpd), respectively.

4. Storm water from the mine and mill area - Storm water drainage from the mine and mill area is collected through of a series of lined ditches, degritting basins, and ponds. These waters are piped to the TSF WWTP for treatment prior to discharge thru Tank 7.
5. Storm water from the Hawk Inlet terminal area - Storm water from the Hawk Inlet terminal area is collected in a degrit basin and piped to the Wheel Wash Sump and then to the TSF WWTP for treatment prior to discharge thru Tank 7.
6. Seepage and runoff from waste rock storage areas 23, 1350, D and E, Pond C, and Pond D - Seepage and runoff from these waste rock storage areas are collected and routed either back to the mill for use in the mill processes or are pumped to the TSF WWTP for treatment prior to discharge. Collection of runoff at Site E is seasonal and associated with waste rock removal activities is pumped to the TSF WWTP for treatment prior to discharge.
7. Tailings disposal facility seepage and runoff - Seepage and contact water from the dry tailings facility are collected in Pond 7/10 system located below the TSF WWTP. Also, runoff from a segment of the B-road, adjacent to the tailings facility is intercepted and piped to Pond 7/10 system.
8. Intercepted groundwater – Groundwater, including beneath Pond 7/10 system and the TSF, Site 1350, Site 23, the mill backslope, and Hawk Inlet terminal area are treated in either the 920 WWTPs or the TSF WWTP prior to discharge via Tank 7.

These eight wastewater streams are combined and treated in either the 920 Area WWTPs (1,200 gpm combined) or the TSF WWTP (3,200 gpm) located near the dry tailings facility. Water treatment in the WWTPs consists of ferric iron co-precipitation, flocculation, and settling of precipitates reducing metal concentrations in the wastewater. The 920 Area WWTP and TSF WWTP effluent is discharged through outfall 002 or outfall 002A (during periods of high precipitation). Sludge from the treatment plants is thickened, filtered, and disposed of in the dry tailings facility.

Outfall 002 extends from the dry tailings area to the Hawk Inlet discharge point at latitude 58° 06' 06" N and longitude 134° 46' 30" W. The effluent discharges through a 160 ft. long diffuser with a depth of 45 ft. at the near-shore end and 69 ft. at the far end. There are 15 discharge ports, "Tideflex" duckbill valves, spaced at 11.4 ft. intervals along the 14-inch diameter diffuser.

Outfall 002A: HGCMC plans to construct a new outfall (outfall 002A) approximately 1 mile to the north of outfall 002 to increase discharge flow capacity during heavy precipitation events. During routine operations, treated wastewater will be discharged via outfall 002. During high precipitation events, excess water over the outfall 002 WTP and discharge capacity will be discharged via outfall 002A at maximum discharge rate of 2000 gpm. The combined treatment capabilities of the three wastewater treatment plants (920 Area and Tailings Facilities Area) are 4,400 gpm. The total annual volume of water authorized for discharge will remain unchanged.

Storm Water: Storm water that is not discharged through outfall 002 may be discharged through the storm water outfalls listed in Table 1.

**Table 1: Storm Water Outfalls**

| Outfall                                                       | Location*                                                                                | Description of Discharge                                                                    | Receiving Water |
|---------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------|
| 003                                                           | Southern part of Hawk Inlet facilities area near the cannery buildings                   | Runoff from parking and storage areas not otherwise captured and routed through outfall 002 | Hawk Inlet      |
| 004                                                           | Pit 7 (inactive rock quarry and topsoil storage) off of A-road at mile 1.9               | Runoff and drainage from inactive rock extraction pit and topsoil storage                   | Wetlands        |
| 005.2                                                         | Zinc Creek (east side of bridge) off of B-road at mile 3.0                               | Runoff from road cut and fill in known mineralized zone                                     | Zinc Creek      |
| 005.3                                                         | Site E (inactive waste rock storage area) off of B-road at mile 4.7                      | Runoff from waste rock storage area and road runoff                                         | Greens Creek    |
| 005.4                                                         | Pit 6 (inactive rock quarry and top soil storage) off of B-road at mile 4.6              | Seepage and runoff from inactive quarry site and topsoil storage area                       | Greens Creek    |
| 005.5                                                         | Culvert at B-road mile 7.8                                                               | Road runoff                                                                                 | Greens Creek    |
| 006                                                           | Pond D (sediment pond from inactive waste rock storage area D) off of B-road at mile 8.0 | Seepage and runoff from inactive waste rock storage area D                                  | Greens Creek    |
| 007                                                           | Pond C (sediment pond from inactive waste rock storage area C) off of B-road at mile 8.2 | Seepage and runoff from inactive waste rock Site C and mill backslope                       | Greens Creek    |
| 008                                                           | 960 laydown site (initial portal development waste rock)                                 | Seepage and runoff from inactive waste rock placement site                                  | Greens Creek    |
| 009                                                           | Site 1350 adit inactive waste rock storage area                                          | Runoff and seepage from inactive development rock placement site                            | Greens Creek    |
| 012                                                           | A-Road sandpit area                                                                      | Precipitation that accumulates in sandpit area                                              | Hawk Inlet      |
| Note: See Figure 1 which shows storm water outfall locations. |                                                                                          |                                                                                             |                 |

## 2.3 Permit Background

EPA issued an initial NPDES permit for Greens Creek Mine on March 31, 1987. The initial permit was reissued by EPA on October 15, 1998 and expired on November 17, 2003. Since Kennecott Greens Creek Mining Co. submitted a timely permit renewal application in a letter dated May 6, 2003, the 1998 permit was administratively extended until the effective date of a reissued permit. The current permit became effective on July 1, 2005 and expired on July 1, 2010. However, a timely application for reissuance of the permit was submitted to DEC in December 2009. Because HGCMC submitted a timely application for reissuance, the 2005 permit was administratively extended and effective and enforceable until it was superseded by the effective date of a new permit. The next permit became effective on October 1, 2015 and expired on September 30, 2020. Since, HGCMC submitted a timely permit renewal application in a letter dated April 8, 2020, the 2015 permit was administratively extended until the effective date of a reissued permit per 18 AAC 83.155(c)(1).

## 3.0 COMPLIANCE HISTORY

On February 2, 2017, the Department issued a Notice of Violation (NOV) to HGCMC resulting from an inspection conducted in November 2016. The following violations were cited in the NOV: 1) Failure to have a signed and certified QAPP; 2) failure to timely provide BMP plan to the Department upon request; 3) failure to manage runoff of sediments; 4) illicit storm water discharges; 5) failure to submit noncompliance notification; and 5) on May 6, 2016, 300,000 gallons of storm water was discharged into Greens Creek. The water exceeded the Alaska Water Quality Standards (WQS) for lead concentration.

On November 16, 2018, the Department issued an NOV to HGCMC resulting from an inspection conducted in October 2018. The following violations were cited in the NOV: 1) on April 23, 2017, a broken pipe caused an unpermitted release (166 gallons) of mine drainage to land; 2) on July 7, 2017, 4,600 gallons of recycled drill fluid was discharged into Upper Gallagher Creek; 3) on January 2, 2018, 16,350 gallons of storm water (lead 950.1 µg/L) was released through the permitted Pond C outfall to Greens Creek; 4) on January 4, 2018, a broken nipple on the outfall 002 discharge pipeline released 5,000 gallons of treated effluent to land; 5) HGCMC failed to report all outfall 002 parameters on the May 2018 discharge monitoring report (DMR); and 6) straw wattles for sediment control were not being maintained.

On March 26, 2020, the Department issued an NOV to HGCMC resulting from an inspection conducted on February 13, 2020. The following violations were cited in the NOV: 1) on June 3, 2019, the facility potentially discharged an estimated 25 gallons of ethylene glycol to the water management system due to a leak in a heating system pipeline; and 2) During the period of this evaluation, the facility failed to attach to the DMR, the required excursion information as required by the permit.

HGCMC addressed each of the NOVs expeditiously and took steps to prevent the recurrence of a similar problem.

During the previous permit duration, several noncompliance notifications were issued to HGCMC. However, the company took acceptable remedial step to take care of the noncompliance issues.

DMRs from October 2015 through September 2022 were reviewed to determine the Permittee's compliance with effluent limits. After a DEC inspection completed on June 16, 2022, a Notice of Violation was issued on July 14, 2022 for unauthorized discharge which was caused by unexpected high rains and an unintentional puncturing of a water line.

Monitoring data indicated that some of the storm water discharges exceeded WQS (see, APPENDIX 2 for a discussion of the storm water discharges and concentrations compared to WQS).

## **4.0 EFFLUENT LIMITS**

### **4.1 Basis**

The Clean Water Act (CWA) requires that the limits for a particular pollutant be the more stringent of either technology-based or water quality-based effluent limits (WQBELs).

Technology-based effluent limits (TBELs) are set according to the level of treatment that is achievable using available technology. A WQBEL is designed to ensure that the WQS of a waterbody are met. WQBELs may be more stringent than TBELs. Additionally, narrative limitations designate qualitative restrictions and may also complement quantitative limits.

The permit contains both TBELs and WQBELs for outfall 002 and narrative limitations for the ten storm water outfalls. Sections 4.2 and 4.3 summarize the permit's effluent limitations. See APPENDIX 2 for more details.

### **4.2 Outfall 002 Limits**

While the effluent flow limits for the existing outfall 002 have remained the same as the previous permit's limits, the added flow for the proposed outfall 002A has increased the combined effluent flow limits for this permit. The remaining parameters' effluent limits for the both outfalls are considered to be similar to the effluent limits of the existing outfall 002. For a side-by-side comparison of effluent limits in the preceding permit and this permit, see Table 2 below. For a detailed discussion of how the permit limits were developed, see APPENDIX 2.

**Table 2: Outfall 002 and 002A - Effluent Limits**

| Parameter                      | Units | Effluent Limits                |             |                 |             |
|--------------------------------|-------|--------------------------------|-------------|-----------------|-------------|
|                                |       | Daily Maximum                  |             | Monthly Average |             |
|                                |       | 2015 Permit                    | This Permit | 2015 Permit     | This Permit |
| Flow outfall 002               | mgd   | 4.6                            | 4.6         | 3.7             | 3.7         |
| Flow outfall 002A              | mgd   | --                             | 1.7         | --              | 0.4         |
| Flow (Combined)                | mgd   | 4.6                            | 6.3         | 3.7             | 4.1         |
| Cadmium, total recoverable     | µg/L  | 100                            | 16          | 50              | 6           |
| Copper, total recoverable      | µg/L  | 99                             | 32          | 39              | 13          |
| Cyanide, weak acid dissociable | µg/L  | 19                             | 5           | NA              | 3           |
| Lead, total recoverable        | µg/L  | 327                            | 196         | 123             | 87          |
| Mercury, total                 | µg/L  | 1.9                            | 0.9         | 1.0             | 0.7         |
| Zinc, total recoverable        | µg/L  | 1,000                          | 514         | 500             | 201         |
| TSS                            | mg/L  | 30                             | 30          | 20              | 20          |
| pH                             | s.u.  | within the range of 6.0 to 9.0 |             |                 |             |

### 4.3 Storm Water Outfall Limitations

Numeric effluent limits were not developed for the individual storm water outfalls due to the extremely variable flow and pollutant concentrations of storm water discharges.

Rather than developing numeric effluent limits for each storm water outfall, the permit requires the permittee to implement corrective action if a storm water discharge exceeds a water quality criterion and results in a statistically significant reduction in receiving water quality. This limitation is imposed on a parameter-by-parameter basis for lead, zinc, TSS, pH, and oil and grease. This permit's sampling requirements are unchanged from the 2015 permit required sampling from each outfall, upstream, and downstream. Corrective action requirements are maintained to address any storm water exceedance in a prescribed, approved, timely, and comprehensive manner.

The Permittee currently has an approved best management practices plan (BMP Plan) aimed at achieving the objectives and specific requirements for developing outfall-specific BMPs. APDES regulations allow for the use of BMPs where development of numeric effluent limits is infeasible (18 AAC 83.475). See Section 10.3 for more information regarding the BMP requirements.

## **5.0 MONITORING REQUIREMENTS**

### **5.1 Basis**

Under AS 46.03.110(d), the Department may specify in a permit the terms and conditions under which waste material may be disposed. Permits require monitoring to determine compliance with effluent limits. Monitoring may also be required to gather effluent and receiving water data to determine if additional effluent limits are required or to monitor effluent impact on the receiving waterbody quality.

The Permittee is responsible to conduct the monitoring and report results on Discharge Monitoring Reports (DMRs) and on the application for permit reissuance, as appropriate.

### **5.2 Outfall 002 & 002A – Effluent Monitoring**

As currently constructed, the discharge line from Tank 7 to outfall 002 can not accommodate excess water during wet weather conditions. Installing a new discharge line (outfall 002A) versus replacing the existing discharge line with a larger diameter line will result in less environmental impacts during construction and will allow HGCMC to continue discharge during the construction of the new discharge line. So rather than storing the treated water in Pond 7/Pond 10, HGCMC will have the option of pumping the treated water from the 920 Area Wastewater treatment plants directly to Tank 7 prior to discharge at outfall 002. Majority of the water from Tank 7 will continue to discharge to outfall 002, but during the wet weather conditions, excess water will be discharged through the new outfall 002A.

The effluent monitoring requirements in the permit are summarized in Table 3. With the exception of cadmium and copper, the monitoring requirements are the same as the 2015 permit including the requirement for an annual video and report on the condition of the outfall 002 diffuser and ports. Cadmium monitoring frequency was changed from weekly to monthly because over the last decade cadmium has not been detected greater than 2 ug/L (less than 4% of the monthly average effluent limit). Similarly, copper monitoring frequency was changed from weekly to monthly because since 2013 copper has not been detected above 5 ug/L (less than 13% of the monthly average effluent limit).

**Table 3: Outfall 002 and Outfall 002A- Effluent Monitoring Requirements**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Units    | Monitoring Requirements |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------|-------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          | Minimum Frequency       | Sample Type       |
| Flow                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | mgd      | continuous              | recording         |
| Cadmium <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | µg/L     | monthly                 | 24-hour composite |
| Copper <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | µg/L     | monthly                 | 24-hour composite |
| Lead <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | µg/L     | weekly                  | 24-hour composite |
| Mercury <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | µg/L     | weekly                  | 24-hour composite |
| Zinc <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | µg/L     | weekly                  | 24-hour composite |
| TSS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | mg/L     | weekly                  | 24-hour composite |
| pH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | s.u.     | continuous <sup>c</sup> | recording         |
| Cyanide <sup>d</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | µg/L     | monthly                 | 24-hour composite |
| Temperature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | °C       | weekly                  | grab              |
| BOD <sub>5</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | mg/L     | monthly                 | grab              |
| Fecal coliform bacteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | #/100 mL | monthly                 | grab              |
| Notes:<br>a. Metals shall be measured as total recoverable. See EPA memo on total vs. total recoverable metals from W. Telliard dated August 19, 1998.<br>b. Mercury shall be measured as total. See EPA memo on total vs. total recoverable metals from W. Telliard dated August 19, 1998.<br>c. Permit Part 1.2.4 imposes continuous monitoring requirements as specified in 40 CFR Part 401.17 and adopted by reference in 18 AAC 83.010(g)(1).<br>d. Cyanide shall be measured as weak acid dissociable (WAD). |          |                         |                   |

### 5.3 Storm Water Monitoring

The 2015 permit required HGCMC to monitor storm water outfalls twice per year (once during spring runoff/snowmelt and once during the fall “monsoon” months) at the locations shown in Figure 1. Outfalls 003 through 005 are monitored for oil and grease, lead, zinc, TSS, and pH. outfalls 006 through 012 are monitored for lead, zinc, TSS, and pH, as outlined in Table 4.

The Department has determined that twice yearly storm water monitoring of the outfalls must continue, provided there is discharge. The permit requires, for each storm water monitoring event, that HGCMC monitor the receiving water directly upstream and downstream of where the storm water enters the receiving water. The receiving water must be monitored at the same time as the storm water outfalls and for the same parameters. See Table 4.

The permit includes requirements specifying the method detection limits used for the storm water and associated receiving water monitoring. It also specifies that lead and zinc shall be measured as total recoverable.

**Table 4: Storm Water Outfall Monitoring Requirements**

| Outfall | Location                                                                                 | Parameters <sup>a</sup>                           | Minimum Frequency <sup>b</sup> | Sample Type |
|---------|------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------|-------------|
| 003     | Southern part of Hawk Inlet facilities area near the cannery buildings                   | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 004     | Pit 7 (inactive rock quarry and topsoil storage) off of A-road at mile 1.8               | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 005.2   | Zinc Creek (east side of bridge) off of B-road at mile 3.0                               | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 005.3   | Site E (inactive waste rock storage area) off of B-road at mile 4.7                      | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 005.4   | Pit 6 (inactive rock quarry and top soil storage) off of B-road at mile 4.6              | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 005.5   | Culvert at B-road mile 7.8                                                               | Flow, oil & grease, lead, zinc, TSS, pH, hardness | twice per year                 | Grab        |
| 006     | Pond D (sediment pond from inactive waste rock storage area D) off of B-road at mile 8.0 | Flow, lead, zinc, TSS, pH, hardness               | twice per year                 | Grab        |
| 007     | Pond C (sediment pond from inactive waste rock storage area C) off of B-road at mile 8.2 | Flow, lead, zinc, TSS, pH, hardness               | twice per year                 | Grab        |
| 008     | 960 laydown site (initial portal development waste rock)                                 | Flow, lead, zinc, TSS, pH, hardness               | twice per year                 | Grab        |
| 009     | Site 1350 adit inactive waste rock storage area                                          | Flow, lead, zinc, TSS, pH, hardness               | twice per year                 | Grab        |
| 012     | A-Road sandpit area                                                                      | Flow, lead, zinc, TSS, pH, hardness               | twice per year                 | Grab        |

Notes:

- Flow shall be reported in gpm, lead and zinc shall be measured as total recoverable in µg/L, oil & grease and TSS shall be measured in mg/L, pH shall be measured in s.u., and hardness shall be measured as mg/L of CaCO<sub>3</sub>.
- The samples must be collected once during the spring runoff or snow-melt and once during the fall rainfall events. Sampling is only required when an outfall is discharging.

## 5.4 Internal Monitoring Locations 010 and 011

The effluent monitoring requirements for internal monitoring locations 010 and 011 are summarized in Table 5. Internal monitoring location 010 is an effluent monitoring location for the Hawk Inlet SBR and internal monitoring location 011 is an effluent monitoring location for the 920 Area SBR. Both SBRs are designed to treat domestic wastewater to secondary treatment standards as well as provide disinfection before discharge. The monitoring locations are located between the respective SBR and the TSF WWTF pond.

**Table 5: Internal Monitoring Locations 010 and 011 Requirements**

| Parameter                                                                         | Units | Monitoring Requirements |             |
|-----------------------------------------------------------------------------------|-------|-------------------------|-------------|
|                                                                                   |       | Minimum Frequency       | Sample Type |
| BOD <sub>5</sub>                                                                  | mg/L  | monthly*                | grab        |
| * Samples must be taken on the same day as outfall 002 BOD <sub>5</sub> sampling. |       |                         |             |

## 5.5 Hawk Inlet Monitoring

This permit requires HGCMC to monitor seawater, sediments, and toxicity in Hawk Inlet. Based on recommendations from the Alaska Department of Fish and Game (ADF&G), permit monitoring requirements have been updated since the 2015 permit. The goal of the monitoring program is to demonstrate that WQS are not exceeded outside the boundary of the mixing zone and to assess whether sediments or aquatic organisms may be affected by the facility's discharges. The sampling locations are shown in Figure 2. The changes from the 2015 permit relating to Hawk Inlet monitoring are contained in Permit Parts 1.6.1.1, 1.6.1.2, 1.6.1.3, 1.6.1.4, and 1.6.1.5, where monitoring for the outfall 002A has been added. A summary of the Hawk Inlet Monitoring Program follows.

Water Column Monitoring: The permit requires quarterly receiving water monitoring in Hawk Inlet at three pre-existing sample locations (sites 106, 107, and 108). Sites 106, 107, and 108 are part of the Hawk Inlet ambient water quality monitoring program: 106 is nearest the mouth of the inlet, 107 is nearest the head of the inlet and adjacent to the mine's port facility, and 108 is nearest to the outfall 002. The permit also requires receiving water monitoring at a new location, site 111, during calendar quarters when effluent is released through 002A. Site 111 (Figure 2) is proximal to the outfall 002A.

The samples must be analyzed for the following parameters: cadmium, copper, lead, mercury, zinc, TSS, pH, cyanide, temperature, conductivity, and turbidity. Metals, except for mercury that is measured as total, must be measured as dissolved. Hawk Inlet water quality monitoring data is used to evaluate water quality impacts of outfalls 002 and 002A discharges. To perform this evaluation, it is necessary that the ambient monitoring use analytical methods that have method detection limits below the water quality criteria. Table 6 specifies method detection limits (MDLs) for metals and cyanide required for marine water monitoring.

Receiving water monitoring requirements are the same as required in the 2015 permit. The permit requires that the metals be monitored as dissolved.

**Table 6: Receiving Water Monitoring Parameters and MDLs**

| Parameter          | Units | Minimum Frequency | MDL   |
|--------------------|-------|-------------------|-------|
| Cadmium, dissolved | µg/L  | quarterly         | 0.1   |
| Copper, dissolved  | µg/L  | quarterly         | 0.03  |
| Lead, dissolved    | µg/L  | quarterly         | 0.05  |
| Mercury, total     | µg/L  | quarterly         | 0.002 |
| Zinc, dissolved    | µg/L  | quarterly         | 0.2   |
| TSS                | mg/L  | quarterly         | -     |
| pH                 | s.u.  | quarterly         | -     |
| Cyanide, WAD       | µg/L  | quarterly         | 5     |
| Temperature        | °C    | quarterly         | -     |
| Turbidity          | NTU   | quarterly         | -     |
| Conductivity       | µS/cm | quarterly         | -     |

Permit Part 1.6.3 – Site 108 Monitoring requires effluent sampling on days when mixing zone sampling occurs. This requirement tracks the relationship between effluent and receiving water quality. Monitoring for water quality near the mixing zone has been performed at DEC-approved monitoring site 108, and the permit maintains monitoring site 108 as the site for sampling water quality adjacent to the mixing zone.

Site 111 is a new monitoring location for sampling the water quality adjacent to the mixing zone of outfall 002A. Monitoring at this site must occur during calendar quarters when effluent is released through 002A. The permit maintains monitoring site 111 as the site for sampling water quality adjacent to the outfall 002A mixing zone (Section 1.6.1.1 of APDES Permit).

**Sediment Monitoring:** The permit requires sediment monitoring in Hawk Inlet at least once per year at three pre-existing sample locations (locations S-1, S-2, and S-4) and at least once every three years at pre-existing sample locations S-5N and S-5S, and annually (to establish a baseline) at station S-7 until outfall 002A is constructed and then annually if outfall 002A is used for discharge other than for testing and maintenance. Location S-1 and S-7 are in the areas affected by the discharges from outfall 002 and outfall 002A, location S-2 represents background conditions, location S-4 is in the area of the ore loading dock, and locations S-5N and S-5S are in an area affected by the loading of concentrates onto ships that is listed as impaired (Figure 2). See Section 6.2 for more details about the impairment. Samples must be analyzed for the following parameters: cadmium, copper, lead, mercury, and zinc (Table 7). The permit specifies method detection limits for these parameters. The sediment monitoring requirements are the same as required in the 2015 permit.

**Table 7: Sediment Monitoring Parameters and Methods**

| Parameter                                                                                                                                                                                                                                                                  | Preparation Method | Analysis Method   | MDL <sup>a</sup> (mg/Kg) |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|--------------------------|
| Cadmium                                                                                                                                                                                                                                                                    | PSEP <sup>b</sup>  | GFAA <sup>c</sup> | 0.3                      |
| Copper                                                                                                                                                                                                                                                                     | PSEP <sup>b</sup>  | ICP <sup>d</sup>  | 15.0                     |
| Lead                                                                                                                                                                                                                                                                       | PSEP <sup>b</sup>  | ICP <sup>d</sup>  | 0.5                      |
| Mercury                                                                                                                                                                                                                                                                    | 7471 <sup>e</sup>  | 7471 <sup>e</sup> | 0.02                     |
| Zinc                                                                                                                                                                                                                                                                       | PSEP <sup>b</sup>  | ICP <sup>d</sup>  | 15.0                     |
| Notes:                                                                                                                                                                                                                                                                     |                    |                   |                          |
| a. Dry weight basis.                                                                                                                                                                                                                                                       |                    |                   |                          |
| b. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Puget Sound Estuary Program (PSEP), EPA 910/9-86-157, as updated by Washington Department of Ecology. Subsection: Metals in Puget Sound Water, Sediment, and Tissue Samples, PSEP. |                    |                   |                          |
| c. Graphite Furnace Atomic Absorption (GFAA) Spectrometry - SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods. EPA 1986.                                                                                                                           |                    |                   |                          |
| d. Inductively Coupled Plasma (ICP) Emission Spectrometry - SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods. EPA 1986.                                                                                                                           |                    |                   |                          |
| e. Mercury Digestion and Cold Vapor Atomic Absorption (CVAA) Spectrometry - Method 7471, SW846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods. EPA 1986.                                                                                               |                    |                   |                          |

In-situ Bioassays: The permit requires analysis of tissues from organisms collected in Hawk Inlet at least once per year at seven pre-existing sample locations. Polychaete sediment dwellers (marine worms), *Nephtys procera*, and *Nereis sp.*, must be collected from three pre-existing sample locations (locations S-1, S-2, and S-4) and a new location, S-7 (Figure 2). These locations are the same as required for the sediment sampling, except bioassays are not required at location S-5 since the polychaete test organisms do not occur at location S-5.

The filter feeder, *Mytilus edulis* (blue mussel) must be collected from four pre-existing sample locations (location Stn 1, Stn 2, Stn 3, and Stn 4 (ESL)) and two new locations (location Stn 6, and Stn 7 – Figure 2). Sites Stn 2 and Stn 3 represent background conditions. Locations Stn 4 (ESL) and Stn 1 are in the area influenced by outfall 002, and locations Stn 5 and Stn 6 are in the area influenced by outfall 002A.

Tissue samples must be analyzed for the following parameters: cadmium, copper, lead, mercury, and zinc. The methods used for sample collection and analysis are in Table 8. The in-situ bioassay monitoring requirements have been modified since the 2015 permit to incorporate the new outfall 002A. The in-situ bioassay monitoring requirements include a requirement to collect six samples at each site annually with a minimum monitoring frequency of once per year. Section 8.0 *Anti-backsliding* provides the basis for the sample size and frequency.

**Table 8: In-situ Bioassay Monitoring Organisms and Parameters**

| Sample Location                                                                                                                                        | In-situ Test Organism <sup>a</sup>                                                           | Parameters<br>(total in mg/kg)                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------|
| S-1<br>S-2<br>S-4<br>S-7                                                                                                                               | <i>Nephtys procera</i> (polychaete)<br>and/or<br><i>Nereis sp.</i> (polychaete) <sup>b</sup> | Cadmium,<br>Copper,<br>Lead,<br>Mercury,<br>Zinc |
| Stn 1<br>Stn 2<br>Stn 3<br>Stn 4 (ESL)<br>Stn 5<br>Stn 6                                                                                               | <i>Mytilus edulis</i> (blue mussel)                                                          |                                                  |
| Notes:                                                                                                                                                 |                                                                                              |                                                  |
| a. The organisms must be collected from each of the locations identified.                                                                              |                                                                                              |                                                  |
| b. <i>Nereis sp.</i> may be replaced with other local species if <i>Nereis sp.</i> is not available. Only one species will be included in each sample. |                                                                                              |                                                  |

## 5.6 Non-Routine Discharge Monitoring

The permit requires representative sampling per 18 AAC 83.405(k). This provision specifically requires representative sampling whenever a bypass, spill, or non-routine discharge of pollutants occurs, if the discharge may reasonably be expected to cause or contribute to a violation of an effluent limit under the permit. This provision is included in the permit because routine monitoring could miss permit violations or WQS exceedances resulting from bypasses, spills, or non-routine discharges. This requirement directs HGCMC to conduct additional, targeted monitoring to quantify the effects of these occurrences on the final effluent discharge.

## 5.7 Whole Effluent Toxicity (WET) Monitoring

18 AAC 83.435 requires that a permit contain limitations on WET when a discharge has reasonable potential to cause or contribute to an exceedance of a WQS.

During development of the 2005 permit, EPA reviewed the WET data. The data showed that the effluent from outfall 002 had no reasonable potential to contribute to an exceedance of the WQS for toxicity. Adequate data determined that WET limits were not needed, and there was no reason to believe that the characteristics of the discharge would change over the term of the next permit; therefore, monitoring for WET was removed from the 2005 permit and continued through the 2015 permit and this permit.

## 6.0 RECEIVING WATERS

### 6.1 Water Quality Standards

Section 301(b)(1)(C) of the CWA requires the development of limits in permits necessary to meet water quality standards by July 1, 1977. Per 18 AAC 83.435, APDES permits must include conditions to ensure compliance with 18 AAC 70 – Alaska Water Quality Standards (WQS). Regulations in 18 AAC 70 require that conditions in permits ensure compliance with the WQS. The state’s WQS are composed of use classifications, numeric and/or narrative water quality criteria, and an Antidegradation Policy. The use classification system designates the beneficial uses that each waterbody is expected to achieve. The numeric and/or narrative water quality criteria are the criteria deemed necessary by the state to support the beneficial use classification of each waterbody. The antidegradation policy ensures that the beneficial uses and existing water quality are maintained.

Water bodies in Alaska are designated for all uses unless the water has been reclassified under 18 AAC 70.230 as listed under 18 AAC 70.230(e). Some water bodies in Alaska can also have site-specific water quality criterion per 18 AAC 70.235, such as those listed under 18 AAC 70.236(b). The receiving water for the discharge, Hawk Inlet, has not been reclassified, nor have site-specific water quality criteria been established. Therefore, Hawk Inlet must be protected for all marine water designated use classes listed in 18 AAC 70.020(a)(2).

### 6.2 Water Quality Status of Receiving Waterbody

Any part of a waterbody for which the water quality does not or is not expected to meet applicable WQS is defined as a “water quality limited segment” and placed on the state’s impaired waterbody list. Zinc Creek and Greens Creek are not included on the list of Alaska’s CWA 303(d) impaired waters as published in Alaska’s Final 2020 Integrated Water Quality Monitoring and Assessment Report. However, the 2020 Integrated Water Quality Monitoring and Assessment Report lists a small portion of Hawk Inlet (150’ by 350’) for listing as impaired due to cadmium, copper, lead, mercury, and zinc in sediments where a spill occurred in 1989, even though all samples indicate that the water column meets Alaska Water Quality Standards. The marine sediments, which are confined to a less than one acre area, do not negatively impact water quality in the locations affected by permitted discharges. In 2015, a Restoration Plan was begun for the area. In 2016, the plan was reviewed by the stakeholders and the plan was completed in 2017.

### 6.3 Mixing Zone Analysis For Outfalls 002 & 002A

#### Outfall 002:

Under 18 AAC 70.240, excluding 18 AAC 240(g)(2) and (4) as amended through March 23, 2006, the Department may authorize a mixing zone in a permit. Determination of mixing zones requires an evaluation of critical characteristics of the receiving water, effluent

discharges, and other pertinent factors, combined with use of an approved mixing zone modeling program such as the Cornell Mixing Zone Model (CORMIX). The Department authorizes a mixing zone for the following parameters: copper, lead, mercury, and zinc with a chronic dilution factor of 15.4. The dilution factor was derived from the chronic WQBEL for lead and applicable water quality criteria, and other relevant site-specific discharge and ambient data using DEC's RPA tool, then entered into the CORMIX 12.0 modeling program to obtain mixing zone sizes.

As per 18 AAC 70.240(c)(4)(A) and (d)(8), the mixing zones will not result in an acute or chronic toxic effects in the water column, sediments, or biota outside the boundaries of the mixing zones. At and beyond the boundary of the chronic mixing zone, all chronic aquatic life WQS apply. Based on the acute WQBEL, cyanide required the most dilution with an acute dilution factor of 6.1, lead concentration determined the acute mixing zone size. Chronic WQBEL for lead required the most dilution with a chronic dilution factor of 15.4 to determine the chronic mixing zone size. Other parameters addressed in the Permit meet their respective water quality criteria well within the acute and chronic mixing zones sized for lead. CORMIX modeling incorporated both high and low flow ambient water velocities to determine the mixing zone size necessary to meet ambient flow conditions.

The acute mixing zone is a rectangular box shape extending from the ocean floor to the water surface. It has a maximum width of 162 feet centered along the 160 feet long diffuser and a length of 37.5 feet. For practical reasons, the acute mixing zone size was set at 165 feet by 40 feet. The chronic mixing zone is a rectangular box shape extending from the ocean floor to the water surface. It has a maximum length of 51 feet multiplied by two to account for ebb and flood tide resulting in a total length of 102 feet. The chronic mixing zone is centered along a 160 foot diffuser and has a total width of 162 feet. For practical reasons, the chronic mixing zone dimensions are set at 165 feet by 100 feet. These results were modeled using the multiport diffuser option in CORMIX.

To comply with 18 AAC 70.240, as amended November 13, 2022, regarding the maximum size of an acute mixing zone, that a drifting organism was not to be within an acute mixing zone for longer than 15 minutes. Based on both the 10<sup>th</sup>, 0.1 meters/second (m/s), and 90<sup>th</sup>, 0.28 m/s, percentile receiving water current velocity, a drifting organism passed through the acute mixing zone in less than two minutes and was consistent with *EPA's Technical Support Document for Water Quality-based Toxics Control*. As a result, the Department confirmed that there would be no lethality to organisms passing through the mixing zone.

#### **Outfall 002A:**

The effluent limits and effluent monitoring requirements for the outfall 002A are same as they are for the outfall 002.

Under 18 AAC 70.240, excluding 18 AAC 240(g)(2) and (4) as amended through March 23, 2006, the Department may authorize a mixing zone in a permit. Determination of mixing

zones requires an evaluation of critical characteristics of the receiving water, effluent discharges, and other pertinent factors, combined with use of an approved mixing zone modeling program such as the CORMIX. The Department authorizes a chronic mixing zone for the following parameters: copper, cyanide, lead, mercury, and zinc with a dilution factor of 15.4. The dilution factor was derived from the chronic WQBEL for lead and applicable water quality criteria, and other relevant site-specific discharge and ambient data using DEC's RPA tool, then entered into the CORMIX 12.0 modeling program to obtain mixing zone sizes.

As per 18 AAC 70.240(c)(4)(A) and (d)(8), the mixing zones will not result in an acute or chronic toxic effects in the water column, sediments, or biota outside the boundaries of the mixing zones. At and beyond the boundary of the acute mixing zone, all chronic aquatic life WQS apply. Based on the acute WQBEL, cyanide required the most dilution with an acute dilution factor of 6.1 in determining the acute mixing zone size. Chronic WQBEL for lead required the most dilution with a chronic dilution factor of 15.4 to determine the chronic mixing zone size. Other parameters addressed in the Permit meet their respective water quality criteria well within the acute and chronic mixing zones sized for lead. CORMIX modeling incorporated both high and low flow ambient water velocities to determine the mixing zone size necessary to meet ambient flow conditions.

The acute mixing zone is a rectangular box shape extending from the ocean floor to the water surface. It has a maximum length of 30 and a width of 90 feet. The chronic mixing zone is a rectangular box shape extending from the ocean floor to the water surface. It has a maximum length of 70 feet and a total width of 90 feet.

To comply with 18 AAC 70.240, as amended November 13, 2022, regarding the maximum size of an acute mixing zone, a drifting organism was not to be within an acute mixing zone for longer than 15 minutes. Based on both the 10<sup>th</sup>, 0.07 meters/second (m/s), and 90<sup>th</sup>, 0.2 m/s, percentile receiving water current velocity, a drifting organism passed through the acute mixing zone in less than 2 minutes and was consistent with *EPA's Technical Support Document for Water Quality-based Toxics Control* indicating a residence time of less than 15 minutes. As a result, the Department confirmed that there would be no lethality to organisms passing through the mixing zone.

### **Modeling and Methodology:**

Under 18 AAC 70.240, it outlines regulatory criteria that must be considered when the Department analyzes a permittee's request for a mixing zone. These criteria include the size of the mixing zone, treatment technology, designated and existing uses of the waterbody, human consumption, spawning areas, human health, aquatic life, and endangered species. All criteria must be met to authorize a mixing zone. A summary of this analysis follows.

Ambient Data – To determine the width and length of the mixing zone under critical receiving water conditions, calculations normally use the 10<sup>th</sup> percentile and 90<sup>th</sup> percentile current

velocities. However, since the CORMIX model did not work properly at 10<sup>th</sup> percentile and 90<sup>th</sup> percentile current velocities, the lowest and the highest current velocities values closer to 10<sup>th</sup> percentile and 90<sup>th</sup> percentile respectively were used. For the existing outfall 002, the lowest current velocity used in the modeling was 0.1 meter per second and the highest current velocity used was 0.28 meter per second. Similarly, for the new proposed outfall 002A, the lowest current velocity used was 0.068 meter per second and the highest current velocity used was 0.206 meter per second. Water density inputs were 1018.63 kilograms per cubic meter (kg/m<sup>3</sup>) for the surface and 1020.79 kg/m<sup>3</sup> for the bottom of the water column.

Effluent Data – The mixing zone plume was modeled using the maximum permitted flow limit equal to 3,200 gallons per minute and an effluent temperature of 16° C. The effluent parameter requiring the greatest dilution to meet WQS at outfall 002 is lead, with a maximum expected effluent concentration of 112.21 micrograms per liter (µg/L); therefore, lead determined the chronic mixing zone size. All other parameters needing a chronic mixing zone to meet their respective water quality criteria fit within the chronic mixing zone sized for lead. Consequently, this parameter determined the smallest practicable the mixing zone.

Discharge Data – The average depth of water at the 002 diffuser is 15 meters. The average depth of water at the 002A diffuser is 35 meters.

Size – For outfall 002, both the acute and chronic mixing zones are included in an approved mixing zone size of 165 feet wide by 100 feet length. For outfall 002A, both the acute and chronic mixing zones are included in an approved mixing zone size of 90 feet wide by 70 feet length. CORMIX model simulations based on critical receiving water and effluent conditions along with the Department’s knowledge of the water body’s existing uses were used to determine the appropriate size of the mixing zone.

Technology – 18 AAC 70.240(c)(1) requires the Department to determine if “an effluent or substance will be treated to remove, reduce, and disperse pollutants, using methods found by the Department to be the most effective and technologically and economically feasible, consistent with the highest statutory and regulatory treatment requirements” before authorizing a mixing zone. Applicable “highest statutory and regulatory requirements” are defined in 18 AAC 70.240(c)(A), (B), and (C) as follows:

- A) Any federal TBEL identified in 40 CFR 125.3 and 40 CFR 122.29, as revised as of July1, 2005 and adopted by reference;
- B) Minimum treatment standards in 18 AAC 72.050; and
- C) Any treatment requirement imposed under another state law that is more stringent than the requirement of this chapter.

In accordance with 18 AAC 70.240(c)(1), the most effective technologically and economically feasible methods are used to disperse, treat, remove, and reduce pollutants. Ferric iron co-precipitation, neutralization, filtration, and secondary treatment with an SBR

are used to treat wastewater influent and produce an effluent with a much higher quality than specified by technology-based effluent limitation guidelines (ELGs) for the subcategory of mines that produce copper, lead, zinc, silver, gold, or molybdenum mines as found in 40 CFR Part 440, Subpart J (adopted by reference at 18 AAC 83.010(g)(3)). Additionally, state-of-the-art diffusers were installed in 2010 to help disperse the high quality effluent upon mixing with the receiving water.

Existing Use – Per 18 AAC 70.240(c)(2), when authorizing mixing zones, the Department must ensure that the existing uses of the waterbody outside the mixing zone are not partially nor completely eliminated, and the overall biological integrity of the waterbody as whole is not impaired. The Department has authorized a 165 feet long and 100 feet wide chronic mixing zone for outfall 002 and a 70 feet long and 90 feet wide chronic mixing zone for outfall 002A to ensure water-quality criteria beyond the boundary of the mixing zone are not exceeded. Because water quality criteria are met at the boundary of the chronic mixing zone and the criteria are established to protect the existing uses and biological integrity of the waterbody, the mixing zones are appropriately sized and protective of the existing uses of the waterbody as a whole.

Human Consumption – Per 18 AAC 70.240(c)(4)(B), the mixing zone must not create a public health hazard that would preclude existing uses of the waterbody for water supply or contact recreation. Per 18 AAC 70.240(c)(4)(C), the mixing zone must not preclude or limit established processing activities or commercial, sport, personal use, or subsistence fish and shellfish harvesting. Lastly, per 18 AAC 70.240(d)(6), the pollutants discharged cannot produce objectionable color, taste, or odor in aquatic resources harvested for human consumption; nor can the discharge. The neither the mixing zones for outfalls 002 or 002A are authorized in a location where aquatic resources are harvested or that could result in precluding or limiting established processing activities or commercial, sport, personal use, or subsistence fish and shellfish harvesting. Nor is there any indication that the pollutants discharged would produce objectionable color, taste or odor in aquatic resources harvested for human consumption if such activity occurred near the outfall. Any human consumption of marine water would require a level of treatment that would remove all constituents contained within salt water (e.g., desalination or reverse osmosis). Therefore, human consumption of the marine water is undrinkable in its natural state and the discharge authorized under the Permit is compliant with 18 AAC 70.240(c)(4)(B)–(C) and 18 AAC 70.240(d)(6).

Human Health – Per 18 AAC 70.240(d)(1), the mixing zones for outfalls 002 and 002A must not result in pollutants discharged at levels that will bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota, or at levels that otherwise will create a public health hazard through encroachment on a water supply or contact recreation uses. The Department has reviewed available data provided by the applicant and has determined there are no bioaccumulating or bioconcentrating parameters associated with the discharges. Per 18 AAC 70.250(a)(1)(A), available evidence must reasonably demonstrate that the pollutants

discharged in an authorized mixing zone will not bioaccumulate. None of the discharges are expected to contain bioaccumulative chemicals.

Per 18 AAC 70.240(d)(2) pollutants discharged must not present an unacceptable risk to human health from carcinogenic, mutagenic, teratogenic, or other effects as determined using a risk assessment method approved by the Department and consistent with 18 AAC 70.025, which indicates the lifetime incremental cancer risk level is 1 in 100,000 for exposed individuals. There are no cancer-causing pollutants being discharged at concentrations that present unacceptable risks.

Aquatic Life and Wildlife – Per 18 AAC 70.240(c)(4)(A),(D), and (E), pollutants for which the mixing zones for outfalls 002 and 002A will be authorized will not result in an acute or chronic toxic effect in the water column, sediments, or biota outside the boundaries of the mixing zone; a reduction in fish or shellfish population levels; or in permanent or irreparable displacement of indigenous organisms. In addition, the mixing zone must not result in undesirable or nuisance aquatic life per 18 AAC 70.240(d)(5). Because all criteria are met at the respective acute and chronic mixing zone boundaries, toxic effects in the water column, sediments, or biota will not occur outside these boundaries; existing water quality criteria protect from these occurrences. In addition, there are no anticipated displacement of indigenous species nor promotion of undesirable or nuisance aquatic life.

Endangered Species – Under 18 AAC 70.240(c)(4)(F), the authorized mixing zone must not cause an adverse effect on threatened or endangered species. The United States Fish and Wildlife Service (USFWS) indicated that there are no concerns regarding harm to endangered species. The Humpback Whale and Eastern Stellar Sea Lion are endangered species potentially affected by Greens Creek Mine discharges. However, EPA conducted a Biological Evaluation (BE) in 1998, which determined that negative impacts on endangered species from the permit's discharges is unlikely. Currently, there is no information to refute the findings of the BE.

## **7.0 ANTIBACKSLIDING**

Per 18 AAC 83.480(a), “Except as provided in (b) of this section, when a permit is renewed or reissued, interim effluent limitations, standards or conditions must be at least as stringent as the final effluent limitations, standards, or conditions in the previous permit, unless the circumstances on which the previous permit was based have materially and substantially changed since the permit was issued, and the change in circumstances would constitute cause for permit modification or revocation and reissuance under 18 AAC 83.135.”

Effluent limitations may be relaxed as allowed under 18 AAC 83.480(b), CWA § 402(o) and CWA § 303(d)(4). CWA § 402(o)(2)(B)(i) and 18 AAC 83.480(b)(2) allow less stringent effluent limitations in renewed, reissued, or modified permits if information other than revised regulations, guidance, or test methods that would have justified the application of a less stringent effluent limitation is now available

but was not available at the time of permit issuance. Since the last permit was reissued, the discharger has collected new information to characterize the effluent, and DEC has used that new information to determine that effluent's reasonable potential to cause or contribute to WQS exceedances and thereby calculate permit limits.

Applying CWA § 402(o)(2)(B)(i) and 18 AAC 83.480(b)(2), outfalls 002 and outfall 002A effluent limitations are at least as stringent or more stringent than the effluent limitations of the previous permit. These new effluent limitations are based on the collection and statistical analysis of the effluent data collected during the previous permit cycle. The addition of outfall 002A increases the total authorized flow of treated effluent from 4.6 mgd to 6.3 mgd for daily maximum and from 3.7 mgd to 4.1 mgd for monthly average. However, the mass balance of the metal pollutants discharged is decreased due to the greater proportional reduction of the effluent limits for all metal parameters. The previous permit noted the intent to reduced WAD cyanide monitoring to monthly monitoring if WAD cyanide concentrations remained below the detection level of 5 ug/L for consecutive 16 weeks, which was met. Accordingly, monitoring of WAD cyanide was reduced to monthly sampling.

CWA § 303(d)(4)(A) states that, for waterbodies where the water quality does not meet applicable WQS, effluent limitations may be revised under two conditions: the revised effluent limitation must ensure the attainment of the WQS (based on the waterbody TMDL or the waste load allocation), or the designated use which is not being attained must be removed in accordance with WQS regulations. Since Hawk Inlet in the discharge area is not impaired and does not have a TMDL, evaluation under this provision is not required.

CWA § 303(d)(4)(B) states that, for waterbodies where the water quality meets or exceeds the level necessary to support the waterbody's designated uses, permitting standards like WQBELs may be revised if the revision is consistent with the State's Antidegradation Policy. This provision allows DEC to establish less stringent WQBELs in a permit for discharge so long as the revised permit limit is consistent with the State's Antidegradation Policy and continues to assure compliance with applicable water quality standards. Permitting authorities may use this provision to issue permits reflecting new data.

Even if the requirements of CWA § 303(d)(4) or 18 AAC 83.480(b) are satisfied, 18 AAC 83.480(c) and CWA § 402(o)(3) prohibit relaxed limits that would result in violations of WQS or ELGs. Here, the receiving water meets WQS supporting existing and designated uses and ELGs are required by the permit, and so 18 AAC 83.480(c) and CWA § 402(o)(3) are met. While effluent limits are not relaxed for this permit; however, permitting authorities may use this provision to issue permits reflecting new data.

Since the previous permit was reissued, new information has been collected to characterize the effluent from the facility. DEC's analysis of its effluent water quality data resulted in changes to effluent limits. The reasonable potential analysis demonstrated that some parameters required more stringent limits to ensure compliance with WQS and ELGs. Limits that are more stringent in this permit, in comparison to the previous permit, include: the daily maximum and monthly average limit for cadmium, copper,

cyanide, lead, mercury, and zinc. The daily maximum and monthly average limit for TSS, and pH are unchanged. Flow limit is increased primarily due to the proposed construction of an additional outfall 002A (See Table 2 in the APDES permit AK0043206). In other words, DEC tailored effluent limits in the renewed permit according to new information that was not available at the time of original permit issuance. The new effluent limits will not result in a violation of WQS, and, as set forth below, do not violate the State's Antidegradation Policy. As such, the new effluent limits comply with the antibacksliding exception in 18 AAC 83.480(b)(2) and CWA § 402(o)(2)(B)(i), as well as the overarching WQS and antidegradation requirements in 18 AAC 83.480(c) and CWA § 303(d)(4)(B).

## 8.0 ANTIDEGRADATION

Section 303(d)(4)(B) of the CWA states that, for waterbodies where the water quality meets or exceeds the level necessary to support the waterbody's designated uses, WQBELs may be revised if the revision is consistent with the State's Antidegradation policy. The State's Antidegradation policy is found in the 18 AAC 70 WQS regulations at 18 AAC 70.015. The Department's approach to implementing the Antidegradation policy is found in 18 AAC 70.016, Antidegradation implementation methods for discharges authorized under the federal Clean Water Act. Both the Antidegradation policy and the implementation methods are consistent with 40 CFR 131.12 and approved by EPA. This section analyzes and provides rationale for the Department's decisions in the permit issuance with respect to the Antidegradation policy and implementation methods.

Using the policy and corresponding implementation methods, the Department determines a tier protection level, whereby a higher numbered tier indicates a greater level of water quality protection. Tier 1 and Tier 2 classifications protect on a parameter-by-parameter basis. A Tier 3 protection level applies to a designated water. At this time, no Tier 3 waters have been designated in Alaska.

In general, 18 AAC 70.015(a)(1) states that existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected. This Tier 1 protection level applies to Hawk Inlet.

18 AAC 70.015(a)(2) states that if the quality of water exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality must be maintained and protected, unless the Department authorizes a reduction in water quality. Hawk Inlet is not listed as impaired (Category 4 or 5) in Alaska's 2020 Integrated Water Quality Monitoring and Assessment Report. The Tier 2 protection level applies to Hawk Inlet.

As a result, both Tier 1 and Tier 2 protection levels apply to Hawk Inlet. The Department may allow a reduction of water quality only after the specific analysis and requirements under 18 AAC 70.016(b)(5)(A)–(C) and 18 AAC 70.016(c)(7)(A)–(F) are met. The Department's findings under these provisions are as follows:

***Tier 1 Analysis: 18 AAC 70.016(b)(5) the department will not authorize a discharge to a Tier 1 water unless the department finds that***

*(A) existing uses and the water quality necessary for protection of existing uses have been identified based on available evidence, including water quality and use related data, information submitted by the applicant, and water quality and use related data and information received during public comment;*

*(B) existing uses will be maintained and protected; and*

*(C) the discharge will not cause water quality to be lowered further where the department finds that the parameter already exceeds applicable criteria in 18 AAC 70.020(b), 18 AAC 70.030, or 18 AAC 70.236(b).*

The water quality criteria on which the permit effluent limits are based serve the specific purpose of protecting the existing and designated uses of the receiving water. Per 18 AAC 70.020 and 18 AAC 70.050, all waters are protected for all uses; therefore, the most stringent water quality criteria found in 18 AAC 70.020 and in the DEC Toxics manual apply and were evaluated here. This ensures protection of water quality necessary to fully maintain designated and existing uses of the receiving waterbody. As such, existing uses and the water quality necessary for protecting them have been identified in accordance with 18 AAC 70.016(b)(5)(A), because existing uses for Hawk Inlet include all uses.

The permit places limits and conditions on the discharge of pollutants. The Department established the effluent limits after comparing TBELs and WQBELs and applying the more restrictive of these limits. Water quality criteria serve the specific purpose of protecting the existing and designated uses of the receiving water. WQBELs are set equal to the most stringent water quality criteria available for any of the protected water use classes. In accordance with 18 AAC 70.016(b)(5)(B), the new permit ensures that existing uses (i.e. all uses) outside the mixing zone for Hawk Inlet will be maintained and protected because the permit includes numeric effluent limits or continued monitoring, addressing each pollutant of concern.

No parameter for a contaminant of concern in Hawk Inlet exceeds applicable criteria in 18 AAC 70.020(b), 18 AAC 70.030, or 18 AAC 70.236(b). As such, 18 AAC 70.016(b)(5)(C) does not apply.

The Department concludes the terms and conditions of the permit will be adequate to fully protect and maintain the designated and existing uses of the water and that the findings under 18 AAC 70.016(b)(5) are met to authorize a discharge based on a Tier 1 analysis. As explained above, the Department will continue to a Tier 2 analysis because under 18 AAC 70.016(c)(1), Tier 2 is presumed for all water as the default protection level for all parameters unless an exception applies, and here no exception applies.

***Tier 2 Analysis: 18 AAC 70.016(c)(7) [I]f, after review of available evidence, the department finds that the proposed discharge will lower water quality in the receiving water, the department will not authorize a discharge unless the department finds that [the conditions of 18 AAC 70.016(c)(7)(A)–(F) are met].***

Here, the proposed discharge from the facility may lower water quality in Hawk Inlet. Therefore, the Department cannot authorize a discharge unless it makes the following findings. Its analysis of 18 AAC 70.016(c)(7)(A)–(F) follows.

***18 AAC 70.016(c)(7)(A)*** [The department will not authorize a discharge unless it finds that] the reduction of water quality meets the applicable criteria of 18 AAC 70.020(b), 18 AAC 70.030, or 18 AAC 70.236(b), unless allowed under 18 AAC 70.200, 18 AAC 70.210, or 18 AAC 70.240[.]

The permit requires that the discharge shall not cause or contribute to a violation of WQS, except if excursions are authorized within the permit in accordance with provisions in 18 AAC 70.200 – 70.240 (i.e., mixing zone, variance, etc.). WQBELs are set equal to the most stringent water quality criteria available under 18 AAC 70.020(b) for all of the protected water use classes. Because of the nature of the permitted discharges, other pollutants are not expected to be present in the discharges at levels that would cause, have the reasonable potential to cause, or contribute to an exceedance of any WQS. Basing the permit effluent limits on WQS serves to protect existing and designated uses.

As a result of the reasonable potential analysis summarized in APPENDIX 2 of the Fact Sheet, copper, cyanide, lead, mercury, and zinc have reasonable potential to exceed water quality criteria. The mixing zones authorized in the wastewater discharge permit, according to 18 AAC 70.240, utilize the available assimilative capacity in the receiving water. Reduction of water quality within the mixing zones is specifically authorized according to 18 AAC 70.240 and as allowed in 18 AAC 70.015(a)(2).

More information about the authorized mixing zone can be found in Part 6.3 of the Fact Sheet. The resulting effluent end-of-pipe limits and monitoring requirements in the permit, listed in Table 2 of the Fact Sheet, result from applying water quality criteria using conservative statistical methods and assumptions to ensure that water quality criteria found at 18 AAC 70.020 will not be exceeded beyond the boundary of the authorized chronic mixing zone. A smaller acute mixing zone has been authorized in the permit, consistent with 18 AAC 70.240(d)(7), to ensure no lethality to passing organisms occurs.

The permit authorizes a chronic mixing zone for outfall 002 sized for cadmium, copper, cyanide, lead, mercury, zinc, and pH with a dilution factor of 13.3 and a rectangular shape, having a length of 165 feet centered on the diffuser and a width of 100 feet and extending from the marine bottom to the surface. The permit also authorizes a chronic mixing zone for outfall 002A sized for cadmium, copper, cyanide, lead, mercury, zinc, and pH with a dilution factor of 13.3 and a rectangular shape, having a length of 70 feet centered on the diffuser and a width of 90 feet and extending from the marine bottom to the surface. WQS will be met at and beyond the boundary of the authorized chronic mixing zones.

Previous permit data determined that WET limits were not needed, and there was no reason to believe that the characteristics of the discharge would change over the term of the next permit; therefore, monitoring for WET was removed since the previous permit. Since the DEC determined that aquatic life will be adequately protected, the applicable criteria of 18 AAC 70.030 are met.

Friends of Admiralty released a report titled, “*Evaluation of Stable Isotope Ratios and Lead Concentrations in Clam Shells Over Time in Hawk Inlet*”, that compared lead and isotope concentrations

in clam shells taken from Hawk inlet and Young Bay. The report attributes lead concentrations in the butter clams have increased over time due to global increases in lead and more recent lead increases from fugitive dust from the Greens Creek Mine. The report evaluated if discharge authorized under this permit was a contributing factor to lead concentrations in the clam shells and concluded that the discharge from outfall 002 was not a contributing factor.

Site-specific criteria as allowed by 18 AAC 70.235 have not been established for Hawk Inlet, as would be listed in 18 AAC 70.236(b), and are therefore not applicable. The permit does not authorize short term variances or zones of deposit under 18 AAC 70.200 or 18 AAC 70.210; therefore, these provisions do not apply.

The Department concludes that the reduction of water quality meets applicable criteria of both 18 AAC 70.020(b) and 18 AAC 70.030 and is allowable under 18 AAC 70.240. Thus, the finding required under 18 AAC 70.016(c)(7)(A) is met.

***18 AAC 70.016(c)(7)(B) [The department will not authorize a discharge unless it finds that] each requirement under (b)(5) of this section for a discharge to a Tier 1 water is met[.]***

See 18 AAC 70.016(b)(5) analysis and findings above.

***18 AAC 70.016(c)(7)(C) [The department will not authorize a discharge unless it finds that] point source and state-regulated nonpoint source discharges to the receiving water will meet requirements under 18 AAC 70.015(a)(2)(D); to make this finding the department will***

*(i) identify point sources and state-regulated nonpoint sources that discharge to, or otherwise impact, the receiving water;*

*(ii) consider whether there are outstanding noncompliance issues with point source permits or required state-regulated nonpoint source best management practices, consider whether receiving water quality has improved or degraded over time, and, if necessary and appropriate, take actions that will achieve the requirements of 18 AAC 70.015(a)(2)(D); and*

*(iii) coordinate with other state or federal agencies as necessary to comply with (i) and (ii) of this subparagraph[.]*

The requirements under 18 AAC 70.015(a)(2)(D) state:

*(D) all wastes and other substances discharged will be treated and controlled to achieve*

*(i) for new and existing point sources, the highest statutory and regulatory requirements; and*

*(ii) for nonpoint sources, all cost-effective and reasonable best management practices[.]*

Here, 18 AAC 70.015(a)(2)(D)(i) applies because the discharge is a point source. As such, the highest statutory and regulatory requirements for this point source are defined at 18 AAC 70.015(d):

*(d) For purposes of (a) of this section, the highest statutory and regulatory requirements are*

- (1) any federal technology-based effluent limitation identified in 40 C.F.R. 122.29 and 125.3, revised as of July 1, 2017 and adopted by reference;*
- (2) any minimum treatment standards identified in 18 AAC 72.050;*
- (3) any treatment requirements imposed under another state law that is more stringent than a requirement of this chapter; and*
- (4) any water quality-based effluent limitations established in accordance with 33 U.S.C. 1311(b)(1)(C) (Clean Water Act, sec. 301(b)(1)(C)).*

The first part of the definition includes all applicable TBELs including 40 CFR § 440.104 – New source performance standards – Ore mining and dressing point source category, Subpart J – Copper, lead, zinc, gold, silver and molybdenum ores subcategory, adopted by reference at 18 AAC 83.010(g). The TBELs set standards of performance for existing and new sources and are incorporated in the permit.

The second part of the definition references the minimum treatment standards for domestic wastewater discharges found at 18 AAC 72.050. Since the discharge does not include domestic wastewater, this aspect is irrelevant.

The third part of the definition refers to treatment requirements imposed under another state law that are more stringent than 18 AAC 70. Other regulations beyond 18 AAC 70 that apply to this permitting action include 18 AAC 15 and 18 AAC 72. Neither 18 AAC 15 nor 18 AAC 72, nor any other state law that the Department is aware of, impose more stringent requirements than those found in 18 AAC 70.

The fourth part of the definition refers to WQBELs, which are designed to ensure that the WQS of a waterbody are protected and may be more stringent than TBELs. Section 301(b)(1)(C) of the CWA requires the development of limits in permits necessary to meet WQS by July 1, 1977. WQBELs included in APDES permits are derived from EPA-approved WQS. APDES regulation 18 AAC 83.435(a)(1) requires that permits include WQBELs that can achieve water quality standards established under CWA § 303, including state narrative criteria for water quality. The permit requires compliance with the WQS by imposing WQBELs for cadmium, copper, cyanide, lead, mercury, and zinc, and monitoring for other constituents of concern.

In summary, the highest statutory and regulatory requirements that apply to this point source are TBELs and WQBELs. The Department incorporates and requires compliance with both, as relevant to create standards of performance. After review of the methods of treatment and control and the applicable statutory and regulatory requirements, including 18 AAC 70, 18 AAC 72, and 18 AAC 83, the Department finds that the discharge authorized under this general permit meets the highest applicable

statutory and regulatory requirements in applicable TBELs and WQBELs. Therefore, the 18 AAC 70.016(c)(7)(C) finding is met.

**18 AAC 70.016(c)(7)(D)** *[The department will not authorize a discharge unless it finds that] the alternatives analysis provided under (4)(C)–(F) of this subsection demonstrates that*

- (i) a lowering of water quality under 18 AAC 70.015(a)(2)(A) is necessary; when one or more practicable alternatives that would prevent or lessen the degradation associated with the proposed discharge are identified, the department will select one of the alternatives for implementation; and*
- (ii) the methods of pollution prevention, control, and treatment applied to all waste and other substances to be discharged are found by the department to be the most effective and practicable[.]*

The Department finds that a lowering of water quality under 18 AAC 70.015(a)(2)(A) is necessary because the current permitted method of treating discharge is the only practical method in the current state of the project, per the analysis under 18 AAC 70.016(c)(7)(D). The Department considered the most effective and practicable methods of prevention, control, and treatment, which in this case are the practices and requirements set out in the permit that will be applied to all wastes and other substances to be discharged. These findings, discussed further here, satisfy 18 AAC 70.016(c)(7)(D)(i) and (ii).

Water from the underground mine and process water from the mill is treated in the wastewater treatment plants (WWTP) at the 920 Area and pumped to Tank 7 prior to discharge through outfall 002 and 002A or pumped to Pond 7/Pond 10 and then to the Tailings Storage Facility (TSF) WWTP for treatment prior to discharge. This design allows water to be discharged via outfalls without the redundant treatment at the TSF WWTP. The design, construction, and operations of the treatment systems has been reviewed and approved by the Department.

Seepage and runoff from waste rock storage areas 23 and 1350, D and E, Pond C, and Pond D are collected and routed either back to mill for use in mill processed or pumped to the TSF WWTP for treatment prior to discharge. Runoff from B-road and dry tailings disposal facility seepage is collected in Pond 7/Pond 10 then treated at TSF WWTP prior to discharge. The design, construction, and operations of the treatment systems has been reviewed and approved by the Department.

The intercepted groundwater including beneath Pond 7, Pond 10, the TSF, Site 1350, Site 23, the mill backslope, and Hawk Inlet terminal are treated in either the 920 WWTPs or the TSF WWTP prior to discharge. The design, construction, and operations of the treatment systems has been reviewed and approved by the Department.

Sanitary wastes from the mine and mill area (920 Area) and Hawk Inlet terminal area are treated to secondary standards and disinfected in a sequencing batch reactor (SBR) package plant. Treated sanitary wastewater from the Hawk Inlet terminal area will be pumped to the TSF WWTP for additional treatment prior to discharge via Tank 7 or pumped to Pond 7/Pond 10 and then to TST WWTP prior to

discharge. The design, construction, and operations of the treatment systems has been reviewed and approved by the Department.

The Department concludes that the lowering of water quality is necessary under 18 AAC 70.015(a)(2)(A) and determines that the methods of pollution prevention, control, and treatment applied to all waste and other substances to be discharged are the most effective and practicable methods. Therefore, the 18 AAC 70.016(c)(7)(D) finding is met.

*18 AAC 70.016(c)(7)(E) [The department will not authorize a discharge unless it finds that] except if not required under (4)(F) of this subsection, the social or economic importance analysis provided under (4)(G) and (5) of this subsection demonstrates that a lowering of water quality accommodates important social or economic development under 18 AAC 70.015(a)(2)(A)[.]*

The permit applicant provided the Department with economic information to demonstrate that a lowering of water quality accommodates important economic development where the receiving water is located, per 18 AAC 70.016(c)(4)(G) and (5)(B).

Based on a 2017 economic impact report by the McDowell Group, Greens Creek Mine employs an average of 414 workers with total annual wages of \$50.9 million. Juneau residents comprised 47 percent of employees and earned \$24 million in wages. Overall, Alaska residents comprised 66 percent of the workforce and earned \$34 million in wages. Greens Creek employees earned average annual wages of \$122,800 which is more than double the Juneau average of \$51,700. Mine is Juneau's largest private sector employer in terms of annual average, full time employment, and total annual wages. Goods and services spending totaled \$75 million statewide with businesses located in Juneau. Mine property and sales tax generated \$2.4 million in payment to the City and Borough of Juneau. Additionally, Greens Creek Mine pays about \$1.1 million per year to the State of Alaska, predominantly for the Mining License Tax. Mine contributes to Alaska charities and non-profit organizations. Moreover, interruptible power purchase from Alaska Electric Light & Power company helps keep electricity rates low for all Juneau customers. Communities near Juneau also potentially benefit from mine operation in the form of employment, skilled labor education, and training. Moreover, this project offers benefits to the State of Alaska in the form of statewide employment and contracting, as well as revenue generated from mineral royalty and taxes.

The effluent limits in the permit will meet WQS, provide for water quality adequate to protect designated and existing uses, and treat and control discharges by the most effective and reasonable means and to the highest statutory and regulatory requirements. Allowing the discharge is economically important for the City & Borough of Juneau and the State of Alaska.

*18 AAC 70.016(c)(7)(F) [The department will not authorize a discharge unless it finds that] 18 AAC 70.015 and this section have been applied consistent with 33 U.S.C. 1326 (Clean Water Act, sec. 316) with regard to potential thermal discharge impairments.*

Discharges authorized under the permit are not associated with a potential thermal discharge impairment: therefore, further analysis here is not applicable.

## 9.0 ELECTRONIC DISCHARGE MONITORING REPORTS

E-Reporting Rule - Phase I. The permittee must submit a DMR for each month by the 28th day of the following month. DMRs shall be submitted electronically through NetDMR per Phase I of the E-Reporting Rule (40 CFR 127). For access to the NetDMR Portal, go to <https://cdxnodengn.epa.gov/oeca-netdmr-web/action/> login. DMRs submitted in compliance with the E-Reporting Rule are not required to be submitted as described in APPENDIX 1 - Standard Conditions unless requested or approved by the Department. Any DMR data required by the Permit that cannot be reported in a NetDMR field (e.g., full WET Reports, mixing zone receiving water data, etc...), shall be included as an attachment to the NetDMR submittal. DEC has established an e-Reporting Information website at <http://dec.alaska.gov/water/compliance/electronic-reporting-rule/> which contains general information about this new reporting format-

E-Reporting Rule - Phase II (Other Reports). Phase II of the E-Reporting rule will integrate electronic reporting for all other reports required by the Permit (e.g., Annual Reports and Certifications) and implementation is expected to begin during the permit cycle. Permittees should monitor DEC's E-Reporting website at <http://dec.alaska.gov/water/compliance/electronic-reporting-rule/> for updates on Phase II of the E-Reporting Rule and will be notified when they must begin submitting all other reports electronically. Until such time, other reports required by the Permit may be submitted in accordance with APPENDIX 1 Standard Conditions..

## 10.0 OTHER PERMIT CONDITIONS

### 10.1 Standard Permit Provisions

Permit APPENDIX 1 of the Permit contains standard regulatory language that must be included in all APDES permits. These requirements are based on the regulations and cannot be challenged in the context of an individual APDES permit action. The standard regulatory language covers requirements such as monitoring, recording, reporting requirements, compliance responsibilities, signatory authority, and other general requirements.

### 10.2 Quality Assurance Project Plan

The permittee is required to develop procedures to ensure that the monitoring data submitted are accurate and to explain data anomalies if they occur. The permittee is required to develop and implement procedures in a QAPP that documents standard operating procedures the permittee must follow for collecting (e.g., sample collection), handling, storing, and shipping samples; laboratory analysis (e.g., most sensitive methods); and data reporting. If a QAPP has already been developed and implemented, the permittee must review and revise the existing QAPP to ensure it includes the necessary content. The permittee must submit a letter to the Department prior to discharging or within 120 days of the effective date of the Permit

certifying that the QAPP has been revised and implemented. The QAPP shall be retained onsite and made available to the Department upon request.

### **10.3 Best Management Practices Plan**

Under AS 46.03.110 (d), the Department may specify in a permit the terms and conditions under which waste material may be disposed. This permit requires the Permittee to develop a Best Management Practices (BMP) Plan to prevent or minimize the potential for the release of pollutants to waters and lands of the United States through plant-site runoff, spillage or leaks, or erosion. The permit contains conditions that must be included in the BMP Plan. The permit requires the Permittee to develop or update and implement a BMP Plan within 60 days of the effective date of the final permit. The BMP Plan must be kept on site and made available to the Department upon request.

Under 18 AAC 83.475, it authorizes the Department to require Best Management Practices (BMPs) in APDES permits. BMPs are measures that are intended to prevent or minimize the generation and the potential for release of pollutants from industrial facilities to waters of the U.S. These measures are important tools for waste minimization and pollution prevention. HGCMC's 2015 permit required preparation of a BMP Plan. This permit contains general BMP Plan requirements, similar to what is required for most major industrial facilities in Alaska. The permit requires that the BMP Plan be updated as discussed below.

Where BMPs are used in lieu of numeric effluent limits for storm water discharges, the BMPs must demonstrate adequate water quality protection. It is not apparent from the past storm water monitoring that the BMPs currently utilized by HGCMC are protecting the receiving water quality. See Table 13 (Summary of Storm Water Monitoring Data) in APPENDIX 2 , which shows that the storm water discharges have exceeded WQS. Therefore, the permit includes a requirement that HGCMC develop BMPs for each storm water outfall to protect the receiving water quality. The permit includes BMP Plan requirements that are based on the storm water pollution prevention plan (SWPPP) requirements for metal mining facilities (Sector G) in DEC's APDES Storm Water Multi-Sector General Permit (AKR060000). The monitoring required in this permit (Section 5.3), along with periodic inspections, are required to evaluate the effectiveness of BMPs and to provide sufficient information to determine if the storm water discharges cause or contribute to degradation of water quality.

The permit requires that the BMP Plan be maintained and that any modifications to the facility are made with consideration to the effect the modification could have on the generation or potential release of pollutants. The BMP Plan must be revised if the facility is modified or as new pollution prevention practices are developed.

## 11.0 OTHER LEGAL REQUIREMENTS

### 11.1 Endangered Species Act

The Endangered Species Act (ESA) requires federal agencies to consult with the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) if their actions could beneficially or adversely affect any threatened or endangered species.

As a state agency, DEC is not required to consult with these federal agencies regarding permitting actions; however, DEC voluntarily contacted the agencies to notify them of the issuance of this permit and to obtain listings of threatened and endangered species near the discharge. The following responses and information are from USFWS and the NOAA NMFS ESA/Marine Mammal Protection Act (MMPA) species map at the IPaC Information for Planning and Consultation website:

- DEC reviewed the USFWS IPaC website at <https://ecos.fws.gov/ipac/>. The website indicated that the Short-Tailed albatross (*Phoebastria (=diomedea) albatrus*) is found in the project area.
- DEC reviewed the NOAA NMFS MMPA species map <https://www.fisheries.noaa.gov/resource/data/alaska-endangered-species-and-critical-habitat-mapper-web-application> which indicated that the Fin Whale (*Balaenoptera physalus*) is found in the project area.

The antidegradation analysis, found in Section 70, determined that the existing water uses and the level of water quality necessary to protect existing uses will be maintained and protected. In addition, the mixing zone analysis found in section 6.3, the Department confirmed that there will be no lethality to organisms passing through the mixing zone..

### 11.2 Essential Fish Habitat

Essential fish habitat (EFH) includes the waters and substrate (sediments, etc.) necessary for fish from commercially fished species to spawn, breed, feed, or grow to maturity. The Magnuson-Stevens Fishery Conservation and Management Act (January 21, 1999) requires federal agencies to consult with NOAA when a discharge has the potential to adversely affect (reduce quality and/or quantity of) EFH. As a state agency, DEC is not required to consult with federal agencies regarding permitting action; however, DEC consulted with NOAA's EFH online mapper and found the project zone was EFH for Chinook, Chum, Pink, Sockeye, and Coho Salmon but no Habitat Areas of Particular Concern for Hawk Inlet. The Alaska Department of Fish and Game's Fish Passage website at <http://www.adfg.alaska.gov/index.cfm?adfg=fishpassage.database> revealed that Hawk Inlet is an EFH.

Dr. James Balsiger of the National Marine Fisheries Services provided a scoping comment letter dated November 24, 2022, on the HGCMC North Extension Project Supplemental Environmental Impact Statement (SEIS) which identified Hawk Inlet as EFH for twelve federally-managed Gulf of Alaska fish, including Pacific cod, Walleye pollock, Sablefish, Pacific ocean perch, Yellowfin sole, Northern rock sole, Southern rock sole, Alaska plaice, Dover sole, Flathead sole, Rex sole, and Arrowtooth flounder.

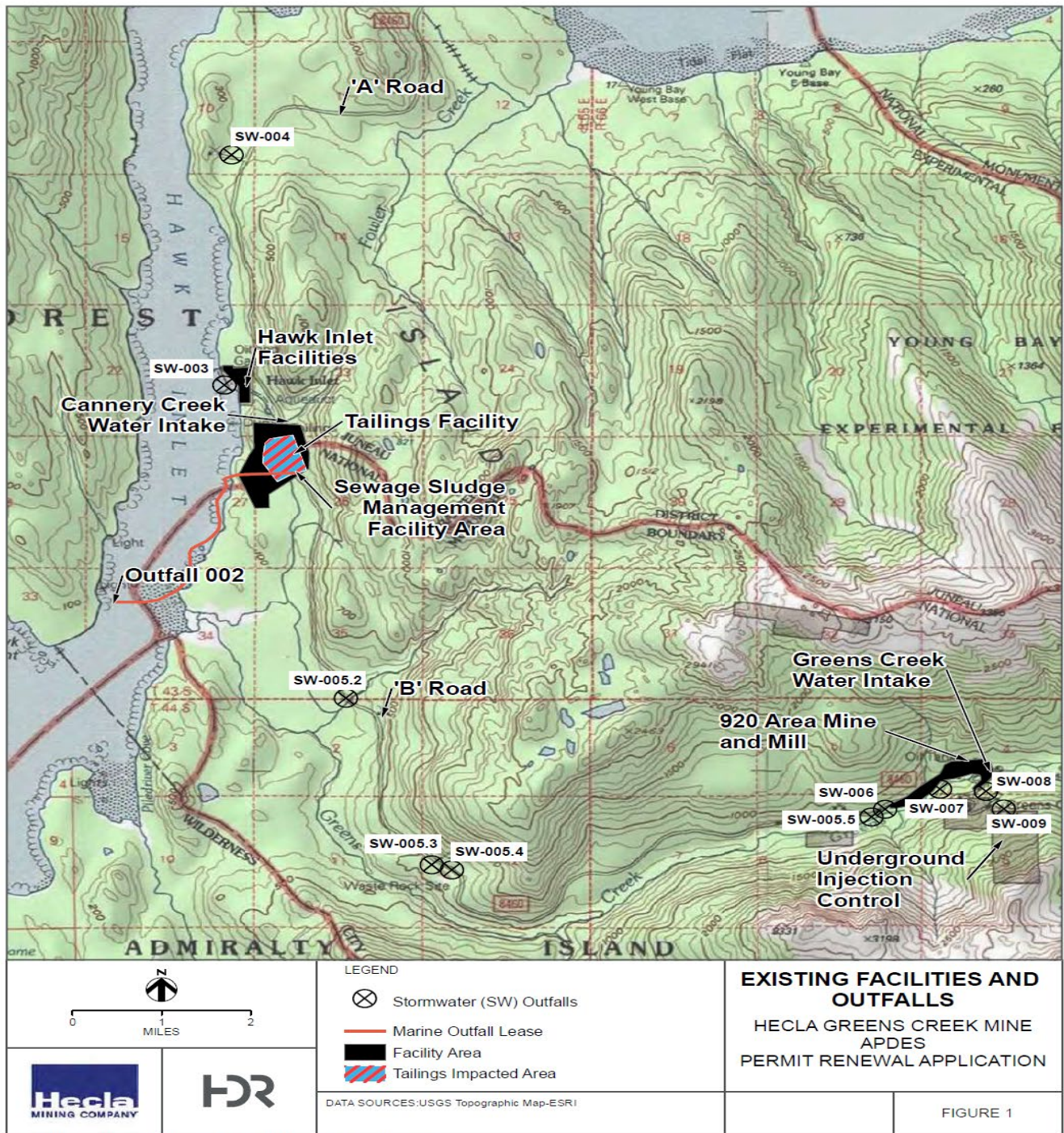
## **12.0 Permit Expiration**

The permit will expire five years from the effective date of the permit.

## 13.0 References

- Alaska Department of Environmental Conservation, 2003. Alaska Water Quality Criteria Manual for Toxics and Other Deleterious Organic and Inorganic Substances, as amended through December 12, 2008.
- Alaska Department of Environmental Conservation, 2020. Alaska's Final 2020 Integrated Water Quality Monitoring and Assessment Report, May 17, 2020.
- Alaska Department of Environmental Conservation, 2020 Water Quality Standards, Amended March 5, 2020.
- Alaska Department of Fish and Game, 2021. Fish Passage Website, <http://www.adfg.alaska.gov/index.cfm?adfg=fishpassage.database>
- HDR Consulting, 2019. Final Environmental Audit of the Greens Creek Mine. January 2019.
- HGCMC, 2017. Hawk Inlet Monitoring Program 2011 Annual Report. March 2018
- HGCMC, 2020. Hawk Inlet Monitoring Program 2011 Annual Report. March 2021
- NMFS, Office of Habitat Conservation, 2013. Essential Fish Habitat Mapper v3.0. Retrieved from <http://www.habitat.noaa.gov/protection/efh/habitatmapper.html>.
- NOAA, Bathymetric Data Viewer at <https://www.ncei.noaa.gov/maps/bathymetry/>
- SRK Consulting, 2009. Environmental Audit of the Greens Creek Mine. March 2009.
- U.S. Environmental Protection Agency. 1991. Technical Support Document for Water Quality-based Toxics Control. Office of Water Enforcement and Permits, Office of Water Regulations and Standards. Washington DC, March 191. EPA/505/2-90-001.
- U.S. Fish and Wildlife Service IPaC website, 2021. <https://ecos.fws.gov/ipac/>.

Figure 1: Facility Map



PATH: Q:\WATER\_MISC\ALASKA\HECLA\MAP\_DOCUMENTS\VICINITY\TOPOMAP.MXD - USER: BRJONES - DATE: 4/1/2020

Figure 2: Hawk Inlet Monitoring Sites



Figure 3: Mixing Zone for Outfall 002

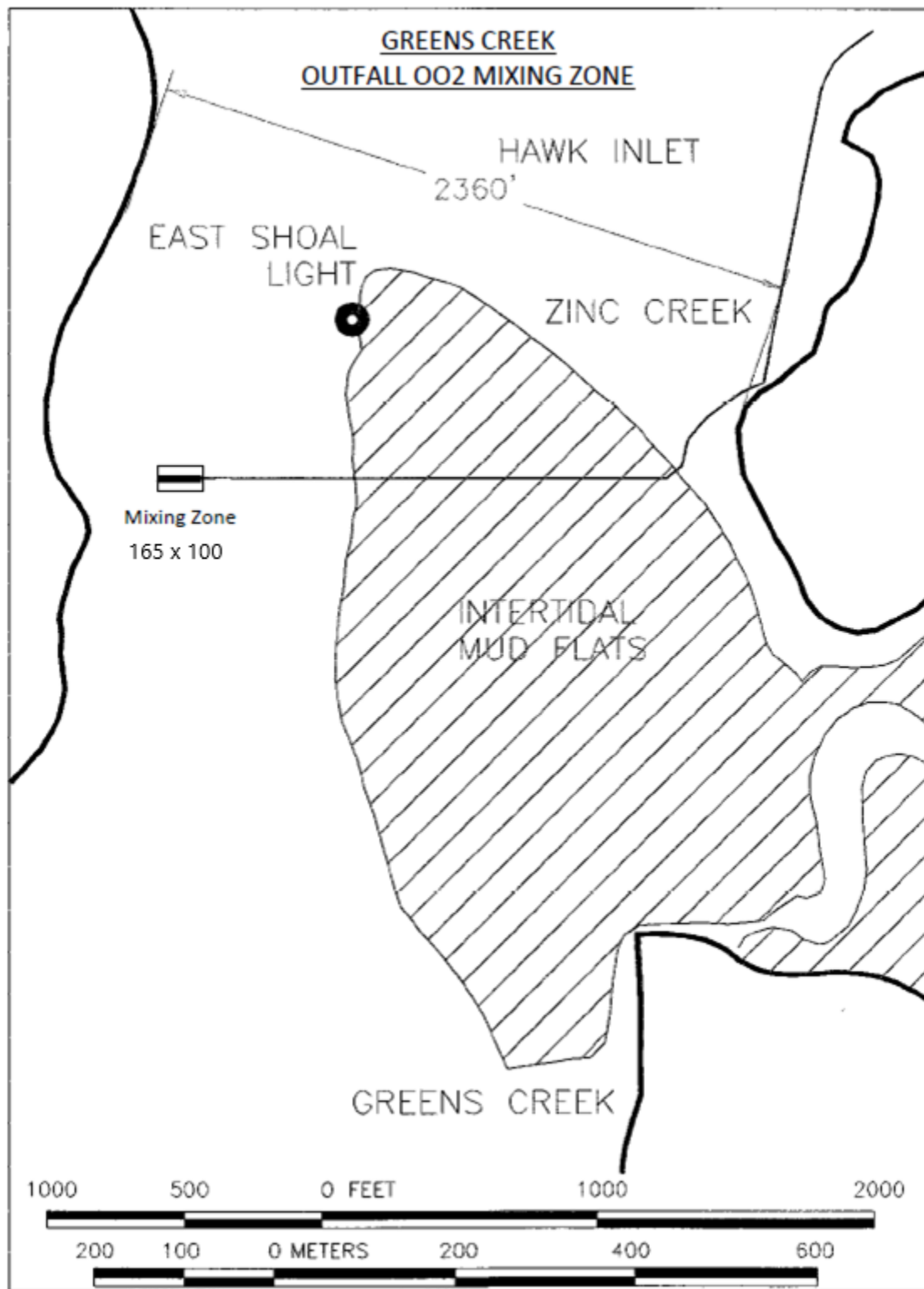


Figure 4: Outfall 002a



**APPENDIX 1 FACILITY INFORMATION**

| APPENDIX F FACILITY INFORMATION |                                                                                                                          |                              |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Facility Name and Location      |                                                                                                                          |                              |
| Name:                           | Hecla Greens Creek Mine                                                                                                  |                              |
| APDES ID Number:                | AK0043206                                                                                                                |                              |
| Location:                       | 18 miles southwest of Juneau on Admiralty Island                                                                         |                              |
| Mailing Address:                | P.O. Box 32199<br>Juneau, AK 99803                                                                                       |                              |
| Facility Background:            | The facility’s previous permit was effective October 1, 2015. The current permit application was received April 8, 2020. |                              |
| Non-Domestic System Information |                                                                                                                          |                              |
| Treatment Train:                | Degrit basins, settling pond, chemical precipitation, and pressure filtration                                            |                              |
| Design Flow:                    | 6.33 million gallons per day                                                                                             |                              |
| Existing Flow:                  | 4.6 million gallons per day                                                                                              |                              |
| Months when Discharge Occurs:   | Year round                                                                                                               |                              |
| Outfall 002 Location:           | Latitude: 58° 06' 06" North                                                                                              | Longitude: 134° 46' 30" West |
| Outfall 002A Location:          | Latitude: 58° 07' 23" North                                                                                              | Longitude: 134° 45' 35" West |
| Receiving Waterbody Information |                                                                                                                          |                              |
| Receiving Waterbody:            | Hawk Inlet                                                                                                               |                              |

## **APPENDIX 2: BASIS FOR EFFLUENT LIMITS**

This section discusses the basis for and the development of effluent limits in the permit. This section includes: an overall discussion of the statutory and regulatory basis for development of effluent limitations (Section I); discussions of the development of technology-based effluent limits (Section II) and water quality-based effluent limits (Section III); and a summary of the effluent limits developed for this permit (Section IV).

### **I. Statutory and Regulatory Basis for Limits**

Sections 101, 301(b), 304, 308, 401, 402, and 405 of the Clean Water Act (CWA) provide the basis for the effluent limitations and other conditions in the permit. The Department evaluates the discharges with respect to these sections of the CWA and the relevant Alaska Pollutant Discharge Elimination System (APDES) regulations to determine which conditions to include in the permit.

In general, the Department first determines if any federally-promulgated technology-based effluent limits have been developed that must be considered as the base or floor for permit limits. The Department then evaluates the effluent quality expected to result from these controls to see if the discharge could result in any exceedances of the water quality standards (WQS) in the receiving water. If reasonable potential exists that exceedances could occur, the Department must include water quality-based effluent limits in the permit. The permit limits reflect whichever requirements (technology-based or water quality-based) are more stringent. For outfalls 002 and 002A, a mixing zone was requested. In authorizing a mixing zone for outfalls 002 and 002A, the Department considered “the characteristics of the effluent, including volume, flow rate, dispersion, and quality after treatment,” as required by 18 AAC 70.240(b)(2). Water quality-based and technology-based analyses were performed to determine the most stringent limits. In conducting the water quality-based analysis, the tailings storage facility’s wastewater treatment plant performance in conjunction with CORMIX modeling were used to determine dilution necessary and available to meet all WQS at and beyond the mixing zone’s boundary.

### **II. Outfalls 002 and 002A- Technology-Based Evaluation**

Section 301(b) of the CWA requires industrial dischargers to meet technology-based effluent limitation guidelines (ELGs) established by EPA. ELGs are enforceable through their incorporation into an APDES permit. For dischargers in industrial categories for which EPA has not yet issued an ELG, and for types of discharges not covered by an applicable ELG, best professional judgment is used to establish technology-based effluent limits. The 1972 amendments to the CWA established a two-step approach for imposing technology-based controls. In the first phase, industrial dischargers were required to meet a level of pollutant control based on the best practicable control technology currently available (BPT). The second level of pollutant control was based on the best available technology economically achievable (BAT). In 1977, enactment of Section 301(b)(2)(E) of the CWA allowed the application of best conventional pollutant control technology (BCT) to supplement BPT standards for conventional pollutants with cost effectiveness constraints on incremental technology requirements that exceed BPT. The BPT/BAT/BCT system of standards does not apply to a new source, which is defined by EPA as a source, the construction of which is commenced after the publication of proposed regulations

prescribing a standard of performance, which will be applicable to the source. Direct dischargers that are new sources must meet New Source Performance Standards (NSPS), which are based on the best available demonstrated control technology.

At 40 CFR Part 440, EPA has established ELGs for the Ore Mining and Dressing Point Source Category. Subpart J of these guidelines, titled *Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory*, became effective on December 3, 1982. ELGs are applicable to mines that produce gold bearing ores from open-pit or underground operations and to mills that use the froth-flotation process, alone or in conjunction with other processes, for the beneficiation of gold. At 40 CFR §440.104 NSPS are used to provide the technology-based effluent limitations for cadmium, copper, lead, mercury, zinc, total suspended solids (TSS) and pH. The BAT (40 CFR 440.103) and BPT (40 CFR 440.102) ELGs that apply to the Greens Creek Mine discharges are shown in the Table 9.

**Table 9: Outfalls 002 & 002A - Technology Based Effluent Limits**

| Parameter     | Daily Maximum              | Monthly Average |
|---------------|----------------------------|-----------------|
| Cadmium, µg/L | 100                        | 50              |
| Copper, µg/L  | 300                        | 150             |
| Lead, µg/L    | 600                        | 300             |
| Mercury, µg/L | 2                          | 1               |
| Zinc, µg/L    | 1,000                      | 500             |
| TSS, mg/L     | 30                         | 20              |
| pH, s.u.      | within the range 6.0 - 9.0 |                 |

### III. Water Quality-Based Evaluation

In addition to the technology-based limits discussed above, the Department evaluated the Greens Creek Mine discharges to determine compliance with Section 301(b)(1)(C) of the CWA. This section requires permit limits necessary to meet WQS by July 1, 1977.

Under 18 AAC 83.435, the Department must implement section 301(b)(1)(C) of the CWA. Under 18 AAC 83.435(b), it requires that APDES permits include limits for all pollutants or parameters which “are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality.” The limits must be stringent enough to ensure that WQS are met and must be consistent with any available wasteload allocation (WLA).

To determine if water quality-based limits are needed and develop those limits when necessary, the Department follows guidance in the *Technical Support Document for Water Quality-based Toxics Control* (TSD, EPA 1991). The water quality-based analysis consists of the following four step sequence:

1. Identify the applicable water quality criteria (see Section III.A);
2. Determine if there is “reasonable potential” for the discharge to exceed a water quality criterion in the receiving water (see Section III.B);

3. If there is “reasonable potential” or where a parameter has a technology-based limit and it requires dilution to meet WQS, develop effluent limits based on the waste load allocation (WLA) (see Section III.C).

The following sections provide a detailed discussion of each step.

#### A. Water Quality Criteria

The first step in determining if water quality-based limits are needed is to identify the applicable water quality criteria. Alaska’s WQS are found at 18 AAC 70. The applicable criteria are determined based on the beneficial uses of the receiving water.

The beneficial uses for Hawk Inlet, the receiving waters of outfalls 002 and 002A and storm water outfall 003, and the regulatory citation of the water quality criteria applicable to the uses are as follows:

- aquaculture water supply - 18 AAC 70.020(b)(2)(A)(i)
- seafood processing - 18 AAC 70.020(b)(2)(A)(ii)
- industrial uses - 18 AAC 70.020(b)(2)(A)(iii)
- contact recreation - 18 AAC 70.020(b)(2)(B)(i)
- secondary recreation - 18 AAC 70.020(b)(2)(B)(ii)
- growth and propagation of fish, shellfish, other aquatic life and wildlife - 18 AAC 70.020(b)(2)(C)
- harvesting for consumption of raw mollusks or other raw aquatic life - 18 AAC 70.020(b)(2)(D)

The beneficial uses for wetlands, Zinc Creek and Greens Creek, the receiving waters of storm water outfalls 004 through 009 and 012, and the regulatory citation for the water quality criteria applicable to the uses are as follows:

- domestic water supply - 18 AAC 70.020(b)(1)(A)(i)
- agriculture water supply - 18 AAC 70.020(b)(1)(A)(ii)
- aquaculture water supply - 18 AAC 70.020(b)(1)(A)(iii)
- industrial uses - 18 AAC 70.020(b)(1)(A)(iv)
- contact recreation - 18 AAC 70.020(b)(1)(B)(i)
- secondary recreation - 18 AAC 70.020(b)(1)(B)(ii)
- growth and propagation of fish, shellfish, other aquatic life, and wildlife - 18 AAC 70.020(b)(1)(C)

For a given pollutant, different uses may have different criteria. To protect all beneficial uses, the reasonable potential analysis and permit limits are based on the most stringent water quality criteria for protecting those uses. For Hawk Inlet, the most stringent applicable WQS are summarized in Table 10. The most stringent applicable WQS for wetlands, Greens Creek, and Zinc Creek are summarized in Table 11.

**Table 10: Most Stringent of the Water Quality Criteria Applicable to Greens Creek Mine Discharges into Hawk Inlet (outfalls 002, 002A, 003, & 012)**

| Parameter<br>(µg/L unless otherwise noted)                                                                                                                             | Acute Aquatic Life Criterion                                                                                                               | Chronic Aquatic Life Criterion | Human Health Criterion <sup>c</sup> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------------|
| Cadmium (TR) <sup>a, b</sup>                                                                                                                                           | 40.28                                                                                                                                      | 8.85                           | na                                  |
| Copper (TR) <sup>a, b</sup>                                                                                                                                            | 5.8                                                                                                                                        | 3.7                            | na                                  |
| Lead (TR) <sup>a, b</sup>                                                                                                                                              | 217.16                                                                                                                                     | 8.47                           | na                                  |
| Mercury (total) <sup>b</sup>                                                                                                                                           | 2.062                                                                                                                                      | 1.106                          | 0.051                               |
| Zinc (TR) <sup>a, b</sup>                                                                                                                                              | 95.1                                                                                                                                       | 86.14                          | 69,000                              |
| WAD cyanide                                                                                                                                                            | 1.0                                                                                                                                        | 1.0                            | 220,000                             |
| pH (s.u.)                                                                                                                                                              | within the range of 6.5 - 8.5                                                                                                              |                                |                                     |
| Fecal coliform bacteria (FC)                                                                                                                                           | the FC median Most Probably Number (MPN) may not exceed 14 FC/100 mL and not more than 10% of the samples may exceed a MPN of 43 FC/100 mL |                                |                                     |
| Notes:                                                                                                                                                                 |                                                                                                                                            |                                |                                     |
| a. TR = total recoverable                                                                                                                                              |                                                                                                                                            |                                |                                     |
| b. Standards for metals have been converted from dissolved to total recoverable by dividing the dissolved criterion by the conversion factor identified in regulation. |                                                                                                                                            |                                |                                     |
| c. Human health criterion for consumption of aquatic organisms                                                                                                         |                                                                                                                                            |                                |                                     |

**Table 11: Most Stringent of the Water Quality Criteria Applicable to Greens Creek Mine Discharges into wetlands, Greens Creek, & Zinc Creek (outfall 004 through 009)**

| Parameter <sup>a</sup><br>(µg/L unless otherwise noted)                                                                                                                                                                                                                                                                                                                                                                                                                                             | Acute Aquatic Life Criterion <sup>b</sup> | Chronic Aquatic Life Criterion <sup>b</sup> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------|
| Lead <sup>c</sup> (TR)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 26                                        | 1.0                                         |
| Zinc <sup>c</sup> (TR)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 56                                        | 56                                          |
| pH (s.u.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | within the range of 6.5 - 8.5             |                                             |
| Notes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                           |                                             |
| a. TR = total recoverable. Lead, zinc, and pH were included in this table since these are the only parameters for which there are storm water monitoring data.                                                                                                                                                                                                                                                                                                                                      |                                           |                                             |
| b. The standards for metals have been converted from dissolved to total recoverable by dividing the dissolved criteria by the conversion factor identified in regulation.                                                                                                                                                                                                                                                                                                                           |                                           |                                             |
| c. The lead and zinc criteria depend upon hardness, measured as mg/L CaCO <sub>3</sub> . The 15 <sup>th</sup> percentile hardness of the receiving water is used to calculate the criteria since it is a reasonably conservative value protective under most conditions. The 15 <sup>th</sup> percentile hardness at Greens Creek background Site 48 is 41 mg/L CaCO <sub>3</sub> based on data collected from October 2006 through September 2011. Hardness data was not available for Zinc Creek. |                                           |                                             |

## B. Reasonable Potential Analysis

### 1. Outfalls 002 and 002A

The Department compared the maximum projected receiving water concentration to the criteria for that pollutant to determine if there is “reasonable potential” to cause or contribute to an exceedance of water quality criteria for each pollutant present in the discharge. If the projected receiving water concentration exceeds the criterion, there is “reasonable potential”, and a limit must be included in the permit. The Department used the recommendations in Chapter 3 of the TSD to conduct the reasonable potential analysis.

This section discusses how reasonable potential was evaluated for outfall 002. Because of the extreme variability of the data from the storm water outfalls, the need for effluent limits for storm water was determined separately. The storm water analysis is provided in Section III.C.

The maximum projected receiving water concentration was determined using the following mass balance equation, for discharge to the mixing zone in marine waters:

$$C_d = C_u + ((C_e - C_u)/D)$$

where,  $C_d$  = maximum projected receiving water concentration at the edge of the mixing zone

$C_e$  = maximum expected effluent concentration

$C_u$  = background concentration of pollutant

$D$  = dilution in mixing zone

Where no mixing zone is allowed:  $C_d = C_e$

After  $C_d$  is determined, it is compared to the applicable water quality criterion. If it is greater than the criterion, a water quality-based effluent limit is developed for that parameter. The following discusses each of the factors used in the mass balance equation to calculate  $C_d$ .

$C_e$  (maximum expected effluent concentration or MEC): Per the TSD, the maximum expected effluent concentration in the mass balance equation was represented by the 99th percentile of the effluent data. The 99th percentile was calculated using the statistical approach recommended in the TSD, i.e., by multiplying the maximum observed effluent concentration by a reasonable potential multiplier (RPM):

$$C_e = (\text{maximum observed effluent concentration}) \times \text{RPM}$$

The RPM accounts for uncertainty in the effluent data. The RPM depends upon the amount of effluent data and variability of the data as measured by the coefficient of variation (CV) of the data. When there are not enough data to reliably determine a CV, the TSD recommends using 0.6 as a default value. Once the CV of the data was determined, the RPM was determined using the statistical methodology discussed in section 3.3 of the TSD. In this procedure, RPMs with a 95% confidence level and a 99% probability were calculated. See Table 12 for a summary of the maximum reported effluent concentrations, CVs, and RPMs used in the reasonable potential analysis.

C<sub>u</sub> (background concentration of pollutant): The ambient concentration in the mass balance equation is based on a reasonable worst-case estimate of the background pollutant concentration. Where sufficient data exists, the 85<sup>th</sup> percentile of the ambient data is generally used as an estimate of worst-case. The C<sub>u</sub> used for each parameter is provided in Table 12.

D (dilution): A mixing zone is defined as a limited area or volume of water where the discharge plume is progressively diluted by the receiving water. WQS may be exceeded in the mixing zone as long as acutely toxic effects are prevented from occurring and the applicable existing designated uses of the waterbody are not impaired as a result of the mixing zone. A mixing zone is authorized at the discretion of the Department based on the WQS regulations.

The WQS allow for the use of mixing zones and the 18 AAC 70.240 provides conditions for mixing zones. The standards allow water quality within a mixing zone to exceed chronic water quality criteria so long as chronic water quality criteria are met at the boundary of the mixing zone. Acute water quality criteria may be exceeded within a zone of initial dilution inside the chronic mixing zone.

Outfall 002 and outfall 002A: The Department authorized a mixing zone for outfall 002 representing 1 part effluent to 13.27 parts receiving water for a dilution factor of 14.27.

Reasonable Potential Summary: Results of the reasonable potential analysis for outfall 002 are provided in Table 12. Water quality-based limits were not needed for mercury (monthly average), cyanide, or fecal coliform bacteria in outfall 002.

**Table 12: Reasonable Potential Determination for Outfall 002**

| Parameter <sup>a</sup><br>(µg/L unless<br>otherwise<br>noted) | Effluent Data                                     |                                                     |                                      |                                                             |                                                            | Background<br>Receiving<br>Water<br>Conc. (C <sub>u</sub> ) <sup>g</sup> | Max<br>Projected<br>Receiving<br>Water<br>Conc. (C <sub>d</sub> ) | Reasonable<br>Potential <sup>h</sup><br>(yes or no) |
|---------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------------|--------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------|
|                                                               | Max<br>Observed<br>Effluent<br>Conc. <sup>b</sup> | Coefficient<br>of<br>Variation<br>(CV) <sup>c</sup> | Number<br>of<br>Samples <sup>d</sup> | Reasonable<br>Potential<br>Multiplier<br>(RPM) <sup>e</sup> | Max<br>Expected<br>Effluent<br>Conc.<br>(MEC) <sup>f</sup> |                                                                          |                                                                   |                                                     |
| Cadmium                                                       | 1.88                                              | 1.4783                                              | 269                                  | 1.0                                                         | 1.90                                                       | 1.327                                                                    | 1.36                                                              | no                                                  |
| Copper                                                        | 6.89                                              | 1.0763                                              | 269                                  | 1.0                                                         | 6.97                                                       | 0.560                                                                    | 0.98                                                              | yes                                                 |
| Lead                                                          | 110.80                                            | 0.7724                                              | 269                                  | 1.0                                                         | 111.98                                                     | 1.270                                                                    | 8.46                                                              | yes                                                 |
| Cyanide as<br>WAD CN                                          | 5.00                                              | 0.6000                                              | 222                                  | 1.1                                                         | 5.32                                                       | 0.150                                                                    | 0.49                                                              | yes                                                 |
| Mercury                                                       | 0.30                                              | 0.1717                                              | 269                                  | 1.0                                                         | 0.30                                                       | 0.008                                                                    | 0.03                                                              | yes                                                 |
| Zinc                                                          | 362                                               | 1.0342                                              | 269                                  | 1.0                                                         | 366.25                                                     | 12.921                                                                   | 35.84                                                             | yes                                                 |

**Notes:**

- Parameters where there are applicable water quality criteria and effluent monitoring data available.
- The maximum observed effluent concentrations are based on effluent samples collected by HGCMC from May 2016 through April 2021.
- The CV is calculated as the standard deviation of the data divided by the mean. The CVs for cadmium, copper, lead, mercury, and zinc were calculated based on outfall 002 effluent samples collected by HGCMC from May 2016 through April 2021. The vast majority of the effluent data available for cyanide during the same period was reported at less than method detection limits; therefore effluent-specific variability cannot be determined, so a default CV of 0.6 was used.
- The number of samples is used to develop the RPM.
- The RPM is based on the CV and the number of data points.
- For each parameter, the MEC equals the maximum observed effluent concentration times the RPM producing a number based on water treatment plant performance for determining if there is a reasonable potential to exceed WQS in the receiving water outside the mixing zone.
- According to Section 2.5.3 of RPA Guidance (2014), the receiving water concentrations are assigned as 15% of the most stringent applicable water quality criterion. Cadmium is an exception because its MEC is less than the most stringent applicable water quality criterion. Consequently, there is no reasonable potential for cadmium to exceed WQS at the end-of-pipe and no mixing zone dilution needed.
- Reasonable potential is evaluated at the mixing boundary, and it exists if C<sub>d</sub> exceeds the most stringent applicable water quality criterion in Table 10.

## 2. Water Quality Analysis for Storm Water Outfalls

HGCMC monitors the storm water twice per year during storm events. The results of storm water monitoring are summarized in Table 13.

**Table 13: Summary of Storm Water Monitoring Data**

| Outfall                                                                                                                                                                                                                                | Receiving Water | n | Flow<br>(gpm) |       | pH<br>(s.u.) |      | TSS<br>(mg/L) |       | Hardness<br>(mg/L as CaCO <sub>3</sub> ) |      | Oil & Grease<br>(mg/L) |      | Lead<br>(µg/L) |         | Zinc<br>(µg/L) |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---------------|-------|--------------|------|---------------|-------|------------------------------------------|------|------------------------|------|----------------|---------|----------------|-------|
|                                                                                                                                                                                                                                        |                 |   | Min.          | Max.  | Min.         | Max. | Min.          | Max.  | Min.                                     | Max. | Min.                   | Max. | Min.           | Max.    | Min.           | Max.  |
| 003                                                                                                                                                                                                                                    | Hawk Inlet      | 9 | 0.2           | 4.5   | 7.04         | 7.98 | <5            | 283   | 101                                      | 207  | <2.0                   | <1.8 | 1.8            | 302.0   | 40             | 580   |
| 004 <sup>2</sup>                                                                                                                                                                                                                       | Wetlands        |   |               |       |              |      |               |       |                                          |      |                        |      |                |         |                |       |
| 005.2                                                                                                                                                                                                                                  | Zinc Creek      | 7 | 0.3           | 5.0   | 3.76         | 4.69 | <5            | 17    | 26                                       | 78   | <2.1                   | <1.9 | 3.9            | 9.1     | 28             | 168   |
| 005.3                                                                                                                                                                                                                                  | Greens Creek    | 9 | 10.0          | 400.0 | 6.83         | 7.78 | <5            | 218   | 114                                      | 360  | <2.3                   | 3.0  | 2.6            | 151.5   | 231            | 976   |
| 005.4                                                                                                                                                                                                                                  | Greens Creek    | 9 | 0.1           | 3.0   | 6.55         | 7.51 | <5            | <5    | 36                                       | 90   | <2.0                   | <1.9 | <0.1           | 1.3     | <6             | 14    |
| 005.5                                                                                                                                                                                                                                  | Greens Creek    | 6 | 0.3           | 11.0  | 7.43         | 8.51 | <5            | 3,010 | 67                                       | 509  | <2.0                   | 4.3  | 777.0          | 4,860.0 | 952            | 5,750 |
| 006                                                                                                                                                                                                                                    | Greens Creek    | 1 | 500.0         | 500.0 | 7.41         | 7.41 | 201           | 201   | 352                                      | 352  | NA                     | NA   | 373.2          | 373.2   | 1,040          | 1,040 |
| 007 <sup>2</sup>                                                                                                                                                                                                                       | Greens Creek    |   |               |       |              |      |               |       |                                          |      |                        |      |                |         |                |       |
| 008                                                                                                                                                                                                                                    | Greens Creek    | 9 | 2.0           | 24.0  | 6.81         | 7.86 | <5            | 6     | 159                                      | 234  | NA                     | NA   | <0.1           | 2.0     | 18             | 58    |
| 009                                                                                                                                                                                                                                    | Greens Creek    | 9 | 1.0           | 10.0  | 7.10         | 7.59 | <5            | 5     | 67                                       | 119  | NA                     | NA   | <0.1           | 2.0     | 125            | 936   |
| Notes:<br><sup>1</sup> This table is based on samples collected by the Permittee biannually during storm events from October 2015 through September 2020.<br><sup>2</sup> No discharge was occurred during the storm events monitored. |                 |   |               |       |              |      |               |       |                                          |      |                        |      |                |         |                |       |

Comparing the lead and zinc data in Table 13 with the water quality criteria in Table 10 and Table 11 shows that the discharges from outfalls 003 through 009 have exceeded the water quality criteria at some time. However, numeric effluent limits were not developed for the individual storm water outfalls. This is due to the difficulty in developing numeric limits for storm water discharges that are intermittent and extremely variable in flow and variable in pollutant concentrations as well as the uncertainty regarding the effect of the storm water outfalls on the receiving waters.

Rather than develop numeric effluent limits for each storm water outfall, the permit requires the permittee to implement corrective action if a storm water discharge exceeds a water quality criterion and results in a statistically significant reduction in receiving water quality. Also, the permit requires development of outfall-specific best management practices (BMPs). APDES regulations, 18 AAC 83.475, require the use of BMPs where development of numeric effluent limits is infeasible.

### C. Water Quality–Based Effluent Limit Calculation

Once the Department determines that the effluent has a reasonable potential to exceed WQS at the end-of-pipe (comparing the MEC in Table 12 to the WQS in Table 10) or a parameter has a technology-based limit that exceeds WQS, a water quality-based effluent limit for the pollutant is developed. The first step in calculating a permit limit is development of a WLA for the pollutant.

### Mixing Zone Based WLA

When the Department authorizes a mixing zone for the discharge, the WLA is calculated using the available dilution, background concentrations of the pollutant, and the WQS.

Acute and chronic aquatic life standards apply over different time frames and may have different mixing zones; therefore it is not possible to compare the WLAs directly to determine which standard results in the most stringent limits. The acute criteria are applied as a one-hour average and may have a smaller mixing zone, while the chronic criteria are applied as a four-day average and may have a larger mixing zone. To allow for comparison, long-term average (LTA) loads are calculated from both the acute and chronic WLAs. The most stringent LTA is used to calculate the permit limits.

### End-of-Pipe WLAs

In many cases, there is no dilution available, either because the receiving waterbody exceeds the criteria or because the Department does not authorize a mixing zone for a particular pollutant. When there is no dilution available, the criterion becomes the WLA. Establishing the criterion as the WLA ensures that the Permittee's discharge does not contribute to an exceedance of the criterion. As with the mixing-zone based WLA, the acute and chronic criteria must be converted to LTAs and compared to determine which one is more stringent. The more stringent LTA is then used to develop permit limits.

### Permit Limit Derivation

Once the appropriate LTA has been calculated, the Department applies the statistical approach described in Chapter 5 of the *TSD* to calculate maximum daily and average monthly permit limits. This approach takes into account effluent variability [using the Coefficient Variation (CV)], sampling frequency, and the difference in time frames between the average monthly and maximum daily limits.

The maximum daily limit is based on the CV of the data and the probability basis, while the average monthly limit is dependent on these two variables and the monitoring frequency. As recommended in the *TSD*, the Department used a probability basis of 95 percent for average monthly limit calculation and 99 percent for the maximum daily limit calculation.

The following is a summary of the steps to derive water quality-based effluent limits. Lead is used as an example.

### **Step 1- Determine the WLA**

The acute and chronic aquatic life criteria are converted to acute and chronic WLAs ( $WLA_{acute}$  or  $WLA_{chronic}$ ) using the following equation:

1.  $Q_d C_d = Q_e C_e + Q_u C_u$   
 $Q_d$  = total flow =  $Q_u + Q_e$   
 $C_d$  = most stringent WQS that cannot be exceeded outside the mixing zone  
 $Q_e$  = effluent flow

$C_e$  = concentration of pollutant in effluent =  $WLA_{acute}$  or  $WLA_{chronic}$

$Q_u$  = background flow

$C_u$  = background concentration of pollutant

Rearranging the above equation to determine the effluent concentration ( $C_e$ ) or WLA results in the following:

$$2. \quad C_e = WLA = \frac{Q_d C_d - Q_u C_u}{Q_e} = \frac{C_d(Q_u + Q_e) - Q_u C_u}{Q_e}$$

With a 14.4: 1 chronic dilution ratio and  $C_u$  equal to 1.2705, this equation becomes:

$$3. \quad C_e = WLA = \frac{C_d(14.4 + 1) - (14.4 * 1.2705)}{1}$$

$$4. \quad WLA = (C_d * 15.4) - 18.3$$

For example, the lead chronic WLA, the calculation is:

$$C_e = WLA_{chronic} = (8.47 * 15.4) - 18.3 = 112$$

For lead, the acute WLA with an acute dilution ratio equal to 5.1: 1, the calculation is:

$$C_e = WLA_{acute} = (217.16 * (5.1 + 1)) - (5.1 * 1.2705) = 1318.2$$

### **Step 2 - Determine the Long-Term Average (LTA)**

$$LTA_{acute} = WLA_{acute} * e^{(0.5\sigma^2 - z\sigma)}$$

where,

$$\sigma^2 = \ln(CV^2 + 1)$$

$$\sigma^2 = \ln(0.7724^2 + 1)$$

$$\sigma^2 = 0.4679$$

$$z = 2.326 \text{ for } 99^{th} \text{ percentile probability basis}$$

$$LTA_{acute} = 339.3$$

$$LTA_{chronic} = WLA_{chronic} * e^{(0.5\sigma^2 - z\sigma)}$$

where,

$$\sigma^2 = \ln\left(\frac{CV^2}{4} + 1\right)$$

$$\sigma^2 = \ln\left(\frac{0.7724^2}{4} + 1\right)$$

$$\sigma^2 = 0.139$$

$$z = 2.326 \text{ for } 99^{\text{th}} \text{ percentile probability basis}$$

$$LTA_{\text{chronic}} = 50.4$$

### **Step 3 - Most Limiting LTA**

To protect a waterbody from both acute and chronic effects, the more limiting of the calculated  $LTA_{\text{acute}}$  and  $LTA_{\text{chronic}}$  is used to derive the effluent limitations.  $LTA_{\text{chronic}}$  is the most limiting LTA.

### **Step 4 - Calculate the Permit Limits**

The TSD recommends using the 95<sup>th</sup> percentile for the Average Monthly Limit (AML) and the 99<sup>th</sup> percentile for the Maximum Daily Limit (MDL). The maximum daily limit (MDL) and the average monthly limit (AML) are calculated as follows:

$$MDL = LTA_{\text{chronic}} * e^{(z\sigma - 0.5\sigma^2)}$$

where,

$$\sigma^2 = \ln(CV^2 + 1)$$

$$\sigma^2 = \ln(0.7724^2 + 1)$$

$$\sigma^2 = 0.4679$$

$$z = 2.326 \text{ for } 99^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation}$$

$$MDL = 196 \text{ ug/L}$$

$$AML = LTA_{\text{chronic}} * e^{(z\sigma - 0.5\sigma^2)}$$

where,

$$\sigma^2 = \ln\left(\frac{CV^2}{n} + 1\right)$$

$$\sigma^2 = \ln\left(\frac{0.7724^2}{4} + 1\right)$$

$$\sigma^2 = 0.139$$

$$z = 1.645 \text{ for } 95^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation} = \frac{\text{standard deviation}}{\text{mean}}$$

n = number of sampling events required per month for lead = 4 (based on weekly sampling as required in the previous permit)

AML = 87 ug/L

#### IV. Summary of Permit Effluent Limitations

As discussed in Section I of this APPENDIX, technology-based limits were applied to each discharge and evaluated to determine whether these limits may result in any exceedances of WQS in the receiving water. If exceedances could occur, then water quality-based effluent limits were developed. The following summarizes the effluent limits developed for each outfall.

Outfall 002: The reasonable potential analysis in Section III.B. demonstrates that discharge at the water quality-based effluent limits for metals will not cause or contribute to an exceedance of WQS at or beyond the boundary of the mixing zone in Hawk Inlet. However, effluent discharge at the technology-based effluent limits will in most cases result in an exceedance of WQS at the boundary of the authorized mixing zone. Consequently, water quality-based effluent limits are implemented to ensure protection of WQS. Technology-based effluents limits are assigned to TSS, and no limits are assigned to Temperature, BOD<sub>5</sub>, and Fecal coliform bacteria.

In a few cases, the total suspended solids (TSS), chronic mercury, and cadmium limits, technology-based effluent limits, which are more stringent than water quality-based effluent limits, have been imposed by the permit. Additionally, the reasonable potential analysis showed that the discharge of fecal coliform bacteria would not cause or contribute to an exceedance of their applicable water quality criterion. Therefore, water quality-based effluents limits were not needed for this parameter, and in addition, there are no technology-based limits associated with this parameter.

The permit also includes flow limits to ensure that the volume discharged does not exceed the flow assumptions used to develop the allowable dilution (mixing zone). Since flow and concentration limits are included in the permit, mass limits are not needed. Controlling flow and concentration is the same as controlling mass. See Table 14 for a summary of outfall 002 effluent limits. These effluent limits also apply to the proposed outfall 002A.

**Table 14: Outfall 002 & Outfall 002A Effluent Limits**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Units | Daily Maximum  |                               | Monthly Average |                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------|-------------------------------|-----------------|----------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       | Effluent Limit | Basis for Limit               | Effluent Limit  | Basis for Limit                  |
| Flow (002)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | mgd   | 4.6            | Design capacity               | 3.7             | catchment area and precipitation |
| Flow (002A)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | mgd   | 1.7            | Design Capacity               | 0.4             | catchment area and precipitation |
| Flow (Combined)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | mgd   | 6.3            | Design Capacity               | 4.1             | catchment area and precipitation |
| Cadmium <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | µg/L  | 16             | ELG                           | 6               | ELG                              |
| Copper <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | µg/L  | 32             | Acute Aquatic WQS             | 13              | Acute Aquatic WQS                |
| Cyanide <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | µg/L  | 5              | Acute WQS                     | 3               | Chronic WQS                      |
| Lead <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | µg/L  | 196            | Chronic Aquatic WQS           | 87              | Chronic Aquatic WQS              |
| Mercury <sup>c</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | µg/L  | 0.9            | Human Health WQS <sup>d</sup> | 0.7             | HH WQS                           |
| Zinc <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | µg/L  | 514            | Acute WQS                     | 201             | Acute WQS                        |
| TSS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | mg/L  | 30             | ELG                           | 20              | ELG                              |
| pH <sup>e</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | s.u.  | 6 to 9         | ELG                           | 6 to 9          | ELG                              |
| Notes:<br>a. Metals shall be measured as total recoverable.<br>b. Cyanide shall be measured as weak acid dissociable<br>c. Mercury shall be measured as total.<br>d. First, the average monthly limit (AML) was set equal to the wasteload allocation of 1.11 µg/L. Then, the daily maximum limit was calculated as a ratio of the AML as prescribed section 5.4.4 of the <i>Technical Support Document For Water Quality-based Toxics Control</i> .<br>e. The limit reflects that there is a pH mixing zone, covers a range, and does not offer specific daily and monthly limits. |       |                |                               |                 |                                  |

**Storm Water Outfalls:** Based on the discussion in Section III.C., numeric effluent limits were not developed for the storm water outfalls. Rather, requirements to sample the receiving waters upstream and downstream of each outfall when the outfall discharge is sampled support the permit requiring the permittee to implement corrective action if a storm water discharge exceeds a water quality criterion and results in a statistically significant reduction in receiving water quality. The permit also includes the requirement to develop outfall-specific BMPs.

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**Re: [EXTERNAL] Copper Flat Mine**

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**From** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

**Date** Wed 7/1/2026 11:40 AM

**To** LeRoy Henderson <elhleroy@yahoo.com>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>

Hello Ervin,

Thank you for your comments. I have filed these and will add you to our interested party list. I will also keep you informed of the upcoming MMD public hearing once the date is set.

Evan



**Evan J. Owen**

Reclamation Specialist

Mining and Minerals Division

NM Energy, Minerals and Natural Resources Dept.

1220 S. St. Francis Dr.

Santa Fe, NM 87505

(505) 490-0967

[evan.owen@emnrd.nm.gov](mailto:evan.owen@emnrd.nm.gov)

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**From:** LeRoy Henderson <elhleroy@yahoo.com>

**Sent:** Tuesday, June 30, 2026 8:10 PM

**To:** Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>; Anderson, Jordan, ENV <Jordan.Anderson@env.nm.gov>

**Subject:** [EXTERNAL] Copper Flat Mine

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Greetings,

I am Ervin Le Roy Henderson in Cuchillo, Sierra County, New Mexico, and I have been a Community Advocate for a few decades, and worked for Duran-Bokich Environmental Contractors at the Copper Flat mine several years ago when THEMAC, NMCC, was doing more Exploratory Drills for gold.

I first started out there at Copper Flat to do a remodel of the bathrooms, but after getting to know the NMCC folks, they found out that I had gone to NM Tech as a geophysics major, and that I knew a lot more than construction work. I was used to glean through all the old documents left there at the shop by Quintana. I learned a lot about Quintana and the true, underlying reason for Quintana's closure and demolition.

I got well acquainted with the geologists and the drillers. I saw all the cores as they were inspected, analyzed, and categorized by the geologists, before shipping to the assayer. There is

no gold, and the copper ore grade is very poor, but with a considerable amount of Moly. I was allowed to read the assay results.

After my work was done around the shop/office, I assisted my brother, Steve Bechtel, in reclaiming the exploratory drills, and various other tasks around the mine site. I had experience from working with my brother reclaiming exploratory drills in the Little Burros Mountains north of Lordsburg, and the closing and making safe the old Manganese mines in the Little Floridas, and the same with abandoned mines in the north Gila, west of Chloride. I have been around a couple mines.

I walked and inspected almost every square foot of Copper Flat, all the way to Gold Dust. I assisted in the inspection of the crusher site, its tunnel, and the mill foundation. The crusher foundation was undamaged. Contrary to some beliefs, the mill foundation is not reusable, for after we dug it out for inspection, there was obvious deterioration due the highly acidic ground and water from the runoff from the benches. There was quite a bit of concern about the effects of 30 years of "hot" runoff. The west and southwest exposed benches are what we called "hot". Most of the runoff found its way into the pit lake. The mine people had to dump potash into the pit lake on regular intervals. They stored the bags of potash in the warehouse part of the shop/office, and they used to have a small boat at the pit lake. Apparently, some animal rights or conservation group forced them to neutralize the pit lake. When THEMAC was doing tours of the mine for the locals, they stayed away from those "hotspots".

When THEMAC first came to town, folks here wanted to know what I thought about the project. I was highly respected in our County. Folks knew I was strict in my research and analysis of the all too many sham and scams which had plagued our County. I have a reputation of being right, and forthright, unfortunately. What I saw at those public meetings was mining done right, on paper. I was all for the mine as it was presented to us. I was not here when Quintana was, but I had heard a lot of anger from folks when they suddenly pulled stakes

After working out there and getting a firsthand experience there and seeing all the old documents, I changed my mind! I made my findings and conclusions public through our local papers. I had a very large following in the County.

I have a background in financial management and as a paralegal. I started working for my brother as something to do after I retired. I believe some pertinent information on this project has been kept hidden. I believe that THEMAC, dba New Mexico Copper Corp is gambling on getting a mine permit so they can turn their orphan mine into a financial asset. There is more to why this Porfiry deposit sat for 30 years!

Respectfully submitted,  
Ervin Le Roy Henderson

[REDACTED]

---

**[EXTERNAL] Comment**

---

From LeRoy Henderson <elhleroy@yahoo.com>

Date Wed 7/1/2026 5:06 PM

To Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

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CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Good afternoon Evan Owen...

Thank you for your quick response, and acceptance of my Comment... I want to add something: I think and suggest that this small orphan mine, with low grade ore, should be set into some kind of "reserve status"... The history of this little mine goes way back, and its history of little or no return, no long life potential, not even any interest during or after World War II when they had that "Strategic Minerals" Federal program, has made it questionable as to being "worthwhile"... the Manganese mines in the Little Floridas we closed up, were part of that program...

At some point in our world's history, the world's supplies of metals and minerals will get low, and little deposits like Copper Flat will become feasible... Feasibility today, has to be a big consideration, as well as, is it best for the State today... Also, the last I knew, they have nowhere to take their concentrate, except overseas... Apparently, Morency would not accept it... There are projects internationally where companies are reclaiming tailings piles, looking to glean rare earths, a little bit of leftovers, and such... Those well-placed projects are more valuable than Copper Flat today...

Thinking to the future is vital... Today, there is really too much competition from world mines with massive deposits, and refining infrastructure... Thirty, 40, 50 years from now, Copper Flat may be a good asset... In planning for New Mexico's future, take advantage of that world control and supply... Set Copper Flat in a deposit box, and let it gain in value!!!

Plus there is the fact that that long stretch of ore leading up to the crusher foundation, their best ore, has been oxidizing for over 30 years... That makes it very difficult to mill... the best ore is the streaks of copper pyrite... beautiful rock, difficult to process...

In regards to my concerns about acidity in areas, I want to point out that the soil and rock used to bury the mill site came from the benches that the rock, ore, was of a composition that with water, it "seeped", "bled", "oozed" in a slow chemical reaction, eating away at any concrete it touched... I think you see what I am trying to describe... It is essentially toxic and eroding... It was a concern at Copper Flat, and we were on the watch for any such signs...

Respectfully submitted,  
Ervin Le Roy Henderson



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**Re: [EXTERNAL] Copper Flat Mine**

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**From** Max Yeh <maxwyeh@gmail.com>

**Date** Sat 8/8/2026 1:12 PM

**To** Cathey, Craig D., OSE <craig.cathey@ose.nm.gov>

**Cc** Serrano, Ryan, OSE <Ryan.Serrano@ose.nm.gov>; Owen, Evan, EMNRD <Evan.Owen@emnrd.nm.gov>

Dear Mr. Cathey,

Could you inform me if NMCC has applied or spoken to you about applying for a Dewatering Permit?

I have been calculating run-off into the pit, and since there is a large area of about 300 acres that drains into the pit, the run-off amounts to quite a bit of water.

In addition, the pit, even now, extends below the water table, and that would mean that when they dewater in order to mine, they will be withdrawing groundwater. As I remember the Dewatering Act, dewatering specifically does not create a right to use that water, so it seems that for the mine to use dewatering water for ore processing, which is described in the Mining Operations and Reclamation Plan now before the MMD, it would violate the Act. Has this issue been part of your discussions with NMCC?

On Tue, Apr 14, 2026 at 2:27 PM Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)> wrote:

Mr. Yeh,

Thank you for the information you provided regarding potential water use at the Copper Flat Mine. We are closely monitoring activities at the mine and will ensure that all water rights are applied to beneficial use in accordance with New Mexico statutes, administrative code and policies of the State Engineer.

Please let me know if I can provide any additional information.

Best Regards,

***Craig Cathey***

District IV Manager

New Mexico Office of the State Engineer  
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<https://nmwrrs.ose.state.nm.us/nmwrrs/index.html>

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***view notices for publication:***

<https://www.ose.state.nm.us/NFP/nfp.php>

***enter your meter readings:***

<https://www.ose.state.nm.us/Meter/>

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**From:** Max Yeh <[maxwyeh@gmail.com](mailto:maxwyeh@gmail.com)>  
**Sent:** Tuesday, January 27, 2026 11:09 AM  
**To:** Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)>  
**Cc:** Serrano, Ryan, OSE <[Ryan.Serrano@ose.nm.gov](mailto:Ryan.Serrano@ose.nm.gov)>; Tessa Davidson <[tted@tessadavidson.com](mailto:tted@tessadavidson.com)>; Carter Kruse (TEI - Montana) <[Carter.Kruse@retranches.com](mailto:Carter.Kruse@retranches.com)>; Dustin Long (TEI-Ladder) <[Dustin.Long@tedturner.com](mailto:Dustin.Long@tedturner.com)>; Bob Cunningham <[bcunni4668@aol.com](mailto:bcunni4668@aol.com)>; Greg Daviet <[director4@ebid-nm.org](mailto:director4@ebid-nm.org)>; David Salopek <[dpsalo@zianet.com](mailto:dpsalo@zianet.com)>; Corey Durr <[cdurr@blm.gov](mailto:cdurr@blm.gov)>; Allyson Siwik <[grip@gilaresources.info](mailto:grip@gilaresources.info)>  
**Subject:** Re: [EXTERNAL] Copper Flat Mine

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Dear Mr. Cathey,

I just received information from the NMED that the discharge permit it is considering for Copper Flat Mine authorizes pit water to be used for production and for dust control. This information increases the need for OSE to have some input into this process since this use may be an unauthorized appropriation.

As you know, the mine has adjudicated water rights in the pit (some 5 afy for dust control and some 30 afy for evaporation), but it has no water rights from the pit for mining. Since NMCC does have water rights for mining in other wells, this proposed use requires an approved transfer permit from the OSE, does it not? Has NMCC applied for such a transfer?

The 5 afy dust control seems far too little; so, it would seem that any extra water taken from the pit for that purpose also needs a transfer permit. Has there been any discussion with NMCC about the need for these applications?

Thank you for your consideration. I look forward to hearing from you.

On Tue, Nov 18, 2025 at 8:59 AM Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)> wrote:

Mr. Yeh,

Thank you for the information regarding the Copper Flat Mine. Cheryl Thacker has retired, so please feel free to address your questions directly to me.

Many of the issues that you raise are new to me and will require some time for my staff and I to research and understand better. I will provide you with a more detailed response in a few weeks.

Best regards,

***Craig Cathey***

District IV Manager

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**From:** Max Yeh <[maxwyeh@gmail.com](mailto:maxwyeh@gmail.com)>  
**Sent:** Thursday, November 6, 2025 5:59 PM  
**To:** Cathey, Craig D., OSE <[craig.cathey@ose.nm.gov](mailto:craig.cathey@ose.nm.gov)>  
**Cc:** Serrano, Ryan, OSE <[Ryan.Serrano@ose.nm.gov](mailto:Ryan.Serrano@ose.nm.gov)>  
**Subject:** [EXTERNAL] Copper Flat Mine

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Dear Mr. Cathey,

I write you concerning the Copper Flat Mine in Sierra County. I understand that Cheryl Thacker retired last month, and since she had been instrumental in the OSE's many years of involvement with this project, I am uncertain to whom I should now address my questions.. I hope as supervisor of this district, you will be able to give me some direction.

Upon the SE's denial of the Tulla Resources's application to transfer water rights for use at Copper Flat, the mine's owner, NMCC, submitted an updated application for mining with MMD based on the use of a dry stack tailings process which reduces the amount of fresh water need in its operation. At the same time, it has filed for a renewal of its waste water discharge permit from the NMED. I expect that it will also submit an alteration of its federal mining permit from the BLM. I think that the OSE must participate in these decisions because water rights and water use are central to the project.

The revised Mining Operation and Reclamation Plan is available on the MMD website. Having gone over it, I would like to ask OSE for some determination or comment on issues the MORP raises concerning water rights and water use. I attach a detailed explanation of these issues as a memorandum.

Briefly, the mine was adjudicated some 1,100 afy groundwater rights. It has no surface water rights. Yet, it plans to use double the amount of rights it has. The additional water comes from water harvesting (albeit, harvesting of water that has been in contact with mined minerals) and also from what seems an extra-legal way of extracting groundwater.

At the time of BLM's FEIS, I asked Ms. Thacker about using captured run-off water without having surface water rights, but at that time, the OSE was no longer involved in the BLM process since it had recused itself because of the pending litigation with NMCC over its water rights. The earlier DEIS, in which the OSE participated, did not propose water harvesting as a source of production water. Originally, NMCC's plan was to channel contact run-off water to the tailings pond, where it would simply evaporate. Ms. Thacker thought then that that was the normal process for handling contact run-off. However, the FEIS introduced catchment ponds at the various waste rock piles and using the contact run-off water for production.

NMCC's decision to use dry stack tailings and to proceed to mine with only a minimal amount of water rights, highlight its need for other water sources. The new 500 acre dry stack storage facility adds enormously to the amount of contact run-off, and capturing that run-off essentially doubles the amount of water available for production use.

I would like the Water Rights Division to have some kind of say in this use. Of course, contact run-off should not go into the stream, but one cannot simply allow polluting run-off to be a legal way to get the right to use surface water. This is especially true for uses like mining, where there is zero return after use.

The second issue, I want to lay before the OSE is the strange case of extracting groundwater by extracting water from saturated ore mined from below groundwater level. NMCC will extract this water from the ore in its processing and recycle it as more production water. Basically, the pit (which OSE classified as a well), which has no water rights for mining (5 afy for dust control and 30 something for evaporation) will supply the mine 250 afy of groundwater by taking the water by truck-fulls rather than pumping it out. Here, too, I ask that the OSE have a say.

A third water issue which seems to me to concern OSE is the reclamation plan which calls for the filling of the pit with groundwater (24/7 pumping of groundwater for 2.5 years). It does not seem to me a beneficial use of water to create an eventually polluted pond. Lawyers can easily find cases in which such peripheral use of water (not central to the production of copper) has been deemed non-beneficial by the courts. This waste is especially egregious because the mine will have tons of waste rock that can be used, at least partially, to fill the pit. Since the aim is simply to cover up the lower pit walls to prevent acid formation, every cubic yard of waste rock used is a cubic yard of groundwater saved while accomplishing the same end. Again, I request that OSE take a look at this issue as part of its review of water and water rights at Copper Flat.

Given the push by OSE/ISC in the last few years to address the issue of water supply in the state, it seems to me reasonable that the Water Rights Division in LC engage in overseeing the use of water and water rights at Copper Flat Mine. I ask this on behalf of the 100+ members of the Percha-Animas Watershed Association.

Thank you.

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Max

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| Max

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Max