United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

April 9, 2024

In Reply Refer To:
FWS/R4/ES/DCN080741

Jeff Cown, Director
Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive, SE
14th Floor East Tower – Suite 1456
Atlanta, Georgia 30334-4713

Dear Director Cown:

The U.S. Fish and Wildlife Service (Service) has reviewed information on the Georgia Department of Natural Resources - Environmental Protection Division (GA-EPD) website and associated information concerning the revised Mining Land Use Plan submitted by Twin Pines Minerals, LLC (TPM or Applicant) and associated draft permits for air quality, surface mining, and groundwater withdrawal for a proposed mining project in Charlton County, Georgia. The Applicant proposes to mine heavy mineral sands from Trail Ridge, a geomorphic feature that impounds the Okefenokee Swamp along its east side for approximately 30 miles.

The Service is seriously concerned that mining operations will negatively impact the Okefenokee Swamp and the Okefenokee National Wildlife Refuge (ONWR), a unique public resource of national, cultural, and biological significance. The ONWR is visited by 400,000 members of the public each year, who spend $91.5 million per year in Ware, Charlton, and Clinch Counties, alone. The ONWR has also been nominated as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site and if designated in 2026, the number of visitors is expected to double.[1] We anticipate the proposed mining operation your agency has been asked to approve is likely to cause permanent, negative alterations to the hydrologic regimes, permanent decreases in habitat quality for federally listed and imperiled species that rely on the wetland ecosystem, and an overall decrease in its value to the public. It is clear from the response to public comments on the Mining Land Use Plan, including the Service's comments and the National Park Service's independent technical review, that TPM cannot show that its mining project will not cause impacts to ONWR.

[1] "Depending on the extent, geographic distribution, and character of new visitation, the Okefenokee region can expect to gain as many as 700 new jobs and grow its economic output to over $140 million. This translates to a 1-2% increase in GDP regionwide," (Gloss,2024, p. 2) Gloss, Lance. 2024. Projected Economic Impact of UNESCO World Heritage Site Designation: The Okefenokee National Wildlife Refuge. The Conservation Fund. February 12, 2024. EIA_WHS_Okefenokee_2024_Final-1-1.pdf (okeswamp.org), accessed March 22, 2024

The Service strongly recommends denial of the permits for the TPM mining project because issuing these permits will not be in the public interest and general welfare.[2] We, like you, do our utmost to make decisions that, regardless of complexity, serve the public interest, in accordance with our authorities. We respectfully submit the following comments regarding federally listed and imperiled species, water rights, individual permits, and associated TPM applications, models, and analyses, and urge you to please consider them and ultimately, in accordance with your authorities, deny the permits for the TPM mining project.

Significance of the Okefenokee Swamp

Spanning approximately 684 square miles, the Okefenokee Swamp reigns as North America's largest blackwater wetland and is among the planet's largest hydrologically intact freshwater ecosystems. The Okefenokee Swamp is safeguarded by the 407,000 acres of the ONWR, which preserves over 93% of the Okefenokee Swamp's expanse and is the largest National Wildlife Refuge east of the Mississippi River. In 1974, Congress established 353,981 acres of the ONWR as Wilderness,[3] making it the third largest Wilderness on the East Coast and protecting 87% of the ONWR as Wilderness. In stark contrast to other significant wetlands, the Okefenokee Swamp holds the unique distinction of being a source, rather than the recipient, for rivers and serves as the headwaters of two major river systems – the Suwanee River to the south and the St. Marys River to the east. This unique hydrology, coupled with protections afforded by the ONWR, has shielded the Okefenokee Swamp from many human-induced impacts and preserved its integrity as the largest and most pristinely intact blackwater wetland in the United States.

The ONWR is the 16th most visited refuge in the nation, drawing over 400,000 visitors annually, ten percent of which are international. A comprehensive 2024 economic study found that the ONWR provides a staggering $91.5 million in spending each year in Ware, Charlton, and Clinch Counties. Associated tourism supports 750 jobs, $79 million in economic output, and $11.1 million in annual tax revenue in the area. These numbers will continue to balloon if the ONWR is designated as a UNESCO World Heritage Site, with a decision on the designation anticipated in the summer of 2026.

The ONWR boasts an astonishing mosaic of different habitats, each with unique vegetation and faunal communities. This diversity of habitat types contributes to high biodiversity, which includes over 850 plant species, 200 bird species, 64 reptiles, 50 mammals, 39 fish, 37 amphibians, and countless invertebrates – including up to 1,000 species of moth alone. Among these, many are federal trust species and state species of greatest conservation need; the ONWR serves as a vital haven for species that have lost much of their former range due to habitat loss.

---

[2] GA-EPD authority to deny the air quality, surface mining, and groundwater withdrawal permits can be found at Ga. Code Ann. § 12-9-6(b)(3) and Ga. Comp. R. & Regs. 391-3-1.03(8); Ga. Code Ann. § 12-4-73(a)(2) and Ga. Comp. R. & Regs. 391-3-3.01(4)(c); and Ga. Code Ann. § 12-5-96(c)(4) and Ga. Comp. R. & Regs. 391-3-2.05(5)(b), respectively.

[3] 353,981 acres within ONWR is designated as a wilderness area under the Wilderness Act of 1964. 16 U.S.C. 1131-1136.

Honored with prestigious designations, including the National Natural Landmark by the National Park Service in 1974 and a Wetland of International Importance by the Ramsar Wetlands Convention in 1971, the ONWR is an American beacon of ecological significance. Now, poised for potential UNESCO World Heritage Site designation in 2026, its intact hydrology and ecology mark it as a site of global significance for conservation and protection.

Moreover, the ONWR holds deep cultural significance as part of the Muscogee (Creek) Nation ancestral homeland and the Creek Nation has proposed it to be recognized as a significant Traditional Cultural Property. Trail Ridge, which is included in the proposed TPM mining boundary, bears the traces of an ancestral travel corridor and hints at the rich cultural heritage embedded within its soil, with past settlements and at least two reported mound complexes documented within the vicinity of the TPM mining project (Weisman and Kirkland 1998, Richard Kanaski pers. comm. 2022). The Service recommends that GA-EPD consult with Tribes that have a close, cultural connection to the Okefenokee Swamp and the surrounding area.

Risk of Irreversible Injury

The ONWR and Okefenokee Swamp are unique, irreplaceable, national treasures. In 1997, former Secretary of the Interior Bruce Babbitt stated he believed it was inappropriate for DuPont to carry out mining activities along the eastern boundary of the ONWR because of the unknown consequences to this unique and priceless ecosystem. He stated, "[Y]ou can study this, you can write all the documents in the world, but they are not going to prove beyond a reasonable doubt that there will be no impact." In a letter to Georgia Governor Brian Kemp dated November 22, 2022, Secretary of the Interior Deb Haaland similarly asserted that the Department of the Interior has serious concerns with the potential negative impacts of proposed TPM mining activities at the Okefenokee Swamp ecosystem and ONWR, stating that the "proposed mining activity in this area poses an unacceptable risk to the long-term hydrology and future of the swamp ecosystem."

The Service contends that the likely effects of the proposed TPM mining project on the Okefenokee Swamp and ONWR present an unacceptable risk to the environment and the economic livelihoods that are supported by ecotourism. Multiple independent experts have identified serious deficiencies regarding TPM's hydrologic monitoring, highlighted the paucity of data and unsupported assumptions that underly the models used to evaluate the potential impacts of the proposed mine.

Under Ga. Comp. R. & Regs. 392-3-2.05(1)(i), in considering permit applications, the GA-EPD must consider any other relevant information, including the best geologic and hydrologic information available on the aquifer or ground water system of the area. The Service is concerned there is a lack of scientific agreement regarding the connection between proposed TPM groundwater withdrawals and the surficial aquifer that underlies the Okefenokee Swamp and the GA-EPD has not adequately considered the best geologic and hydrologic information available. Some hydrologists have concluded that the surficial aquifer is perched on the clays of the upper Hawthorn Group and consider it to be the upper confining unit to the Floridian Aquifer in the region (*e.g.*, Williams and Kuniansky 2015). Other hydrologists have concluded the opposite, that the Hawthorne layer is permeable and allows flow between the aquifers (*e.g.*,

Kitchens and Rasmussen 1995). If there is permeability, pumping from the Upper Floridan Aquifer may cause an increase in downward vertical leakage that will lower water levels in the Okefenokee Swamp. The Service is deeply concerned that because the Upper Floridan Aquifer systems show statistically significant declines in groundwater levels (Sutton *et al*. 2021), the proposed groundwater withdrawal for TPM mining operations will exacerbate this trend both locally and regionally. Given the significant potential for negative impacts to the Okefenokee Swamp, we do not see how GA-EPD can find with certainty that there is not a groundwater connection between the Okefenokee Swamp and the proposed mining operation and that modeling and hydrogeologic characterization provided by TPM is adequate to assess any of these important concerns. The Service requests the GA-EPD delay issuing the permits to allow for additional review and modeling across the ONWR.

As noted in our comment letter dated March 18, 2023, the Service remains deeply concerned that lowered groundwater levels, particularly during periods of drought, will heighten the risk of more frequent and severe catastrophic wildland fires within the Okefenokee Swamp ecosystem, similar to the 2017 West Mims Fire. The lightning-caused West Mims Fire started in the southern portion of the ONWR and quickly spread. Control of the fire was limited due to the effects of long-term drought and extreme fire weather conditions (Bates 2020), conditions that would become more frequent with lowered groundwater levels. The fire cost taxpayers an estimated $45.5 million to suppress and destroyed over $58 million in private timberland, the majority of which is located in close proximity to the proposed TPM mine site. Although fire is a natural and integral part of the Okefenokee Swamp's ecosystem function, increased frequency and intensity of large wildfires can impair the Okefenokee Swamp's ability to recover, permanently change habitat structure, increase the risk to human life and infrastructure, and threaten the millions of dollars of commercial timberland that immediately surround the Okefenokee Swamp.

Lowered groundwater levels would compound already increasing wildfire risk patterns observed in the eastern United States (Donovan *et al*. 2023). Natural fire provides beneficial ecosystem services to wetland habitats that are adapted to frequent, low-intensity burns by increasing plant diversity and creating suitable habitat for fire-adapted wildlife species. However, more frequent and intense wildfire can result in significant negative effects within the Okefenokee Swamp ecosystem due to its interactions with underground stores of peat. When dry, as occurs when groundwater levels are lower than typical, peat becomes highly combustible and can burn underground for days, making it difficult to control. Water levels within the Okefenokee Swamp are a critical factor in determining both the frequency and intensity of these fires. As water levels drop, different portions of the swamp become susceptible to drought and wildfire (Kendall *et al*. 2022). The Service strongly recommends the denial of permits to the TPM project. However, if permits were approved, the Service requests that the Applicant develop a drought management plan and provide an adequate bond to mitigate the costs of wildland fire suppression and infrastructure loss and contribute to wildland fire mitigation efforts within the Okefenokee Swamp's wildland-urban interface. The Service believes that this is appropriate under Georgia Regulation 391-3-3-.09, which states that when a mining site is located adjacent to lands containing natural or other resources that may be adversely affected by the operation, the

operator must include in the Mining Land Use Plan a plan to mitigate adverse effects of those impacts.

Lowered groundwater levels and subsequent increases in wildland fire activity and intensity would result in degradation of the estimated 200 million metric tons of carbon-rich peat soils found within the Okefenokee Swamp. This would diminish the carbon storage capacity of the Okefenokee Swamp, a major storage area in the Southeast, greatly reducing its ability to retain and capture carbon and assist in controlling greenhouse gasses and climate change. Even slight changes in the hydrology of a low-relief environment such as the Okefenokee Swamp can significantly accelerate peatland degradation when combined with seasonal changes in climate. If the top four feet of peat within the Okefenokee Swamp's southeast water basin were compromised by oxidation or fire, approximately 28 million metric tons of carbon dioxide could be released over time, equal to approximately 25% of Georgia's annual atmospheric emissions in 2021 (US EIA 2021). Instead of a carbon sink, the Okefenokee Swamp could become a major contributor to atmospheric carbon, exacerbating climate change.

The Service is also concerned that some of the implementation and remedial actions proposed as part of the project have not been used before in similar applications and are untested, unproven technologies. The Service does not believe these technologies should be considered sound engineering and conservation measures required by Ga. Comp. R. & Regs. 391-3-3.08. Examples of proposed unproven technologies include:

- Use of bentonite clay to change the hydraulic conductivity of the soil and possibly perch water in wetlands. Bentonite clay is widely used as a soil amendment; however, the specific purpose and use on this project is untested and unproven;

- Use of evaporators to process excess water (proposed 1.1 million gallons), evaporators have been used in other applications, but for the purpose in this project it is untested and unproven;

- Use of a dry, moving pit mining system. As far as we know, this system has not been used in heavy mineral sand mining. It is untested and unproven in this application.

As required by Ga. Comp. R. & Regs. 391-3-3.09, when a mining site is located adjacent to lands containing natural or other resources which may be adversely affected by the operation, the operator must include in the Mining Land Use Plan a plan to mitigate adverse effects of those impacts. The Service asserts these proposed actions are experimental and unproven, may exacerbate impacts from lowered groundwater levels within the Okefenokee Swamp, and include no clear metrics for determining the success of reclamation actions to mimic pre-project conditions. In our March 2023 comment letter, we expressed similar concerns and recommended that the GA-EPD perform additional analyses on the effects these novel processes may have. The GA-EPD has responded that they are comfortable with the operation and remediation measures as proposed. If this is based upon the interpretation of TPM's predictive hydrological modeling, the Service contends that enough uncertainty exists regarding the predicted effects of project

operations on the Okefenokee Swamp's hydrology alone to deny permits. The additional risk imposed by untested technologies poses an equal and compounding unacceptable risk to the character and ecosystem of the ONWR. The Service recommends that novel or experimental actions as part of the proposed project first be conducted in an area with less ecological sensitivity to demonstrate their effectiveness. This approach would ensure that any unforeseen or unexpected effects do not pose a risk to these sensitive and significant ecological areas.

The Service questions what remediation actions would be available to the GA-EPD if the project is permitted and one or more of the novel, unproven technologies do not perform as expected. If the permits were to be approved, the Service recommends that GA-EPD require independent monitoring be performed to assess the success or failure of the proposed novel technologies. Monitoring should include opportunities to pause operations if actions are not performing as expected. The Service also asks, if modifications to the project are requested from what is permitted, how will the GA-EPD assess the proposed changes, since these modifications would not have been considered during the permitting process? Would there be additional opportunities to review and comment on the changes that have the potential to affect the local environment before the change is implemented, similar to the current public comment process?

The location of the proposed mine is at the southern end of the Twin Pines property, approximately 2.9 miles from the Okefenokee Swamp. The designation of the proposed TPM mining project as a "demonstration" suggests that mining permits are anticipated for the remainder of the Twin Pines property, which could place mining operations as close as 400 feet to the Okefenokee Swamp. Although GA-EPD states that all future mining will require a completely new application package, the "demonstration" designation on the current package implies that knowledge obtained from this mine will support future mining on Trail Ridge. The proposed project is located on the highest part of the ridge with lower elevations to the north of the site. The top of the ridge and mineral deposits are narrower and closer to the Okefenokee Swamp as one progresses northward with exponentially greater consequences to the Okefenokee Swamp's ecosystems and hydrology, and therefore, should not be considered a "demonstration" mine. The Service requests GA-EPD address whether it is considering the cumulative effects of not only the demonstration project but also the implementation of mining operations across the entire Twin Pines property. If GA-EPD is not addressing the cumulative effects of mining throughout the entire Twin Pines property even though the Applicant has indicated it intends to mine the entire area, the Service requests an explanation about how this non-cumulative approach considers the probable severity and duration of the impairment under foreseeable conditions as required pursuant to Ga. Comp. R. & Regs. 391-3-3.05(1)(d).

Finally, if the proposed project goes forward and results in major irreversible impacts, the Service requests that GA-EPD identify who would be held liable for damages and remediation as well as the statutory or regulatory authority that forms the basis for that liability.

Biological Concerns

The Service is the primary federal agency responsible for the conservation, protection, and enhancement of America's fish and wildlife populations and their habitats. The ONWR provides

habitat and protection for over 850 plant species, 200 bird species, 64 reptiles, 50 mammals, 39 fish, 37 amphibians, and countless invertebrates. These include multiple federal trust and state imperiled species (Enclosure 1). In accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e), the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531-1544), and consistent with our review of the revised Mining Land Use Plan and draft permits, the Service is very concerned that the proposed mining project and associated reclamation activities will inflict irreversible harm upon the unique ecosystems and habitats endemic to the ONWR by altering the area's hydrology and decreasing habitat quality for federally listed and imperiled species, as discussed more fully below. Therefore, the Service strongly recommends the denial of permits to the TPM project.

The predominant ecosystem of the proposed project site is currently classified as non-jurisdictional wetlands by the U.S. Army Corps of Engineers (USACE). We understand that the USACE will not be issuing a Clean Water Act Section 404 Wetland Fill Permit. Nonetheless, the ecological significance of these wetlands should be considered as a major factor, regardless of whether or not they are under the USACE's jurisdiction. These wetlands provide vital habitat features that support imperiled species and play a crucial role in the landscape's ecological functioning. The TPM Mining Land Use Plan outlines a reclamation plan to re-create wetlands that are destroyed during project implementation. However, it is probable that post-reclamation wetlands will lack crucial functions and the vital habitat characteristics, thus overall habitat quality will be significantly diminished.

The usual process by which the Service determines the impacts of proposed projects on species that are listed or proposed-to-be listed as endangered and threatened under the Endangered Species Act is outlined under the Act's section 7 regulations (www.ecfr.gov/current/title-50/part-402#p-402.14(c); (g); (h); (i)). The Service recognizes that the USACE is not issuing a federal permit, and no other federal agency has discretionary control over or is involved in authorizing, funding, or carrying out of the proposed TPM mining project. Therefore, neither your agency, nor the Applicant is required to consult with the Service under Section 7 of the Endangered Species Act.

However, the process used when assessing impacts remains the same and consists of evaluating the following information:

> A description of the proposed action, including any measures intended to avoid, minimize, or offset effects of the action. Consistent with the nature and scope of the proposed action, the description shall provide sufficient detail to assess the effects of the action on listed species and critical habitat, including:
>
> (A) The purpose of the action;
>
> (B) The duration and timing of the action;
>
> (C) The location of the action;
>
> (D) The specific components of the action and how they will be carried out;

(E) Maps, drawings, blueprints, or similar schematics of the action; and

(F) Any other available information related to the nature and scope of the proposed action relevant to its effects on listed species or designated critical habitat.

(i) A map or description of all areas to be affected directly or indirectly by the federal action, and not merely the immediate area involved in the action (*i.e.,* the action area as defined at § 402.02).

(ii) Information obtained by or in the possession of the federal agency and any applicant on the listed species and designated critical habitat in the action area (as required by paragraph (c)(1)(ii) of this section), including available information such as the presence, abundance, density, or periodic occurrence of listed species and the condition and location of the species' habitat, including any critical habitat.

(iii) A description of the effects of the action and an analysis of any cumulative effects.

(iv) A summary of any relevant information provided by the applicant, if available.

(v) Any other relevant available information on the effects of the proposed action on listed species or designated critical habitat, including any relevant reports such as environmental impact statements and environmental assessments.

The Service considers the information outlined above plus other best available information, adds the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species and critical habitat, formulates its opinion as to whether the action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. This analysis also results in the Service determining if the proposed action is reasonably certain to take any listed species of fish or wildlife.

It is important to understand that the action area as defined by the Endangered Species Act regulations means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. Additionally, the effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

"Take", as used here means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. "Harm" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Additionally, "incidental take" refers to takings that

result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant.

The Service wants to make you and the Applicant aware that Section 9 of the Endangered Species Act and its implementing regulations (www.ecfr.gov/current/title-50/section-17.21; www.ecfr.gov/current/title-50/section-17.31) prohibit any person or organization from taking an endangered or threatened species of fish or wildlife. The Service also wants to make you and the Applicant aware that if you or the Applicant determine coverage for incidental take is needed for the TPM mining project, you may seek that coverage pursuant to Section 10 of the Endangered Species Act. Should you or the Applicant decide to avail yourself of that option, the Service is willing to work collaboratively and provide guidance and technical assistance through that process. With these regulatory parameters in mind, summarized below are the anticipated impacts of the proposed TPM mining project on the Service's federal trust resources, including listed species and species proposed to be listed under the Endangered Species Act.

Red-cockaded Woodpecker

The federally Endangered red-cockaded woodpecker (RCW; *Picoides borealis=Dryobates borealis*) was one of the first species listed as Endangered in 1973 under the Endangered Species Act. The pre-settlement landscape of open longleaf and other pine forests throughout the Southeast covered more than 247 million acres, potentially supporting 1.5 million or more RCW breeding groups (Conner *et al*. 2001). The loss of widespread forest conditions suitable for RCW has been well documented as a response to extensive cutting throughout the early 1900s, followed by conversion to agriculture and other non-forest uses, and fire suppression with subsequent intensive forest management practices favoring incompatible short-rotation even-aged silviculture in remaining forests (Service 2020).

By 1973 or shortly after, the best available range-wide estimates were about 10,000 individual RCWs in no more than 4,000 breeding groups. The species continued to decline by 23% after listing and until 1990, as indicated by repeated surveys of active clusters, mostly on public lands. However, the 1990s were a significant decade for RCW conservation and recovery with new science, management techniques, and a better understanding of population dynamics and limiting factors.

Cavity limitations due to insufficient old pines with natural cavities could be alleviated by the advent and installation of artificial cavities in younger pines to sustain existing active RCW clusters with breeding groups. Moreover, populations could be increased by inducing new group formations at recruitment clusters with artificial cavities in restored habitat suitable for foraging. These and other elements became an integrated recovery strategy, and by the late 1990's, were incorporated in the Service's 2003 recovery plan and implemented by various federal, state, and private landowners to halt and reverse the historical decline.

Successful management to stabilize and increase populations further demonstrated that the RCW is a conservation-reliant species (Service 2020). RCW depends on active management including the provision of artificial cavities until forest conditions support adequate old pines for natural

cavity excavation, prescribed fire and compatible forest management to restore and maintain suitable habitat for cavity trees and foraging, the establishment of recruitment clusters to increase population size, translocation to augment growth of vulnerable small populations and for reintroduction, and effective monitoring to affirm response to management.

The ONWR's RCW population is designated as 1 of 13 Primary Core Recovery Populations across the species' range. Primary Core Populations are defined as populations that will harbor at least 350 potential breeding groups (pbg) at the time of delisting. The ONWR's RCW population is combined with the Osceola National Forest RCW population to attain Primary Core status (*i.e.*, 350 pbg's). As of the 2023 RCW breeding season, the ONWR supports 52 active RCW clusters with 33 potential breeding groups. Although the primary concern regarding the TPM mining project is the potential to alter the Okefenokee Swamp's hydrology, the potential to negatively alter the uplands fire regime as a result of those hydrologic changes is equally alarming. Any significant, unintended consequence(s) to ONWR's current RCW management regime (*i.e*., a pragmatic prescribed burning program designed to support a conservation dependent species like the RCW) could inadvertently alter the species' recovery timeline.

The effects of changes to fire frequency and intensity could result in take of RCW in the form of:

- Loss of nest trees.
- Loss/fragmentation/degradation of habitat for foraging.
- Loss/fragmentation/degradation of forested travel corridors.
- Direct death, injury, or harm of individual RCW from destructive wildfire.

RCW may also experience harm from direct exposure to mining practices and indirect exposure by degraded water quality.

Suwannee Alligator Snapping Turtle

The federally proposed Threatened Suwannee alligator snapping turtle (*Macrochelys suwanniensis*) is one of the largest freshwater turtles native to North America. Similar to the alligator snapping turtle (*Macrochelys temminckii*), the Suwanee alligator snapping turtle lives nearly the entirety of its life in the water. Only nesting females, their eggs, and hatchlings are found on dry land. The Suwannee alligator snapping turtle is found exclusively in the Suwannee River system. The headwaters of the Suwannee River originate in the Okefenokee Swamp. Documented turtle occurrences indicate the Suwannee alligator snapping turtle can be found throughout the Okefenokee Swamp, which may serve as an important refuge for the species.

As an aquatic turtle, the Suwannee alligator snapping turtle finds food in the streams and waterbodies that it lives in. Typical food items for this species include freshwater mussels, fish, crayfish, other freshwater turtles, and fruits and nuts from trees growing along the banks of waterbodies. Changes to the hydrology of the Okefenokee Swamp will have significant reverberating effects to the aquatic ecosystems found within the Okefenokee Swamp itself and in downstream reaches that are dependent it as their headwaters. Reductions in flows originating from the Okefenokee Swamp would alter dissolved oxygen levels, temperature regimes, and

sediment transport in the Suwannee River system. Such changes would harm the food resources crucial for the Suwannee alligator snapping turtle by adversely altering habitats essential for its prey species. Moreover, decreasing water levels in the habitats occupied by the Suwannee alligator snapping turtle could lead to the isolation of individuals within populations and disrupt reproductive opportunities for this rare species.

The Service has proposed listing the Suwannee alligator snapping turtle as a Threatened species under the Endangered Species Act, with loss of habitat and degradation of habitat quality cited as significant factors influencing the survival of this species (Service 2021). Alterations to the hydrology of the Okefenokee Swamp and the ecosystems dependent upon it will impede the Service's ability to recover this species to the population levels necessary to remove it from the Threatened and Endangered Species list. The effects of changes to hydrology in the Okefenokee Swamp and Suwannee River could result in take of Suwannee alligator snapping turtle in the form of loss, fragmentation, or degradation of aquatic habitat. Suwannee alligator snapping turtle may also experience harm from direct exposure to mining practices and indirect exposure by degraded water quality. Ultimately, allowing the TPM mining project to move forward will place further regulatory burdens on proponents of other projects that may affect this species.

Eastern Indigo Snake

The federally Endangered eastern indigo snake (*Drymarchon couperi*) inhabits the Trail Ridge Conservation Focus Area (Service 2019) that surrounds the proposed TPM mining project and is known to occur within 13 to 30 miles in all directions from the project site (including locations in Georgia and Florida). Because the species can be difficult to detect due to its low densities and secretive behavior, absence of species records on or adjacent to the project location, or negative survey results, do not directly support absence of the species on or in the vicinity of the project site. Given the distribution of eastern indigo snake records in areas surrounding the project, the species likely relies on the habitat in the vicinity of the project site to maintain connectivity among area populations and across the species' range in Georgia and Florida.

Eastern indigo snakes have large home ranges and can move considerable distances, traveling 14 miles or more in search of mates and over-wintering habitat (sandhill habitat within burrows excavated by gopher tortoises (*Gopherus polyphemus*); Bauder 2018). Their home ranges vary seasonally from several hundred to several thousands of acres. These migratory life history characteristics make them especially vulnerable to habitat fragmentation and road mortality. Therefore, large and connected habitats are needed to maintain viable populations and intact, functional corridors that connect populations are required to ensure long-term species viability. The most recent species status assessment for the eastern indigo snake (Service 2019) highlighted that populations have declined significantly in the north Florida region due to habitat loss and fragmentation. Maintaining connectivity among populations in southeast Georgia and north Florida has been identified as critical to facilitating gene flow vital for the genetic diversity and ecological persistence of the species. The region to the east of the ONWR and extending south, where the proposed project site is located, represents one of only two remaining corridors

that provide habitat connectivity and the potential for gene flow between eastern indigo snake populations in southeast Georgia and north Florida.

The Service is concerned that the proposed reclamation actions will not adequately restore areas that are currently suitable for gopher tortoise to their pre-mining condition, consequently impacting eastern indigo snake over-wintering habitat. In particular, TPM proposes to amend mined soils with bentonite to create a soil layer with reduced hydraulic conductivity at approximately three feet beneath the ground surface. It is probable that this action will create soil characteristics that are physically prohibitive to gopher tortoise burrow excavation (*i.e*., burrows average 15 feet long and 6.5 feet deep). If so, the reclaimed area will not support the same amount of suitable habitat for gopher tortoise that it does currently, thereby diminishing eastern indigo snake habitat and the species' ability for movement across the landscape.

In addition to habitat fragmentation that would likely occur from implementation of the project itself, changes to the hydrology in the area due to the project's proposed activities may further fragment and disrupt habitat quantity and quality. Eastern indigo snake relies on a variety of connected habitat types and the species is particularly attracted to areas with a matrix of uplands and lowlands. They often move between upland and lowland habitats to support essential life functions (*e.g*., foraging, thermoregulation, breeding) throughout the year. The ONWR ecosystem provides an excellent habitat matrix for the eastern indigo snake. During warmer months of the year, eastern indigo snakes use lower elevation and wetter habitats to forage and escape the summer heat. Although the species will consume a variety of prey types, the preferred diet includes amphibians, turtles, small mammals, and other snakes. The lowland and wetter habitats are essential for supporting this diverse prey base. Hydrologic shifts in the area may affect foraging habitat and the predator-prey balance necessary to support viable eastern indigo snake populations. Together, the direct effects of habitat loss and fragmentation and the indirect effects on habitat quantity and quality due to shifts in hydrology may significantly increase the risks to eastern indigo snake populations in the vicinity and the species' overall long-term viability due to impacts to gene flow between Georgia and Florida populations.

The Service strongly recommends the denial of permits to the TPM project. However, in the event permits are issued, the Service recommends that any permit should include, as part of its conditions, the requirement for full implementation of standard protection measures for the eastern indigo snake (www.fws.gov/story/eastern-indigo-snake-conservation).

Tricolored Bat

Georgia is home to 16 species of insectivorous bats, including at least 11 species that likely occur on site or within the immediate vicinity of the proposed TPM project location. Among the species likely present in the area is the tricolored bat (*Perimyotis subflavus*), which was recently proposed to be listed as Endangered by the Service. The tricolored bat faces multiple stressors that have caused marked decline in overall population estimates, including a fungal disease

known as white-nose syndrome, habitat loss and fragmentation, water quality degradation, and mortality at wind energy facilities.

During the spring, summer, and fall, tricolored bats primarily roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. Tricolored bats have also been observed roosting among pine needles; eastern red cedar; Spanish moss; and within artificial roosts like barns, beneath porch roofs, bridges, concrete bunkers, and within caves. Female tricolored bats form maternity colonies of up to 50 individuals and switch roost trees regularly. They usually have twins in late spring or early summer, which are capable of flight in four weeks. During the winter, tricolored bats hibernate in caves and mines; although, in the southern United States, where caves are sparse, they often hibernate in road-associated culverts, as well as sometimes in tree cavities and abandoned water wells. In the southern United States, including the region in which the proposed TPM site is located, hibernation length is shorter compared to northern portions of the range and some tricolored bats exhibit shorter bouts of hibernation and remain active and feed throughout the winter.

Tree clearing activities associated with the development of the TPM site could result in adverse effects to tricolored bats at any time of year. In a fragmented landscape, bats may have to fly across less suitable habitat. This could pose greater risk of predation (*e.g.*, raptors). Recovery from the stress of hibernation and migration may be slower as a result of the added energy demands of searching for new roosting/foraging habitat, especially in an already fragmented landscape where forested habitat is limited. Pregnant females displaced from preferred roosting/foraging areas will have to expend additional energy to search for alternative habitat, which would likely result in reduced reproductive success (failure to carry to full term or failure to raise pup to an age capable of flight) for some females. Females that do give birth may have pups with lower birth weights given the increased energy demands associated with longer flights, or their pups may experience delayed development. These longer flights would also be experienced by pups once they become capable of flight, which could affect the survival of these pups as they enter hibernation with potentially reduced fat reserves. The effects of tree removal at the site could result in take of tricolored bats in the form of:

- Loss of roosts.
- Alteration of habitat around remaining roosts.
- Loss/fragmentation/degradation of habitat for foraging, traveling, staging, and swarming (breeding) at any time of year.
- Loss/fragmentation/degradation of forested travel corridors.
- Direct death, injury, or harm of individual bats from removal of occupied roost trees, especially when non-volant pups or hibernating individuals are present.

Development of the TPM site may also alter available drinking water sources or foraging habitat due to various mining activities. For example, there may be permanent loss from wetland and/or stream fill. Bats may be exposed to chemicals from mining activities near their roosting or foraging areas. They may drink contaminated water sources or forage in affected areas with the potential to eat insects that have been exposed to chemicals (*e.g.*, petrochemicals, deicers). Bats

may be directly exposed to chemicals (*e.g.*, herbicides) in areas where they are roosting. Tricolored bats and other species may experience harm from direct exposure to mining practices and indirect exposure by degraded water quality.

Tricolored bats are also at risk of negative impacts due to changes and impacts to habitats found throughout the Okefenokee Swamp ecosystem resulting from permanently altered hydrologic and fire regimes. The Service strongly recommends the denial of permits to the TPM project. However, in the event consideration for granting the permits remains, the Service recommends that a survey for tricolored bat and other imperiled bat species be completed within suitable habitat by a qualified biologist prior to any consideration of permit approval or denial. To minimize potential impacts to the tricolored bat if the results of survey are positive, the Service recommends requiring tree clearing to occur only outside of the non-volant pup season (May 1-July 31) and the winter hibernation season (December 1-February 28), and any temporary or permanent lighting used be directed away from forested areas from dusk until dawn.

Pollinators

On December 15, 2020, the Service announced that listing the monarch butterfly (*Danaus plexippus plexippus*) under the Endangered Species Act was warranted but precluded. On February 7, 2024, the World Wildlife Fund-Mexico shared the Monarch Butterfly Survey Report 2023-2024 which provides the results of the annual monarch butterfly census. The assessment of the species observed a substantial decrease in the population. This winter, monarch butterflies were found to only occupy 0.9 hectare; the second lowest total since this count began in 1993 and less than half of last year's total.

While monarch butterflies can be found across the continental United States, current research has uncovered previously unknown life history tactics for this species in the Southeast specifically. Kendrick and McCord (2023) recently published findings of monarch butterflies using coastal plain maritime habitats to overwinter and inland swamps in the southeast for breeding, feeding, and migrating. This research discovered monarch butterflies using swallow-wort (*Pattalias palustre*) as a host plant. This finding is significant as it is the first time that monarch butterflies have been recorded using this species as a host plant, which grows on the edges of marshes in the Southeast.

Additionally, shifts in migratory strategies in the eastern United States monarch butterfly population (*e.g.*, stopping over in migration and/or breeding in overwintering populations) are being discovered, which have important implications for disease dynamics, habitat restoration, and understanding the future conditions that may impact the resiliency and long-term persistence of this species. Altering the hydrology of the Okefenokee Swamp could have significant impacts on the monarch butterfly, which may rely heavily on the natural resources afforded by the area.

Sturgeon

The shortnose sturgeon *(Acipenser brevirostrum)* and South Atlantic Distinct Population Segment of Atlantic sturgeon *(Acipenser oxyrinchus)* both inhabit the St. Marys River. These

species are under the purview of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) and are federally protected under the Endangered Species Act. NMFS has designated critical habitat for the Atlantic sturgeon in St. Marys River. In a letter dated May 19, 2023, NMFS expressed concern to the GA-EPD that TPM project activities may adversely impact the St. Marys River and possibly both sturgeon species and their designated critical habitat, citing changes to river water depth, discharge, temperature, and dissolved oxygen. Although the GA-EPD believes that impacts will be non-existent or minimal, the Service remains concerned and asks if there is a plan to monitor potential impacts to sturgeon species that could be impacted by the proposed mining operations, including water quality and quantity parameters important to the species' life histories.

Hydrologic Concerns

In addition to ONWR's riparian rights under Georgia law, federal reservations are entitled under federal law to water sufficient to maintain the purpose of that reservation. *See, e.g., Winters v. United States*, 207 U.S. 564 (1908); *Cappaert v. United States*, 426 U.S. 128 (1976); *Arizona v. California*, 373 U.S. 546 (1963). In 1937, President Franklin Delano Roosevelt established the ONWR by Executive Order pursuant to the Migratory Bird Conservation Act of 1929 (45 Stat. 1222).[4] *See* Executive Order 7593, 2 FR 739 (March 30, 1937). The Executive Order stated that the land within ONWR boundaries was "hereby, reserved and set apart … as a refuge and breeding ground for migratory birds and other wildlife…" *Id.* Based on this reservation, the Service submitted a letter to the GA-EPD dated January 31, 2024, asserting that its water rights be considered as part of its comments on the draft permits (Enclosure 2). We reference that letter here to affirmatively request that it be incorporated as part of our comments.

In 2022, the Service received an independent technical review conducted by hydrologic modeling experts from the National Park Service's (NPS) Everglades National Park South Florida Natural Resources Center pertaining to the proposed TPM mining project. The technical review enclosed in our letter dated March 17, 2023, concluded that the modeling used to predict the magnitude, extent, and types of impacts from the proposed mining process and reclamation plan was not adequate to accurately predict impacts to the Okefenokee Swamp wetland ecosystem including the ONWR. TPM provided a rebuttal to the 2022 NPS technical review, stating "NPS's comments and concerns are unfounded" and rebutted similarly on the independent reviews conducted by Dr. Rhett Jackson and Mark Hutson, concluding the proposed mine, including groundwater withdrawals and mine pit dewatering, will have no or minimal effect on the Okefenokee Swamp and ONWR. The GA-EPD similarly stated that TPM models demonstrate that the mine would have a minimal impact on the ONWR, even during drought periods. The Service disagrees with the GA-EPD's conclusions. The 2022 NPS comments provide a clear and accurate explanation of the faulty assumptions that undermine TPM's models and their predictive capability in assessing impacts on ONWR. The NPS stands by its comments and the Service asserts that its concerns have not been adequately addressed by GA-EPD or

[3] The Migratory Bird Conservation Act, 45 Stat. 1222, itself is intended to "lessen[] the dangers threatening migratory game birds from drainage and other causes, by the acquisition of areas of land and of water to furnish in perpetuity reservations for the adequate protection of such birds…" (emphasis added). *Id.*, Chap. 257.

TPM. On March 29, 2024, NPS provided the Service with specific responses to TPM's rebuttal. The Service requests that the enclosed 2024 NPS technical review (Enclosure 3) be considered as part of our comments on the draft permits. The 2024 NPS technical review highlights our primary concerns regarding critical shortcomings in the modeling and analyses used for prediction of impacts on the Okefenokee Swamp's hydrologic system, including but not limited to:

- Modeling and analyses failed to capture important natural variability in recharge rates and therefore did not adequately quantify potential impacts to ONWR during dry periods, when ecosystems are most vulnerable.
- Modeling techniques using steady-state models with average conditions or level-pool reservoir methods were not appropriate for determining impacts outside of their narrow range of calibration.
- Important modeling and analysis details were not provided, such as specific analysis methodologies and depth-volume curves used to calculate changes in water depth at ONWR.
- Quantification of impacts to ONWR from steady-state model results have been repeatedly presented where the change in flows between the mine site and ONWR were not quantified, and instead results were provided for areas outside of the direct flow path.
- The analysis of incorporation of re-dredged bentonite into the soil column showed effects on stages at the mining site but did not account for multiple re-dredged rows.

The ultimate determination by NPS hydrologists is that the modeling used to predict the magnitude, extent, and types of impacts from the mining processes and proposed reclamation was not adequate to ensure that no harmful impacts will be made to the ONWR. New analyses presented in the current application attempted to resolve some of the issues but are still insufficient in providing reasonable evidence that harmful impacts would not occur. Given the concerns raised by NPS and comments submitted by Jackson (2024) regarding the integrity of the modeling used to predict hydrologic impacts on the ONWR, the Service strongly recommends the convening of an independent panel of hydrologists to review the models submitted by GA-EPD and TPM to fully evaluate their adequacy to predict impacts on the hydrology of the ONWR.

Comments on Draft Permits

The Service maintains that the permits should be denied. However, to the extent that they are issued, the following are the Service's comments on the specific draft permits under consideration for approval or denial by the GA-EPD.

General Comments on Monitoring Requirements

To be protective of the significant natural resources at risk from adverse impacts, all monitoring should include parameters to specify when the measured element(s) are out of compliance and identify a specific course of action in response. Considering the risk to the ONWR and Okefenokee Swamp, to the extent GA-EPD has the authority, the Service requests expressly

specifying that if any permit conditions are out of compliance or if any activities are found to have an unreasonable adverse effect upon the water uses in the area, GA-EPD pursue permit revocation, penalties, or bond forfeiture to the extent of its authority.

Surface Mining Permit

Section A 8 – Pond Operation Monitoring Plan – The Service has reviewed the Appendix P Water Use Management Plan, and we assume that it is to be considered the Pond Operation Monitoring Plan. The Service is interested in knowing whether there is a plan for the disposal of water if all ponds are at capacity and the evaporators are not keeping up or working, in an overflow situation. In this situation there is also no plan mentioned for sampling any overflow water for water quality contaminants. The Service recommends GA-EPD add a requirement to the Pond Operation Monitoring Plan to include a plan for disposal of water if all ponds are at capacity and the evaporators are not keeping up or working in an overflow situation, and a sampling regime of overflow water for water quality contaminants.

Section A 9 and 10 – Evaporators – The Service's understanding is that as proposed, the use of evaporators is an unproven technology in this application. Documents submitted by TPM to GA-EPD (appendix U-2) indicate that the first generation of the technology was tested in 2017 in Utah. The current, third generation was tested in 2022 in New Mexico. No mention is made of testing in humid environments. The ability of the technology is based on calculations and simulations, not actual performance in a similar environment and application. GA-EPD states in the Memorandum Hydrologic Analysis pdf p.36, "… evaporation of wastewater at 1,000 gallons per minute (with 55 evaporators each at 40 gallons per minute capacity), we concluded that the water management as described is feasible and is without the need to discharge." The Service asserts that this unproven, unique technology may not work as designed, particularly in the high humidity environment of southern Georgia. In most cases of evaporation, solids will be left behind as evaporites, but strong air currents can mobilize the evaporites and suspend them in water droplets. If the wastewater contains contaminants, the contaminants might evaporate before or after the actual water fraction, depending on their density or environmental conditions. In general, it is possible for a variety of contaminants to become aerosolized or airborne depending on the material or compound involved and turbulence of the air present. The Service recommends monitoring for any airborne contaminants leaving the immediate edges of the water management ponds. The Service makes this recommendation for monitoring based on the untested nature of the technology in this application. The manufacturer of the equipment states that the process returns clean water to the air as a vapor and TPM states that any solids will be left behind in the pools and disposed of by returning them to the moving mine pit. TPM's description of the solids is 'dissolved solids', 'sludge', and 'slimes'. While all materials had been recently dug up in the mining process, the Service opines that as we previously stated, the process is untested, the quantities of solids, their properties, how they end up being distributed on and possibly off the site are yet to be determined.

Section A.10 Evaporation Pond Annual Report – The Service recommends requiring a monthly report for at least the first twelve months of the reporting period. If there are no overflows or

water levels greater than the "sufficient freeboard" of 1.81 feet, as mentioned in Appendix P Water Use Management Plan, or other more appropriate level as determined by the GA-EPD, then quarterly reports may be appropriate. This recommendation is due to the unknown and untested nature of the process proposed for this part of the project. The effects of spills of 'dissolved solids', 'sludge', and 'slimes' is not known. The Service recommends TPM demonstrate that the processes will perform as proposed rather than base assumptions on calculations and simulations.

Section B Reclamation – Due to the remote location of the proposed project, the Service recommends that monthly aerial images be provided to GA-EPD to monitor mining and reclamation progress, along with an accompanying report describing what has been completed during the monitoring period and issues encountered.

Section B 2 Reclamation – The Service recommends adding a requirement to record the thickness of the consolidated black sands and distance from the surface that it begins at each soil boring location. This would help inform the GA-EPD and others of its characteristics before mining and may be helpful if any adaptive management or additional reclamation efforts are required.

Section C 1 Additional Permittee Requirements – financial assurance responsibility – The bonding requirement in Surface Mining Rule 391-3-3-03 has a maximum of $2,500 per acre "of the affected land". The Service understands GA-EPD authority to determine what is the affected land is limited to the actual mine site and the amount of bond per acre is also limited. However, the Service opines that the bond may not be enough to mitigate for impacts to areas outside the mine footprint, at a minimum, the eastern portions of the Okefenokee Swamp and the upper reaches of the St. Marys River. The Service asserts that if negative impacts do occur as a result of mining operations, there would likely not be enough funding available to appropriately restore the hydrology of the ONWR and the financial burden would most likely fall on state and/or federal government.

Section C 3 – Operational Changes - To maximize transparency of this demonstration mine, we request that any proposed changes to the Mine Land Use Plan be subject to public comment.

Section C 4 through 8 – The Service recommends that the amount of water pumped out of the ground be reported daily to allow public and private land managers to monitor changes in local and regional hydrology, including changes to water quality and water table level characteristics.

Section C 4 – The Service requests a condition in the permit requiring the Applicant complete three years of baseline data gathering, including monitoring water levels in the Okefenokee Swamp and groundwater drawdown under the Okefenokee Swamp, prior to initiation of any ground disturbance or excavation. The Okefenokee Swamp to the west of the project site and St. Marys River to the east of the project site are environmentally sensitive areas with little historical hydrologic data. Due to natural fluctuations in hydrology, we consider three years as a minimum time period to collect baseline data. The Service also recommends that additional ground and surface water monitoring wells be installed and monitored monthly before, during, and after

implementation of mining operations. Application submittals document that the hydrologic modeling extended into the refuge; however, there are no monitoring wells in the Okefenokee Swamp to confirm the validity of the model results once mining operations are initiated. Water quality laboratory analyses are being conducted for locations on the TPM property. However, adequate sampling has not been conducted in environmentally sensitive areas of the southeast basin of the Okefenokee Swamp and the upper portions of the St. Marys River located east and west of the property.

Section C 5 – Water quality trends – The Service recommends that GA-EPD be notified of any change in water quality trends in the Okefenokee Swamp and St. Marys River and its tributaries. The GA-EPD should not leave the decision to the permittee to decide whether or not declining water quality trends can be attributed to mining and/or reclamation operations.

Section C 6 – Report timing – The Service recommends water quality reporting occur on a quarterly basis throughout the life of the TPM mining project.

Section C 7a – The draft permit states that the Permittee shall notify GA-EPD within 30 days of the monitoring event if post-mining groundwater levels drop below 2.7 feet of the normal elevations (3 standard deviations (SD) based on daily groundwater elevations beginning in January 2019 and ending in April 2021 in the historical hydrograph. Considering a standard deviation value of 0.9 feet (1 SD) from the normal elevation, this depth is inappropriate. The Service recommends using an elevation level drop of 1.8 feet (2 SD) to allow greater time to correct any issues concerning groundwater levels and for GA-EPD to determine if trends in groundwater levels trends can be attributed to mining operations. Several elements of the groundwater monitoring requirement are unclear to the Service. Please clarify whether the water levels will be monitored at all of the wells in the groundwater monitoring plan. If the permit condition does require water levels to me monitored at all of the wells in the groundwater monitoring plan, the Service requests that the reporting be required. Does this condition require that a report be generated if any well drops 2.7 feet below normal elevations? If a decline in groundwater levels is observed, what action will be taken by the permittee and GA-EPD? The Service requests adding a requirement to pause pumping activities until groundwater elevations return to normal.

Section C 8 – Contingency Plan – The language “cannot be directly attributed to unrelated mining activities” should be modified to state that the GA-EPD shall be responsible for determining if any groundwater level or water quality can be attributable to any mining-related activities.

Section C 9 and 10 – The Service recommends including as a permit requirement continuing monitoring and reporting abandoned wells and/or piezometers on a monthly basis for at least 5 years post-mining activities, as stated in the Mining Land Use Plan Summary from January 19, 2023.

Groundwater Withdrawal Permit

The general wording and reference to multiple aquifers indicates that this permit was not written with specific reference to the proposed TPM mining operation. The Service requests that GA-EPD ensure that concerns expressed in the public comment period that are applicable to conditions for this specific TPM permit be included. Our understanding is that this area of the State lacks quantified information on aquifers and confining layers, and therefore, there is a high level of uncertainty regarding the effects of groundwater withdrawal on the regional aquifers. The Service asserts that this uncertainty, coupled with anticipated increased groundwater withdrawals from the same aquifer (*i.e.*, four proposed municipal wells in northern Bryan and southern Bulloch Counties), will compound negative impacts to the ONWR.

Section 4 Monitoring and Reporting – The total amount of water produced (pumped) monthly will be reported. The Service recommends that daily production by each of the two wells be monitored and included as part of the reporting requirement. This requirement could help inform any future impacts of the project.

Section 4.c. and d. The Service recommends monitoring the static and pumping levels of the Floridan aquifer and Specific Conductance at least quarterly to gain insight into the impact of the mine on the aquifer. Additionally, quarterly monitoring would provide valuable data for the Suwannee-Satilla Regional Council.

Section 5.b. Water Planning Requirements - The life of the proposed mine is four years. Having a Water Conservation Progress Report required every five years seems to be applying general conditions to the project that are irrelevant to this specific project. The Service recommends requiring an annual Water Conservation Progress Report.

Section 5.e. Water Planning Requirements - The draft permit specifies that TPM must maintain ongoing compliance with applicable Suwannee - Satilla Regional Water Plan (SSRWP) requirements. The SSRWP specifies that GA-EPD "consider "institutionalizing" planning. This would entail a long-term commitment of staff and funding to: monitor and support Plan recommendations; coordinate improved data collection, management, and analysis; continue to develop and improve Resource Assessment tools; and help provide funding, permitting, and technical support to address challenges and water resource needs. Monitoring and documenting TPM's water usage, fluctuations in the surficial and Floridan aquifer at the mine site and making this data available to the public and researchers is important in increasing our knowledge of the water challenges facing southeast Georgia and future modifications to the plan and the permitting process. The Service's recommendation for more frequent monitoring of water parameters supports the SSRWP.

Air Quality Permit

This permit is required to meet the guidelines for a Class I Airshed considering the proximity of the Okefenokee National Wilderness Area.

Section 6.1.b - Performance Testing – The Service recommends that all test results shall be submitted to the GA-EPD within thirty (30) days of the completion of testing. The Service considers 60 days as too long a time period before results of testing are returned to the GA-EPD. Impacts could be occurring that should be addressed in a timelier manner.

The Service's understanding is that as proposed, the use of evaporators is an unproven technology in this application. GA-EPD states in the Memorandum Hydrologic Analysis pdf p.36, "… evaporation of wastewater at 1,000 gallons per minute (with 55 evaporators each at 40 gallons per minute capacity), we concluded that the water management as described is feasible and is without the need to discharge." The Service asserts that this unproven, unique technology may not work as designed, particularly in the high humidity environment of southern Georgia. In most cases of evaporation, solids will be left behind as evaporites, but strong air currents can mobilize the evaporites and suspend them in water droplets. If the wastewater contains contaminants, the contaminants might evaporate before or after the actual water fraction, depending on their density or environmental conditions. In general, it is possible for a variety of contaminants to become aerosolized or airborne depending on the material or compound involved and turbulence of the air present. The Service recommends monitoring for any airborne contaminants leaving the immediate edges of the water management ponds.

Visitor Experience

The Service asserts that proposed TPM mining operations will have probable negative impacts on the visitor experience at the ONWR. We provide the following comments on the revised Mining Land Use Plan regarding potential impacts that are incompatible with visitors' authentic and complete wilderness experiences at the refuge.

Appendix Y Night Lighting Analysis - Sky glow or a light dome on the horizon all night is not compatible with the ONWR's visitor experience goals. Sky glow effects are considered for Stephen C. Foster State Park, which lies within the ONWR, a designated International Dark Sky Park. The appendix states that there will be no impacts to visitors' Wilderness experience but does not specifically state that there will be no additional sky glow from the project visible from overnight visitors' wilderness camping platforms in the southeast portion of the Wilderness such as Monkey Lake Overnight Shelter, located approximately 10.6 miles from the proposed mine. The appendix only says that the light would not be seen. It is unclear if this means project lighting will not be directly seen, indirectly seen, or the sky glow from the lights will not be seen. The Service asks if it can be clearly stated and justified that sky glow or light dome from the mining project will not be seen under any given atmospheric condition.

Appendix Z Noise Analysis - The analysis states that project noise is predicted to be 40 A-weighted decibels (dBA) at the edge of the refuge, comparable to the sound level inside a quiet library or office and less than the sound of a motorboat in the refuge. The closest overnight recreational area in the ONWR is the Monkey Lake Overnight Shelter which is approximately 10.6 miles from the project area. The analysis does not quantify the sound level at the Monkey Lake Overnight Shelter other than to state the information described above. Even at very low dBA levels, any audible droning hum of mining equipment through the day or night is not

compatible with ONWR's Wilderness visitor experience goals. The Service requests that additional analysis be conducted to determine if noise levels at the closest overnight recreational area in the ONWR, the Monkey Lake Overnight Shelter, would be at levels that are incompatible (*i.e.*, audible) with the expected visitor experience at the refuge.

Summary

The Okefenokee Swamp is an irreplaceable natural feature with established national cultural and biological significance. The Service opposes the TPM mining project and is profoundly concerned that the mining operations will result in long-term, permanent, and irreparable impacts to the hydrology, habitats, and visitor experiences unique to the Okefenokee Swamp and ONWR. We do not consider the concerns we have expressed previously to have been adequately addressed, particularly our concerns related to the shortcomings and inconsistencies associated with TPM's groundwater modeling and rebuttal to our comments on the draft Mining Land Use Plan. The Service strongly recommends denial of the permits for the TPM mining project due to threat of permanent and irreversible adverse impacts to a one-of-a-kind, irreplaceable national treasure. However, in the event that permits are approved, the Service expects that GA-EPD will carefully consider the suggested revisions to those permits as outlined above, and that use under any permit would be restricted if it interferes with ONWR's water rights.

Sincerely,

Mike Oetker
Regional Director

Enclosure (1)
Literature Cited

Enclosure (2)
List of Federal Trust and State Imperiled Species Within the Okefenokee National Wildlife Refuge

Enclosure (3)
Letter Submitted from the Service to the GA-EPD Dated January 31, 2024, Asserting its Water Rights

Enclosure (4)
Independent Technical Review of the Twin Pines Permit Application Hydrologic Modeling

Enclosure (1)
Literature Cited

Bates, C. (2020). Wildfire Damage Assessment for the West Mims Fire. Chip Bates, Forest Health Coordinator, Georgia Forestry Commission. 12 p.

Bauder, J.M., D.R. Breininger, M.R. Bolt, R. Breininger, M.L. Legare, C.L. Jenkins, B.B. Rothermel, K. McGarigal. (2018). Multi-level, multi-scale habitat selection by a wide-ranging, federally threatened snake. Landscape Ecology. 33:743-763.

Conner, R. N., D. C. Rudolph, and J. R. Walters. (2001). The red-cockaded woodpecker surviving in a fire-maintained ecosystem. University of Texas Press, Austin, Texas, USA.

Donovan, V. M., R. Crandall, J. Fill, and C.L. Wonkka. (2023). Increasing large wildfire in the eastern United States. Geophysical Research Letters, 50, e2023GL107051. https://doi.org/10.1029/2023GL107051

Jackson, C. R. (2024). *Continued problems with the assessment of the hydrologic effects of the proposed TPM LLC mineral sands mine and a recommendation for an independent expert panel*. Memorandum submitted to Georgia Environmental Protection Division, 27 March 2024.

Kendall, B., Steen, K., Schmidt, H., & Plott, L. (2022). Okefenokee Water Resources: Using Earth Observations to Assess Hydrologic Changes and Wildfire Risk in the Okefenokee Swamp.

Kendrick, M. R. and J.W. McCord. (2023). Overwintering and breeding patterns of monarch butterflies (*Danaus plexippus*) in coastal plain habitats of the southeastern USA. Scientific Reports, 13(1), 10438.

Kitchens, S. and T.C. Rasmussen. (1995). Hydraulic Evidence for Vertical Flow from Okefenokee Swamp to the Underlying Floridan Aquifer in Southeast Georgia. In *Proceedings of the 1995 Georgia Water Resources Conference* (pp. 156-157).

Sutton, C., Kumar, S., Lee, M. K., & Davis, E. (2021). Human imprint of water withdrawals in the wet environment: A case study of declining groundwater in Georgia, USA. Journal of Hydrology: Regional Studies, 35, 100813.

U.S. Energy Information Administration (US EIA). (2021). Energy-related CO2 emission data tables. Available at: https://www.eia.gov/environment/emissions/state.

U.S. Fish and Wildlife Service (Service). (2019). Species status assessment report for the eastern indigo snake (*Drymarchon couperi*). Version 1.1, July, 2019. Atlanta, GA.

U.S. Fish and Wildlife Service (Service). (2020). Species status assessment report for the red-cockaded woodpecker (*Picoides borealis*). Version 1.3, April 2020. Atlanta, GA.

U.S. Fish and Wildlife Service (Service). (2021). Species status assessment report for the alligator snapping turtle (*Macrochelys temminckii*), Version 1.2. March 2021. Atlanta, GA.

Weisman, R. and Kirkland, D. (1998), An Archaeological Reconnaissance of Trail Ridge Charlton County, Georgia. Southern Research, report number 1661, 1998. University of Georgia, Athens, Georgia.

Williams, L. J. and E.L. Kuniansky. (2015). Revised hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama, and South Carolina (No. 1807). U.S. Geological Survey.

Enclosure (2)
List of Federal Trust and State Imperiled Species Within the Okefenokee National Wildlife Refuge

Federal Trust Species

American Alligator (T, Similarity of Appearance)
Bald Eagle (N)
Ciliate-leaf Tickseed (P)

Eastern Diamond-backed Rattlesnake (P)
Eastern Indigo Snake (T)
Florida Pine Snake (P)
Florida Sandhill Crane (N)
Frosted Flatwoods Salamander (T)
Gopher Frog (P)
Hairy Rattleweed (E)
Hartwrightia (P)
Red-cockaded woodpecker (E)
Spotted Turtle (P)
Suwanee Alligator Snapping Turtle (Proposed T)
Tricolored Bat (Proposed E)
Wood Stork (T)

State Imperiled

Blackbanded Sunfish
Crestless Plume Orchid
Dwarf Witch Alder
Florida Wild Privet
Florida Sandhill Crane
Fly Catcher/Golden Trumpet
Gopher Tortoise
Greenfly Orchid
Hooded Pitcherplant
Okefenokee Giant Pitcherplant
Parrot Pitcherplant

Pond Spice
Purple Honeycomb Head
Rafinesque's Big-eared Bat

Round-tailed Muskrat
Sandhill Rosemary
Silver Buckthorn
Southeastern Pocket Gopher
Southern Hog-nosed Snake
Striped Newt
Swallow-tailed Kite
Velvet Sedge
Yellow Flytrap

E – Endangered
T – Threatened
C – Candidate
P – Petitioned, Under Review
N – Not Listed Under the Endangered Species Act
AR – At-Risk

Enclosure (3)
Letter Submitted from the Service to the GA-EPD Dated January 31, 2024, Asserting its Water Rights

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

In Reply Refer To:
FWS/R4/RD/080327

January 31, 2024

Mr. Jeff Cown, Director
Georgia Environmental Protection Division
2 Martin Luther King Jr. Drive, SE
14th Floor East Tower – Suite 1456
Atlanta, Georgia 30334-4713

Dear Director Cown:

As a follow up to my March 2023 letter, I am writing to formally assert the U.S. Fish and Wildlife Service's (USFWS) federal reserved water rights for the Okefenokee National Wildlife Refuge (ONWR). As Georgia Department of Natural Resources - Environmental Protection Division (GA-EPD) considers issuing a potential groundwater permit to Twin Pines Minerals, LLC (TPM) to withdraw water from the Upper Floridan Aquifer (UFA) and to dewater mining pits as part of the proposed mining project in Charlton County, Georgia, it is crucial to carefully consider the implications of such a decision on the delicate ecosystem of ONWR. Prior to any decision to issue or deny a permit, I request that the USFWS and the GA-EPD employees meet and work together to quantify the amount of water the ONWR needs to maintain its primary purpose.

Federal reserved water rights are the amounts of water sufficient to maintain the purpose of the ONWR. In 1937, President Franklin Delano Roosevelt established the ONWR by Executive Order pursuant to the Migratory Bird Conservation Act. The Executive Order reserves "all lands, including lands under water" within ONWR boundaries for the purpose of serving as a "refuge and breeding ground for migratory birds and other wildlife." The United States Supreme Court has long held the federal government has a right to preserve its water from subsequent diversion, whether the diversion is of surface water or groundwater. Cappaert v. U.S., 426 U.S. 128 (1976). The National Park Service (NPS) staff at the South Florida Natural Resources Center (SFNRC) conducted an Independent Technical Review of hydrological modeling of the proposed mining application. Based on the NPS review, significant questions were raised about the potential to directly impact ONWR, especially through the proposed water withdrawal from the UFA and the dewatering of mining pits. Dewatering of the mine pits alone could remove 16% of the total estimated recharge to the modeled area. Disruption to the natural flow of groundwater in this interconnected system could have far-reaching consequences for both the Refuge and surrounding areas. The mining operation, as originally proposed, could have a significant impact to groundwater through either withdrawals or re-direction of current flows. Without sufficient water, the primary purpose of ONWR could be compromised.

Given the significant role that water plays in sustaining the diverse flora and fauna within the ONWR, any decision regarding the proposed mining permit must be made with consideration of federal reserved water rights. It is imperative that these rights be safeguarded to ensure the long-term health and viability of the Okefenokee wetland ecosystem, safeguarding the integrity of ONWR is preserved for future generations to enjoy. We are concerned that the issuance of a permit at this juncture would not preserve sufficient water to fulfill the purposes for which ONWR was established.

Our teams need to meet to determine ONWR's water needs protected by the federal government's reservation prior to any action on the permit application. I look forward to scheduling the requested meeting.

Thank you for your time and attention to this incredibly important issue.

Sincerely,

Mike Oetker
Acting Regional Director

Enclosure (4)
Independent Technical Review of the Twin Pines Permit Application Hydrologic Modeling

United States Department of the Interior

NATIONAL PARK SERVICE

South Florida Natural Resources Center

Independent Technical Review of the Revised Twin Pines Permit Application Hydrologic Modeling

Kiren Bahm and Rajendra Paudel

South Florida Natural Resources Center, National Park Service

Report Submitted to Fish and Wildlife Service

March 2024

Contents

Figures

Executive Summary

The Fish and Wildlife Service (FWS) requested National Park Service (NPS) South Florida Natural Resources Center (SFNRC) hydrology experts to conduct an independent technical review of hydrologic modeling performed as part of the Twin Pines (TP) revised permit application materials for the proposed Saunders Demonstration Mine. The NPS team reviewed several documents for the TP mining permit application posted on the Georgia Environmental Protection Division (GA-EPD) website in 2024 (Georgia Environmental Protection Division, 2024).

The hydrologic modelers at the SFNRC have specialized expertise in multidimensional hydrologic modeling and in the hydrologic modeling tools used as well as many years of experience in freshwater wetlands research and surface water/groundwater interactions. We were tasked to review the modeling performed as part of the TP mining permit application to determine if the modeling was sufficient to conclude that there would be no harm caused to the Okefenokee National Wildlife Refuge (ONWR).

Focusing on modeling and analyses presented in (GSI, 2023-W), (Zeng, 2023), and (GA-EPD, 2024), we reviewed data accuracy, modeling assumptions, modeling methodologies, quantification and interpretation of results, and ultimate conclusions drawn from the analyses.

Our analysis revealed a series of critical shortcomings in the modeling and analyses used for prediction of impacts to ONWR. These shortcomings include:

- Modeling and analyses failed to capture important natural variability in recharge rates and therefore did not adequately quantify potential impacts to ONWR during dry periods, when ecosystems are most vulnerable.
- Modeling techniques using steady-state models with average conditions or level-pool reservoir methods were not appropriate for determining impacts outside of their narrow range of calibration.
- Important modeling and analysis details were not provided, such as specific analysis methodologies and depth-volume curves used to calculate changes in water depth at ONWR.
- Quantification of impacts to ONWR from steady-state model results have been repeatedly presented where the change in flows between the mine site and ONWR were not quantified, and instead results were provided for areas outside of the direct flow path.
- The analysis of incorporation of re-dredged bentonite into the soil column showed effects on stages at the mining site but did not account for multiple re-dredged rows.

Our ultimate determination is that the modeling used to predict the magnitude, extent, and types of impacts from the mining processes and proposed reclamation were not adequate to ensure that no harmful impacts will be made to the ONWR. New analyses presented in the current application attempted to resolve some of the issues but were still not sufficient to provide reasonable evidence that harmful impacts would not occur.

1 Introduction

The Fish and Wildlife Service (FWS) has requested that the hydrology experts at the National Park Service (NPS) South Florida Natural Resources Center (SFNRC) independently review the hydrologic modeling and modeling results presented for public comment as part of the 2024 Twin Pines Saunders Demonstration Mining Permit Application. These materials, along with other supporting documents, have been posted for review on the Georgia Environmental Protection Division (GA-EPD) public website (Georgia Environmental Protection Division, 2024).

The authors of this report are hydrologists at the NPS with specialized experience in coupled surface water-groundwater modeling and in wetlands hydrology. Kiren Bahm has 10 years of experience working with MODFLOW models and has been a hydrologist at the SFNRC for 15 years. Her master's degree is in physics. Dr. Rajendra Paudel has more than 15 years of experience in hydrologic modeling including the applications of groundwater flow models. He has his Ph.D. in Soil and Water Science, focused on hydrologic and water quality modeling.

As part of the 2024 permit application, GA-EPD and GSI have both provided new analyses and modeling results using the GSI steady-state model, level-pool reservoir models, and other methods to quantify the effects of the proposed mining operations on the local environment and on the Okefenokee National Wildlife Refuge (ONWR). NPS has reviewed several documents, focusing on (GSI, 2023-W), (Zeng, 2023), and (GA-EPD, 2024), and found numerous issues and uncertainties with these models and analyses. Findings are presented in this report.

The NPS comments summarized in our previous report (Bahm & Paudel, 2023) provided a clear and accurate explanation regarding specific modeling assumptions that have undermined the predictive capability of the modeling to assess the entirety of potential impacts on ONWR. The NPS stands by their previous review comments and provides responses to the comments made by GA-EPD and GSI in this report.

Section 2 of this report presents our comments on major problems that have not been addressed in the modeling for the Twin Pines Permit Application, focusing on a review of the new modeling and analyses since the last public review. Section 3 provides response comments to GA-EPD and GSI regarding important issues. The last section summarizes our findings and conclusions from this analysis.

2 Findings

2.1 Natural variability is not properly accounted for in assessments

Evaluating effects of the mining operations during dry seasons and droughts is critical to be able to quantify effects on the surrounding ONWR ecosystems. Even a minor reduction in the flow to this freshwater ecosystem can have a disproportionately critical impact on its ecosystem functions (Lake, 2011), (Rolls, Leigh, & Sheldon, 2012). Decreases in water availability can cause dry events to be more severe or more frequent. As such, it is important when evaluating hydrologic impacts, to do so within the context of natural variability of the system. The attempts since the last public review to incorporate variability into the new modeling and analyses are a step in the right direction yet still fall short of fully

addressing this issue. NPS maintains its concern about using an over-simplified representation of the system that does not reflect natural variability when attempting to evaluate the impacts of mining.

Precipitation and evaporation data from the Trail Ridge area are a good example demonstrating the variability in the system. Figure 1 shows the annual precipitation and evapotranspiration data from 2003 to 2017 at the Folkston, GA, station ID USC00093460, near Trail Ridge. In years 2006 and 2010, the evapotranspiration exceeded precipitation, resulting in dry years with a *negative recharge*. In contrast, the GSI study (GSI, 2023-W) used a recharge rate of +3.5 inches / year to model a 'drought' condition. Figure 2 depicts daily precipitation data from the Folkston, GA, station ID USC00093460, located closest to the Trail Ridge, spanning the years 2007-2008. Figure 2 underscores the considerable variability in precipitation, as evidenced by four instances over a two-year period where there was zero precipitation for 30 consecutive days or more, indicating zero recharge.

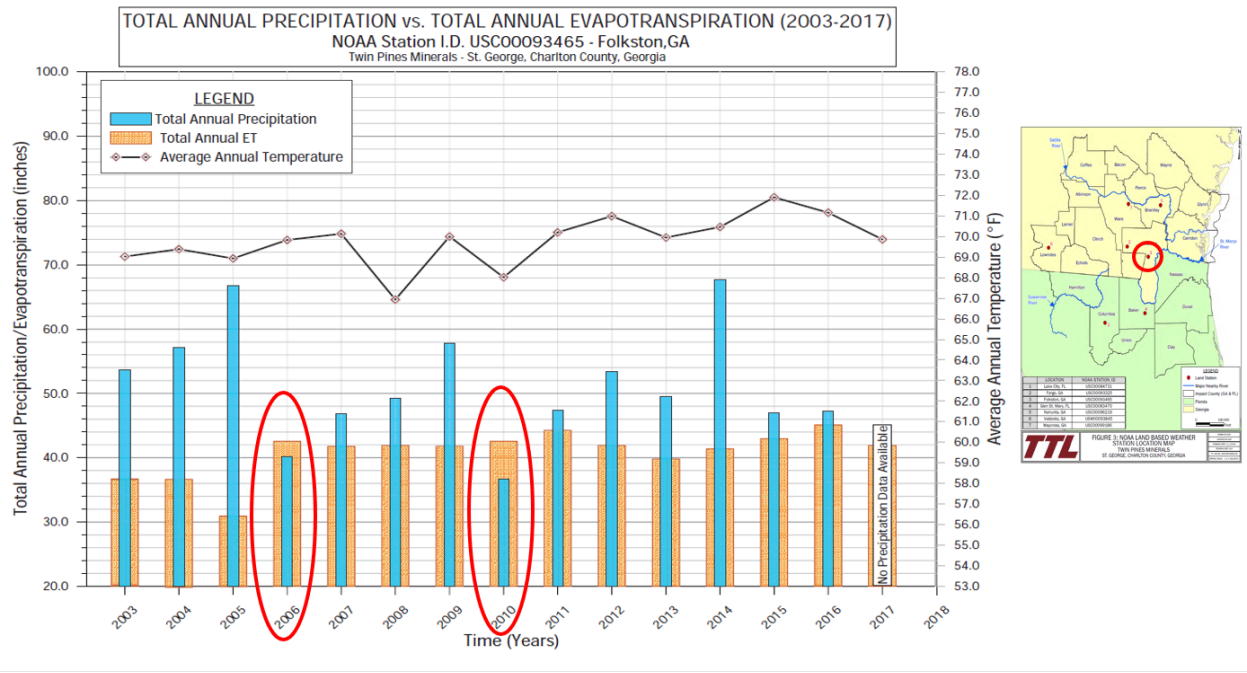

FIGURE 1. MEASURED ANNUAL PRECIPITATION, ET, AND TEMPERATURE AT FOLKSTON, GA. STATION ID USC00093460 IS LOCATED NORTH OF THE PROPOSED MINING LOCATION. REPRODUCED FROM (HOLT R. M., TANNER, SMITH, PATTON, & LEPCHITZ, 2019-JB). AS CAN BE SEEN IN THE GRAPHIC, 2006 AND 2010 WERE VERY DRY YEARS. THE ET VALUE IS HIGHER THAN THE PRECIPITATION VALUE IN THOSE YEARS, INDICATING THE YEARLY RECHARGE WAS A NEGATIVE NUMBER.

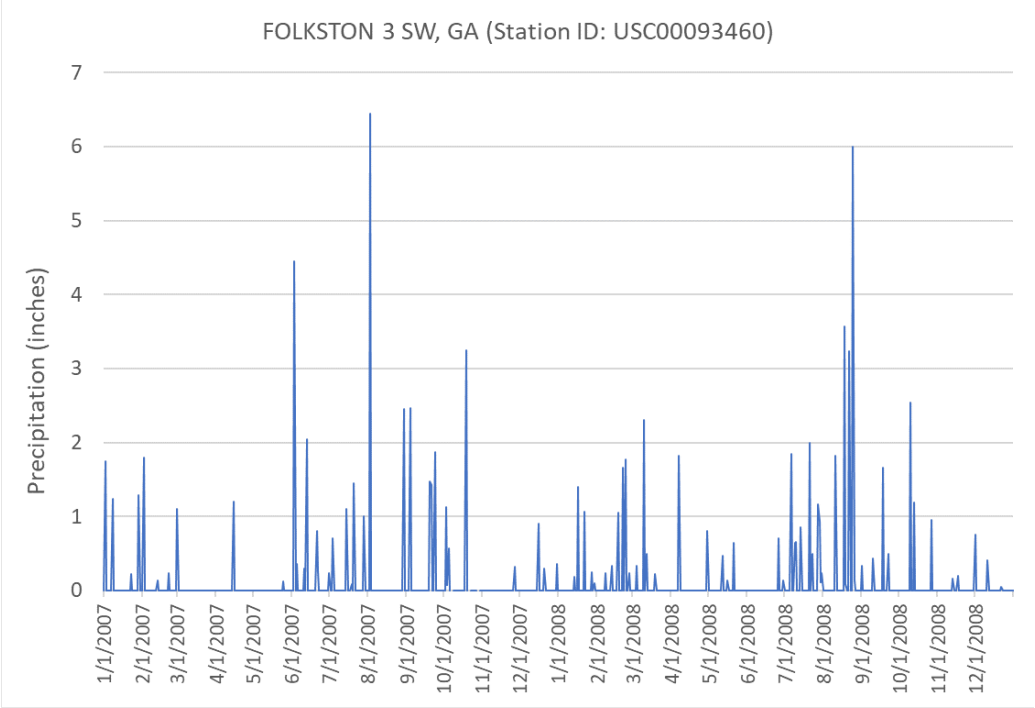

FIGURE 2. DAILY PRECIPITATION DATA AT FOLKSTON, GA, FOR 2-YEAR PERIOD.

RAINFALL PRECIPITATION AT STATION ID: USC00093460, 2007 – 2008. THE LARGER GAPS IN THE DATA ILLUSTRATE THE FREQUENCY OF LONGER PERIODS WITH NO RAINFALL.

References to these figures will be made in the rest of this report when discussing natural variability in the system.

2.1.1 Negative recharge rates were not used in GSI steady-state model

Days without precipitation, or when evaporation is greater than precipitation, indicate zero recharge to the groundwater system.

GSI presents a new analysis using their steady-state model to examine the estimated effects of dewatering the mine pit during dry conditions by running the model with lower recharge rates and lower boundary heads. This is presented in (GSI, 2023-W), Section 2.2, pages 10-14. This new model run was used to make the claim that there would be no impact to ONWR during dry conditions.

This modeling attempt assumes that lowering recharge rate from 4.13 inches/year (representing 'average' conditions) to 3.5 inches/year is appropriate to simulate 'dry' conditions. This is simply unrealistic. As can be seen in Figure 1, 3.5 inches per year of recharge does not accurately represent dry conditions, when the recharge values should be *negative*.

2.1.2 Level-pool reservoir models

Several assessments by GA-EPD presented in (Zeng, 2023) and GSI (GSI, 2023-W) use the level-pool reservoir method to analyze the effects of mining on water levels in the swamp. They characterize the swamp as a wide shallow reservoir, 438,000 acres at a 2-foot depth. Important details are not provided in these analyses such as the shape of the reservoir used for their calculations to simulate the Okefenokee Swamp. The estimation of the swamp's depth-volume relationship is crucial when interpreting variations in swamp volume due to fluctuating water depths seasonally and from year to

year. Since the drought impacts on ONWR are critical, the water depth and area are required to be representative of droughts for assessing the impacts on ONWR. These details are important, and the assumptions made can influence the results. For example, a reservoir with vertical walls would have a different depth-volume relationship (linear) compared to a reservoir with gently sloping walls (nonlinear). In a reservoir with gently sloping walls, the effects of removing a certain volume of water would result in a smaller stage decrease if the reservoir is full. If the reservoir is already at a low stage, removal of the same volume of water would result in a much larger stage decrease. Because we are most concerned with how the Twin Pines water withdrawals may affect the Okefenokee Swamp water depth and hydroperiod during the dry seasons/droughts when water levels are much lower, it is possible that these analyses underestimate the depth decrease to the reservoir in this critical period.

2.1.3 GA-EPD reservoir model of Floridan pumping effects on Okefenokee Swamp

In the section 'Pumping Groundwater from the Floridan Aquifer' by (Zeng, 2023), GA-EPD assesses how much the 1.44 million gallons per day (mgd) direct withdrawal would impact the water depth of the Okefenokee Swamp using a level-pool reservoir method. The analysis begins to touch on our concerns about dry-season impacts, because it uses a multi-year timeseries of precipitation data that provides interannual variability, instead of just using an annual average value.

NPS maintains concerns about using the level-pool reservoir method to draw conclusions about the hydrologic behavior of the Okefenokee Swamp, as described in Section 2.1.2. GA-EPD also makes the point that the aquitard between the Floridan and surficial aquifers is thick enough to not allow flow between the two. However, there remains significant uncertainties in hydrologic connection of the swamp to the Upper Floridan Aquifer due to lack of hydrogeologic data.

2.1.4 GA-EPD reservoir model of dewatering effects on Okefenokee Swamp

In the section 'Seepage into the Mining Pit and Associated Dewatering' in (Zeng, 2023), GA-EPD uses a level-pool reservoir method to investigate the potential impacts of dewatering on the Okefenokee Swamp. NPS maintains concerns about using the level-pool reservoir method to draw conclusions about the hydrologic behavior of the Okefenokee Swamp, as described in Section 2.1.2.

In addition, the analysis only uses half of the 783 gpm average dewatering withdrawal rate. We disagree that one should use only half of the 783 gpm dewatering amount for this analysis. The active section of the mine pit will move back and forth across Trail Ridge. When excavating the western side of the permitted area, the majority of the dewatering water seeps from the western side of Trail Ridge, so it would be more accurate to say that the full 783 gpm is taken from the western side of Trail Ridge approximately half of the time. Because this was a conservative analysis, it would be more appropriate to use the full withdrawal amount with the understanding that it would only apply half of the time. This could cause the projected decrease in water depth of southeast ONWR to double from the GA-EPD predicted values in certain time periods (depending on the depth-volume relationship used).

This analysis lacks important details which must be provided in order to independently verify the conclusions reported in this Section of (Zeng, 2023).

2.1.5 GA-EPD reservoir model of dewatering effects on southeast Okefenokee and Moniac

These analyses from the section titled 'Hydrologic Impact to the Southeast Compartment of the Okefenokee Swamp' from (Zeng, 2023) use a level-pool reservoir model to simulate effects of dewatering by subtracting half of the average predicted amount of water directly from the southeast basin of the Okefenokee Swamp. GA-EPD determines that this could cause a 0.58 inch decrease in surface water levels from the southeast basin of the Okefenokee Swamp, assuming it is entirely disconnected from the rest of the swamp. The analysis uses a 12-year timeseries of water elevation and flow data that provides interannual variability, instead of just using annual averages. Zeng also limited the analysis to only the southeast basin of the swamp, which could become hydrologically disconnected during dry periods. Both changes were improvements for interpreting localized and seasonal impacts. However, the details of how the inflow timeseries was generated and how the results were calculated lacked in the document. This analysis still uses the level-pool reservoir method, which has limitations (described in Section 2.1.2).

GA-EPD also used this analysis to determine impacts of the mining activities on the flow volumes at the Moniac gage. He found that the number of days with zero flow at the Moniac gage would increase from 77 days to 85 days out of a 12-year period. Again, insufficient details were provided in this analysis. Did the number of days with no flow occur in only one year out of 12, or in many years? Did the number of years experiencing at least one day of zero flow increase? These questions are the type of information needed by ecologists to quantify impacts to species and ecosystems.

2.1.6 GSI's generalized water budget assessment of southeast Okefenokee

In pages 14-15 of (GSI, 2023-W), an analysis is performed where modeled reductions in flow from the mining are compared to the estimated water budget of the southeast quadrant of the ONWR. This assessment uses the level-pool reservoir method, which has significant limitations as discussed in Section 2.1.2.

It is unclear why the analysis was done on the southeast *quadrant,* which was assumed to be 25% of the ONWR. In (Zeng, 2023), GA-EPD did an assessment using the Southeastern *Compartment* of the ONWR (Figure 3), which was estimated to be only 6% of the volume of the ONWR. The volume of the southeast quadrant of ONWR is substantially larger than the southeast compartment. Any analyses should make explicitly clear what is meant by 'southeast' so appropriate conclusions can be made regarding any results provided.

In addition, this analysis by GSI again uses annual average values, which cannot be used to quantify potential impacts to the ecosystems of ONWR.

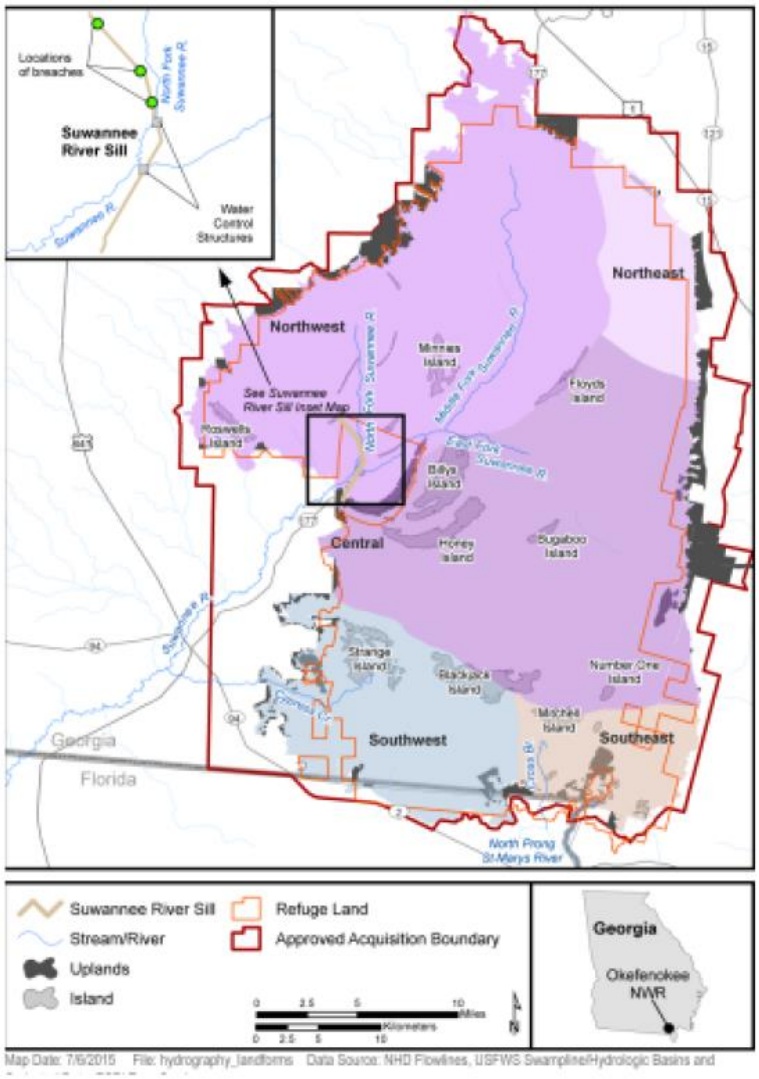

FIGURE 3. LOCAL HYDROLOGIC SUB-BASIN DELINEATION AND SURFACE HYDROLOGY WITHIN ONWR. THIS MAP IS REPRODUCED FROM (ZENG, 2023). THE BROWN SHADED AREA IN THE LOWER RIGHT OF THE FIGURE SHOWS THE SOUTHEAST COMPARTMENT OF THE OKEFENOKEE SWAMP.

2.2 Steady-state models

The steady-state models used in the TP permit application only represent long-term average conditions. While steady-state models are useful for understanding long-term average behavior, they will not capture short-term variations or transient responses to climatic conditions. The accuracy of steady-state models generally limits their application to very specific conditions where the variable of interest is not a function of time. The observed precipitation data (Figures 1 and 2) and groundwater level data (Figure 4 from (Bahm & Paudel, 2023)) indicate substantial seasonal as well as interannual variability. A steady-state groundwater flow model does not accommodate such variability. The worst effects of mining on

ONWR would likely be in extreme events, particularly during droughts. These models built with too simplistic assumptions cannot accurately represent the natural variability.

2.2.1 GSI regional water table contour comparisons

Steady state models are not useful in modeling conditions outside of the narrow premises they were calibrated on. GSI has made several statements without properly reporting necessary disclaimers on the limited conditions under which their conclusions can be considered valid.

For example, on pages 8-9 of (GSI, 2023-W), GSI presents a graphic of predicted regional water levels from non-mining and mining (with dewatering) conditions. The contours are similar for both model runs, and they conclude that there will be "*no perceptible difference in the water table contours under a non-mining and active mining condition off of Trail Ridge*". The authors claim that this is a conservative estimate because the model simulates dewatering as if it had been done 'in perpetuity' (because they are using a steady-state model). For this assessment to be valid, this claim must also include the disclaimer that recharge in the entire area must be 4.13 inches per year 'in perpetuity'. As it is shown in Figure 1, 4.13 inches of recharge does not represent the majority of years, which fluctuate in a range between dry and wet years.

2.2.2 Previous GA-EPD assessment on applicability of steady-state models

GA-EPD has referred to a previous analysis performed by Dr. James Kennedy (Appendix 1 of (Zeng, 2023)) to substantiate that steady-state modeling is adequate to evaluate the impacts of the mine because interannual variability in stages in the area is minimal. Dr. James Kennedy examines contour maps for a day in January and a day in July from the 'State Water Plan revised transient model'. The two days modeled are intended to represent low-recharge conditions and high-recharge conditions, and therefore capture the expected range of annual variability in the system. He provides two screenshots of the contour maps and states that the contours are similar enough to indicate that interannual variability is minimal and concludes that "*a steady state model could be used to simulate conditions at the mine*".

After reviewing the letter explaining Kennedy's analysis, we maintain that it is not obvious how the model used accurately replicates the hydrology around Trail Ridge, and therefore how it can be used to substantiate that steady-state modeling is acceptable for this permit application.

Problems with this analysis include:

1. The two contour surfaces for January 1, 2020, and for July 30, 2020, are exactly the same. The likelihood of not having at least a small amount of variation in the location of the isolines seems minimal. This issue causes concerns that the State Water Plan transient model is not capable of modeling seasonal differences, or that there was potentially an error in the presentation or interpretation of the model results. This is discussed in more detail in (Bahm & Paudel, 2023). For example, in (Bahm & Paudel, 2023), Figure 16 shows groundwater elevation and precipitation for station PZ-01 (close to Trail Ridge) clearly depicting the considerable difference in groundwater levels in June and July (e.g., greater than 4 ft.). This contradicts the claim that "*The lack of change in hydraulic heads between January and July indicates that a steady state model could be used to simulate conditions at the mine*" made in Zeng, 2023.
2. The units on the isolines lines are not given, but as can be seen in Figure 4, the values around Trail Ridge only reach a maximum of 105. If these units are presumed to be feet, they are nowhere near the actual stages along Trail Ridge which have a measured range from

approximately 150 to 170 feet (see measured groundwater surfaces in Figures 7, 8, and 9 in (Holt R. M., Tanner, Smith, Patton, & Lepchitz, 2019-Ib)).

3. If the isolines denote stages in feet, the contour surface in Kennedy's model around Trail Ridge (Figure 4) has the highest stages in the west and the lowest stages in the east, with a constant decreasing slope in between. The model does not show a hydraulic ridge in the Trail Ridge area. Actual stage measurements in the area show Trail Ridge with high stages (~160-170 ft) along the centerline of the ridge, with decreasing stages towards the east and west (see measured groundwater surfaces in Figures 7, 8, and 9 in (Holt R. M., Tanner, Smith, Patton, & Lepchitz, 2019-Ib)).

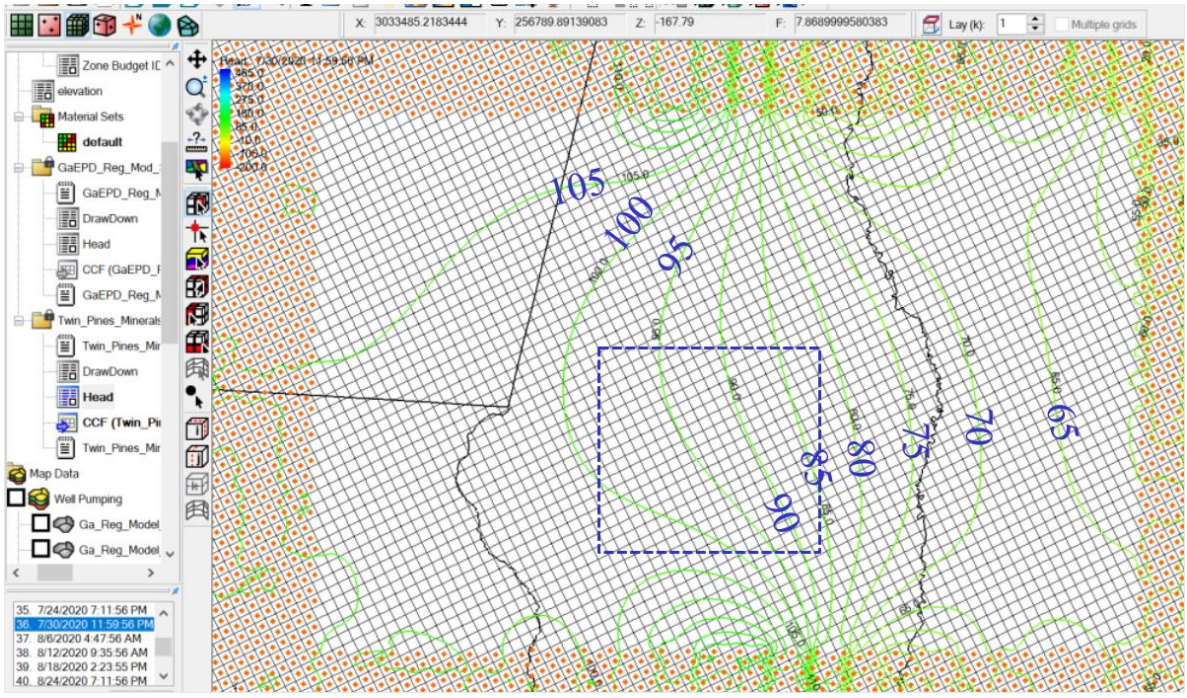

FIGURE 4. A SCREENSHOT FROM THE GA-EPD MODEL USED TO JUSTIFY ACCEPTABILITY OF STEADY-STATE MODELING. THIS FIGURE IS REPRODUCED FROM (ZENG, 2023) APPENDIX 1. THE DASHED BLUE LINE AND BLUE NUMBERS HAVE BEEN ADDED BY THE AUTHORS OF THIS REPORT. THE DASHED BLUE LINE INDICATES THE DOMAIN OF GSI'S STEADY-STATE MODEL. THE BLUE NUMBERS SHOW THE VALUES OF THE ISOLINES (SHOWN IN GREEN). THE ISOLINE VALUES WITHIN THE DASHED BLUE BOX RANGE FROM 80 TO 105.

GA-EPD should provide more detailed documentation of their model and Kennedy's analysis and substantiate their conclusion that steady-state modeling is appropriate. With the information currently provided in Dr. Kennedy's letter to Mr. Wiedl, this argument appears flawed.

2.3 GSI re-dredging analysis

In response to NPS' comments in (Bahm & Paudel, 2023), GSI amended their post-mining conductivities of the homogenized soil layers to represent re-worked bentonite (GSI, 2023-W). The new analysis concluded that if 25% of the first cut was re-dredged and the bentonite from that first cut was mixed into the soil column for the second cut, the hydraulic conductivity of the soil column above and below the new bentonite layer would decrease from 2.21 ft/day to 1.93 ft/day. By running these values

through their steady-state model, they calculated that reworking of bentonite into the entire soil column would result in stage increases in the mined area of up to 1.14 ft.

The limitation of this analysis is that it only calculated the change in hydraulic conductivity for the *second* row of excavation, but then applied that value to all the rest of the mined rows. This analysis did not consider *successive* reworking of the soils along each subsequent row, which could incrementally increase the percent of bentonite in the reworked soils. This would continue to further reduce hydraulic conductivity as mining proceeds from south to north.

Using the same equations as in GSI's analysis (GSI, 2023-W), Figure 5 shows a hypothetical condition where the estimated percent of bentonite and associated hydraulic conductivity values for the reworked sands are extrapolated over 46 potential rows at the mining site, assuming the bentonite layer was placed in every row.

		% Bentonite					
Layer Material	**Layer Thickness (feet)**	**Cut #1**	**Cut #2**	**Cut #3**	**Cut #4**	**...**	**Cut #46**
Bentonite	3	10.900	11.064	11.220	11.369	...	14.076
Reworked Sand	47	0.000	0.164	0.320	0.469	...	3.176

		Hydraulic Conductivity (ft/day)					
Layer Material	**Layer Thickness (feet)**	**Cut #1**	**Cut #2**	**Cut #3**	**Cut #4**	**...**	**Cut #46**
Bentonite	3	0.0003	0.0003	0.0002	0.0001	...	0.0000
Reworked Sand	47	2.2105	1.9328	1.7001	1.5042	...	0.1628

This value for hydraulic conductivity of the soil column was used for GSI's analysis

If 46 rows of redredging were to successively incorporate reworked bentonite, the hydraulic conductivity of the soil column would successively decrease to this value

FIGURE 5. TABLES SHOWING PREDICTED PERCENT BENTONITE AND ASSOCIATED HYDRAULIC CONDUCTIVITIES FOR A HYPOTHETICAL CONDITION IF 46 SUCCESSIVE CUTS WERE TO INCORPORATE RE-DREDGED SOILS CONTAINING A LAYER WITH 10.9% ADDED BENTONITE.

Repeated re-dredging of the bentonite layer as the mining proceeds northward could result in homogenized soils with significantly lower hydraulic conductivity values than before the mining. GSI's modeling of the second row showed a one-foot increase in some stages, so the effects of many more re-dredged rows could result in significantly higher ponding or runoff. The actual implementation of the bentonite layer will depend on results of geologic coring performed during the mining, but there remains a large degree of uncertainty on what hydraulic conductivities the post-mining soil layers will have.

There are also uncertainties in other parts of the analysis. The hydraulic conductivity of the sand-bentonite mixture, for example, is derived from a bench-scale laboratory study, which comprises a limited dataset consisting of only 7 data points. This suggests potential uncertainties in the extrapolation of the regression model used to represent real field conditions.

On a side note, the legend in Exhibit 4-4 of (GSI, 2023-W) does not appear to match the description in the text. It is presumed that the legend should indicate higher positive stage differences for most of the mining site where hydraulic conductivities of the soils have decreased.

2.4 GSI repeats errors in quantification of potential effects on ONWR

The analyses performed in (GSI, 2022-O) quantifying the water balance for pre- and post-mining conditions for portions of the ONWR did not include the water in the drain cells directly downstream of the mine, but only the ones farther to the north (see Figure 6). Drain cells in the GSI model only quantify water flow from the ground to the surface. We are happy that this omission was acknowledged in GSI's follow up report, where they state "*any contributions to the Okefenokee would occur from the River Styx, a tributary located between approximately 1.3 and 2.3 miles from the western boundary of the proposed mine*" (GSI, 2023-W). GSI provided an updated analysis of mining effects in Section 2.2 of its report, which is appreciated.

It is unfortunate, however, that GSI went back to using the incorrect analysis method for its analyses in Section 4.8 of (GSI, 2023-W), where they again quantified changes in flows north of the mine instead of directly downstream of the mine (where the effects on ONWR are most likely to occur).

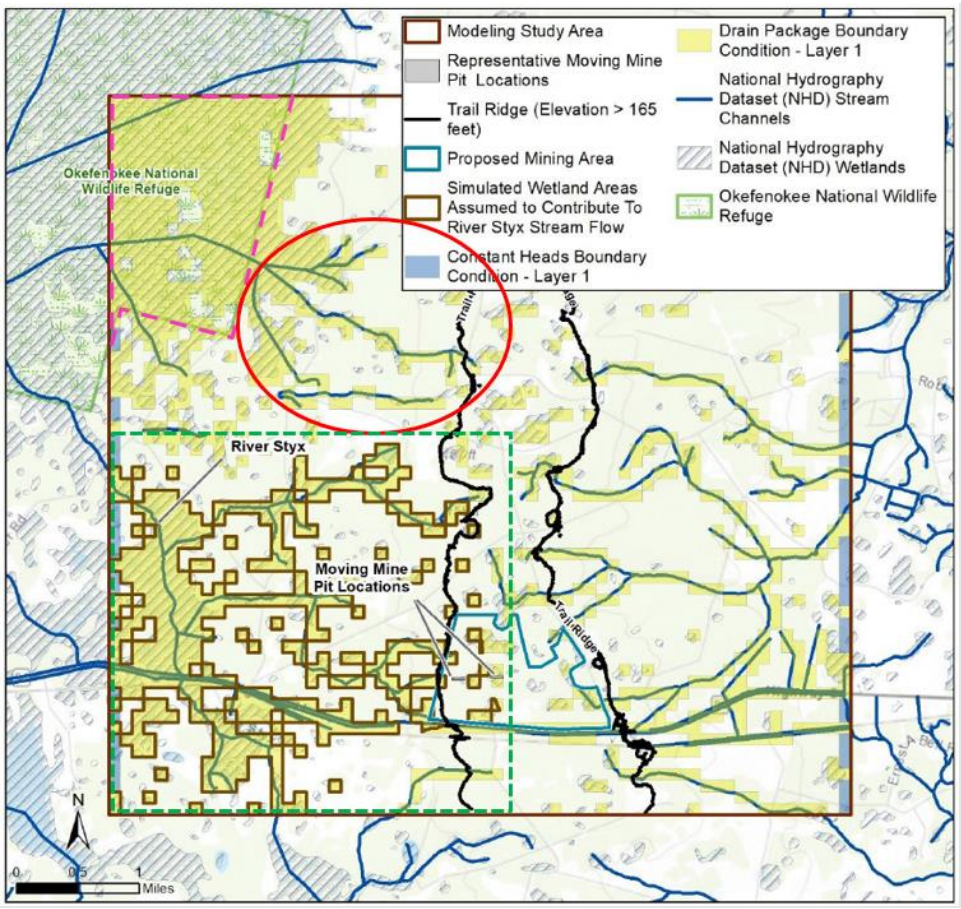

FIGURE 6. EXPLANATION OF GSI METHODOLOGIES OF QUANTIFYING FLOWS TO ONWR. THIS FIGURE IS REPRODUCED FROM (GSI, 2023-W). THE RED CIRCLE AND GREEN AND PINK DASHED LINES ARE ADDED BY THE AUTHORS OF THIS REPORT. THE FIGURE DEPICTS THE MODEL DOMAIN (BROWN BOX), THE LOCAL STREAM CHANNELS (BLUE LINES), AND THE

DRAIN CELLS (YELLOW) IN THE MODEL. THE PINK DASHED LINE INDICATES THE DRAIN CELLS THAT WERE USED TO QUANTIFY CHANGES IN FLOWS TO ONWR IN (GSI, 2022-O). FLOWS FROM CELLS WITHIN THE RED CIRCLE (UPSTREAM OF THE PINK DASHED AREA) THAT WOULD HAVE EVENTUALLY REACHED ONWR WERE NOT CONSIDERED IN THOSE ANALYSES. MORE IMPORTANTLY, IN (GSI, 2022-O), FLOWS FROM DRAIN CELLS WITHIN THE GREEN DASHED SQUARE THAT WOULD FLOW DIRECTLY FROM THE MINING SITE INTO ONWR WERE OMITTED WHEN QUANTIFYING IMPACTS OF THE MINE ON ONWR. IN A SUBSEQUENT ANALYSIS FROM (GSI, 2023-W), THIS ERROR WAS CORRECTED, BUT YET ANOTHER ANALYSIS IN THE SAME REPORT REPEATS THE ERROR.

3 Responses to comments from GA-EPD and GSI

3.1 Responses to GA-EPD

3.1.1 Appropriateness of steady-state modeling

"There were critical comments … on the model's being a steady-state one rather than a transient one" (Zeng, 2023).

GA-EPD states that the purpose of the steady-state model is to compare estimated hydrologic effects of pre- and post-mining sediment structure to ensure that significant changes in groundwater flow do not occur. They state that significant changes were not found in the simulations performed (such as recharge rate simulations and hydraulic conductivity simulations) and therefore a transient model would also not show differences. GA-EPD also claims that modeling of extreme conditions has been performed with the steady-state modeling to date (Zeng, 2023), such as the simulation with lowered recharge rate and lowered boundary conditions. They also assert that an analysis by Dr. James Kennedy supported the steady-state model as stated in Dr. Kennedy's letter to Mr. Wiedl in March 2020 (Zeng, 2023).

NPS finds numerous important problems with these claims and stands by its assertion that the steady-state modeling performed thus far is not sufficient to project impacts on ONWR. Specific issues with this modeling are discussed below.

Recharge rate simulations: The analysis performed by GSI looked at effects of changes in recharge rate for wet, average, and dry conditions, represented by 4.5, 4.13, and 3.5 inches per year. Note that 'recharge' in this context is defined as precipitation minus runoff and evaporation, and is the amount of water that infiltrates into the groundwater system. It is completely inadequate to assert that the difference between a wet year and a dry year is only one inch of recharge. By looking at the difference between precipitation and evaporation alone in Figure 1, one can easily see that dry years have *negative* recharge rates, so using a positive recharge rate of 3.5 inches per year to model a dry year is incorrect (see discussion in Section 3)

Hydraulic conductivity simulations: Modeling performed to evaluate sensitivity to hydraulic conductivity of each layer of the soil profile was performed by GSI, and changes were quantified by calculating the gross volume of groundwater that flows east or west of the centerline of Trail Ridge. The steady-state model showed high sensitivity to changes in hydraulic conductivity, with large changes in groundwater and surface water stage over the mining footprint. The analysis determined that the amount of groundwater flowing to the east or west would not change but failed to evaluate changes in runoff and surface water flows. Groundwater moving to the surface was quantified to be over 90% of the water in the model, but changes in the dynamic surface water system were not examined. This is a critical

shortcoming of the modeling approach. Changes in the dynamic surface water flows cannot be ignored, as impacts to ONWR waters cannot be determined until this is analyzed.

Recharge rate with lowered boundary conditions: The analysis performed by GSI has multiple issues. The lowered recharge rate used was 3.5 inches per year but should have been a negative value (see discussion in Section 3). In addition, GSI did not evaluate the change in flows downstream of the mine (along the River Styx which feeds directly into ONWR) when claiming that ONWR would not be affected, thus underestimating the impacts of the mining activities. NPS criticized this in our previous report (Bahm & Paudel, 2023), and GSI acknowledged this in (GSI, 2023-W), stating "any contributions to the Okefenokee would occur from the River Styx, a tributary located between approximately 1.3 and 2.3 miles from the western boundary of the proposed mine (Exhibit 2-3)." Yet GSI still went back to using the erroneous method for their analysis of recharge rate with lowered boundary conditions (see discussion in Section 2.4).

Kennedy's analysis: Dr. Kennedy's analysis that asserts steady-state models are appropriate is not sufficient. The letter from Dr. Kennedy does not substantiate his assertions. This is discussed in detail in Section 2.2.2.

3.1.2 Constant head boundary

"There were comments … questioning whether it was appropriate to have a constant head boundary condition at the edge of the model domain" (Zeng, 2023).

GA-EPD maintains that having a constant-head boundary is appropriate for modeling potential impacts to ONWR and substantiate this claim with references to GSI's model, and to additional analyses subsequently performed by GA-EPD.

GSI's model: GA-EPD states that "*First, Dr. Panday's additional sensitivity runs confirmed that altering the boundary conditions to reflect gage height changes at a USGS gage west of the model domain would not change findings of no significant difference in hydrology within the model domain*." (Zeng, 2023). This is not exactly true. Dr. Panday only quantified change in hydrology for the northeast corner of the model domain, not the entire model domain. This is the same problem discussed in Section 2.4. GSI did not quantify impacts in the wetlands downstream of the mine that feed into the ONWR.

GA-EPD analyses: GA-EPD created reservoir models to examine projected changes in water surface elevations in ONWR. These models are overly simplified and of limited use to evaluate impacts to ONWR ecology. Please see Section 2.1.2 for more details.

3.1.3 Extent of model domain

"There were comments … questioning whether the model domain is not far enough on the western side, i.e. whether the rest of the Okefenokee Swamp should be included in the model domain" (Zeng, 2023).

NPS did not state that "the rest of the Okefenokee Swamp" needs to be included in the model domain but maintains the model domain does not include the complete flow path between the mine site and the part of the ONWR directly downstream. In addition, in multiple analyses, GSI did not quantify mining effects along this direct pathway, instead choosing to quantify effects in a different part of the model domain in a different watershed (see Section 2.4). Despite this issue being called out in (Bahm & Paudel,

2023), GSI repeated this quantification error in (GSI, 2023-W). GSI and GA-EPD have both used this erroneous analysis method to support claims that there will not be effects on ONWR.

3.1.4 Effects of pumping from Floridan Aquifer

"Major concerns have been raised by many stakeholders regarding whether the groundwater withdrawal from the Floridan Aquifer in the amount requested would cause impacts to the Okefenokee Swamp, including the Okefenokee National Wildlife Refuge, or ONWR" (Zeng, 2023).

GA-EPD presents an analysis using a reservoir model of Okefenokee Swamp to substantiate that impacts to ONWR would be small. NPS maintains that the details of the reservoir analysis were not provided, and this type of analysis does not take into account potential impacts during droughts. See Sections 2.1.2 and 2.1.3 for details.

3.2 Responses to GSI

3.2.1 Appropriateness of the Theis Solution

"NPS's claim regarding the appropriateness of the Theis solution to calculate Upper Floridan Aquifer drawdown is unsupported. Furthermore, any drawdown in the surficial aquifer as a result of pumping in the Upper Floridan aquifer will be negligible because of a thick confining layer separating them. Finally, as per the current Mine Land Use Plan, which NPS does not consider, the Upper Floridan wells will likely almost never be used" (GSI, 2023-W).

Twin Pines used the "Theis solution" to estimate water level drawdown due to pumping from the Upper Floridan aquifer. While the Theis solution provides valuable insights, it has some limitations that make it too simplistic for accurate predictions of water level drawdowns (Zech et al., 2016), (Baalousha, 2024). The Theis solution assumes certain simplifications, such as the aquifer being homogeneous, isotropic, constant pumping, and under steady-state conditions. The hydrogeologic data referenced in the TP application materials ((Holt R. , Tanner, Smith, Patton, & Lepchitz, 2019-E), (Holt R. , Tanner, Smith, Patton, & Lepchitz, 2019-F), (GSI, 2021-Na)) indicate that this aquifer system is more complex than it is assumed in the application of the Theis solution. Therefore, additional considerations to the solution or a more detailed approach (e.g., numerical model) is needed for accurate assessments of drawdowns. Furthermore, because of the lack of data on hydrogeologic characteristics (e.g., lithology, hydrology-property data), there remains considerable uncertainty regarding the hydrologic connection of the swamp to the Upper Floridan Aquifer in that region. The conclusions that "*any drawdown in the surficial aquifer as a result of pumping in the Upper Floridan aquifer will be negligible because of a thick confining layer*" (GSI, 2023-W) lacks a robust analysis.

GSI and GA-EPD have both made the argument that because mine dewatering will be used as process water for the spoils, the Upper Floridan aquifer will "*likely almost never*" be pumped up to the permitted volume of 1.44 mgd. Regarding the last sentence in the quote above, GSI is incorrect to state that NPS did not consider this assumed frequency of use of the Upper Floridan wells. Our approach is that because the permit is asking for 1.44 mgd withdrawals, that specific amount is what needs to be examined.

3.2.2 Validation/Verification

"NPS's suggestion of supporting model calibration through a validation/verification approach is not supported by current industry standard best practices for groundwater modeling" (GSI, 2023-W).

Regarding the GSI response to comments on validation and verification, their use of the term "*current industry standard best practices*" is ambiguous. Model validation/verification is a fundamental process to ensure the reliability of a calibrated model when applied under field conditions that are different from the model calibration (Johnson & Weimer, 1996), (Hassan, 2004). The critical step of validation/verification is not limited to statistical models/analysis but is equally applicable to process-based models, like MODFLOW, which this study utilizes. NPS still emphasizes the necessity of conducting a model validation exercise to gain confidence in the model's predictive capabilities, especially when evaluating the impacts of mining and post-mining conditions. Without a thorough validation process, the robustness of the calibrated model remains in question.

3.2.3 Hydraulic conductivity and groundwater elevation data

"NPS is incorrect in asserting that available hydraulic conductivity and groundwater elevation data are insufficient to characterize the groundwater system" (GSI, 2023-W).

NPS is accurate in highlighting the inadequacy of hydraulic conductivity and groundwater elevation data for a comprehensive characterization of the groundwater system. As illustrated in Figures 15 and 16 of (GSI, 2021-Nb), the majority of the stations employed to determine hydraulic conductivity are clustered in proximity to the mining site, with a notable absence of stations near the boundary of ONWR. Given the heterogeneity in aquifer and soil conditions, it is imperative to establish additional testing locations for hydraulic conductivity in close proximity to ONWR. Also, the groundwater elevation data covers a limited period (from Jan 2019 to Oct 2019), therefore, the average values derived from this short period data do not represent the interannual variability.

3.2.4 Use of steady-state models

"NPS's assertion that steady-state models cannot be used to quantify potential effects on Trail Ridge and surrounding area hydrology is incorrect" (GSI, 2023-W).

In earlier review comments (Bahm & Paudel, 2023), NPS already provided several reasons why the steady-state groundwater flow model is not appropriate to evaluate the impacts of mining on Okefenokee Swamp. In Section 2.2 of this document, we have reiterated the limitations of the steady-state model to evaluate impacts of mining on ONWR specifically during droughts.

Additionally, the statement by (GSI, 2023-W) claiming that "*A transient analysis on the other hand would not depict the maximum impact and obscure the analysis*" is not supported by analysis or modeling results.

3.2.5 Direct flow path

"NPS's claim that there is no direct flow path in the model between the proposed mine site and the ONWR is incorrect" (GSI, 2023-W).

NPS stated in (Bahm & Paudel, 2023) that '*The model omits a direct flow path between the mine and the ONWR*'. When read in context, one should understand that this does not refer to *all* flow paths, just the surface water flow path. Notably, the GSI model does not have a surface water component. In addition, the analyses performed in (GSI, 2022-O) quantifying the water balance for pre- and post-mining conditions for portions of the ONWR did not include the water in the drain cells directly downstream of

the mine, but the ones farther to the north. Drain cells in the GSI model only quantify water flow from the ground to the surface. This is discussed in detail in Section 2.4.

3.2.6 Drain elevations

"NPS correctly observes that drain elevations in the model do not match the description in the report (GSI, 2021); however, the drain elevations are consistent with the conceptual model, as described below" (GSI, 2023-W).

NPS appreciates the clarification on drain elevations provided in (GSI, 2023-W) but remains concerned that the use of the drain package is simply not the best method available for this analysis.

3.2.7 Spatial and temporal variability

"NPS incorrectly states that recharge rates need to be spatially and temporally variable to properly understand potential changes in regional hydrology due to mining, especially during periods of drought. While recharge variability may affect the flows to the ONWR, it has marginal impact when differences in flows are considered between non-mining, mining, and post-mining conditions" (GSI, 2023-W).

The disparity in flows to ONWR under "non-mining, mining, and post-mining conditions" relies on a model incorporating constant recharge rates (4.13 inches/year) across both space and time. Not using variable recharge rates in the model causes significant uncertainty on the modeling outcome and on estimating potential impacts on ONWR. Additional analysis or modeling are needed before concluding that there are marginal differences in flows to ONWR. Incorporating variable recharge rates (which account for spatial and temporal variations) into the modeling would allow important evaluation of the impacts on flows to Okefenokee Swamp and St. Mary's River, especially during droughts.

Figure 1 and Figure 2 in this report illustrate the substantial daily, seasonal, and interannual variability in precipitation within the region, emphasizing the importance of incorporating spatiotemporal variability in recharge rates into the model. It is critical to appropriately represent the drought conditions in the models for evaluating the mining impacts on ONWR, particularly during extreme events.

Furthermore, the statement "*The addition of spatiotemporal variability for recharge would have no impact on the analysis of the difference between non-mining, mining, and post-mining conditions …*" by (GSI, 2023-W) is not supported by data or analyses.

3.2.8 Constant head boundary

"NPS states that use of a constant head boundary condition in the model is inappropriate; however, this is incorrect, and further, irrelevant, as any impacts of mining in the proposed mining area on the ONWR do not reach the constant head condition along the western boundary due to its sufficient distance from the proposed mine area" (GSI, 2023-W).

As previously stated, the conclusions drawn regarding the impacts of mining on ONWR were derived from modeling that relied on several simplistic assumptions to represent the hydrogeologic system and conditions.

3.2.9 Drain package

"NPS states that the MODFLOW drain package was not appropriate for simulating surface water dynamics. There is no intent to simulate surface water dynamics as this is a groundwater analysis issue. Water that leaves the drains can be assumed to mostly flow to the ONWR. If the same amount of water drains to these wetlands for non-mining, mining, and post-mining conditions, then that same amount of water will flow to the ONWR" (GSI, 2023-W).

NPS clearly explained in our review comments (Bahm & Paudel, 2023) why the MODFLOW drain package was not appropriate to evaluate the impacts of mining on ONWR.

"There is no intent to simulate surface water dynamics as this is a groundwater analysis issue" (GSI, 2023-W).

NPS disagrees with this statement. This is both a groundwater and a surface water analysis problem, given that surface water accounts for 90% of the flows in the model domain that encompasses extensive wetlands and streams. Accumulating the discharges from all drainage cells might lead to underestimations or overestimations of flows to ONWR depending on the complex interactions among various flow dynamic processes. Dismissing the consideration of surface water dynamics overlooks crucial aspects of the overall hydrological analysis.

The drain cells can quantify water that moves from the groundwater to the surface water in the model. Each cell separately 'captures' the surface water, quantifies it, and removes it from the model. The water captured at each drain cell does not then flow downstream, because it is removed from the model at the drain cell location. Because the GSI model simulates groundwater only, it must use this workaround to account for surface water. Flows from groundwater to surface water account for roughly 90% of the water budget in the GSI model, so using the Drain Package limits the reliability of the model results in capturing important processes.

"If the same amount of water drains to these wetlands for non-mining, mining, and post-mining conditions, then that same amount of water will flow to the ONWR" (GSI, 2023-W).

This assertion by (GSI, 2023-W) was derived from modeling that relied on several simplistic assumptions to represent the hydrogeologic system and conditions. Therefore, it is challenging to determine if this assertion is valid. There would be likely higher evaporation losses from surface water during mining relative to pre-mining conditions.

3.2.10 No-flow boundaries

"NPS claims that the positioning of the no-flow boundary condition is not appropriate. This boundary is appropriate as flow lines are generally parallel to the north and south boundaries which are the no-flow boundaries. Furthermore, these boundaries do not impact how mining would change hydrogeologic conditions" (GSI, 2023-W).

NPS maintains its concern that the positioning of the no-flow boundaries is a problem with the GSI model. Proper modeling practices state that the boundaries should be far enough away from the area of interest being modeled that the impacts of the area will not reach the boundary. Figures 4 and 9 of (GSI, 2023a) depict model output of head difference maps that clearly show predicted effects reaching the southern boundary of the model. These graphics are reproduced in Figure 7 of this report.

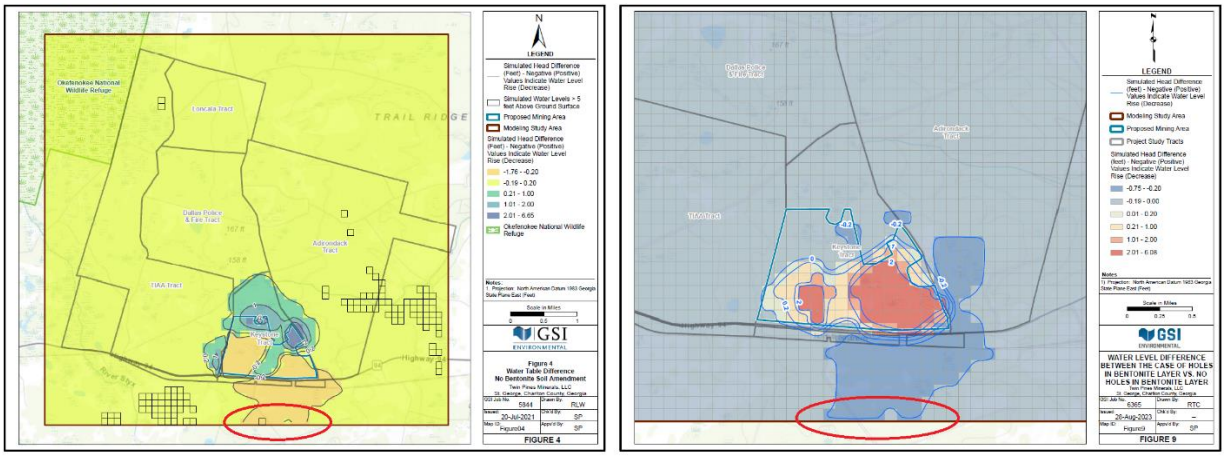

FIGURE 7. MODEL OUTPUT FROM THE GSI STEADY-STATE MODEL SHOWING PREDICTED MINING EFFECTS EXTENDING TO THE SOUTHERN BOUNDARY OF THE MODEL DOMAIN. REPRODUCED FROM FIGURES 4 AND 9 IN (GSI, 2023A). RED CIRCLES ADDED BY THE AUTHORS OF THIS REPORT.

3.2.11 Natural variability in the system

"NPS states that the model is not set up to mimic the system's natural variability. This is not relevant, as the modeling effort was designed to evaluate the impact of mining on the local hydrogeology, and adding more complexity to a model than is needed is not appropriate" (GSI, 2023-W).

NPS maintains its concern over the simplified representation of the system used to evaluate the impacts of mining. While simulating the transient behavior of groundwater flow introduces complexity to a model, it is essential to incorporate processes that capture the natural variability and dynamic nature of the system. This is particularly crucial in areas with ecologically sensitive wetlands or streams, such as the ONWR, especially when evaluating the hydrologic impacts of proposed mining activities during extreme events. Ignoring these dynamics can lead to oversimplified assessments that fail to accurately reflect the environmental consequences (Rolls, Leigh, & Sheldon, 2012). This comment is relevant in this region because of the dynamic nature of hydrologic conditions (as discussed previously in (Bahm & Paudel, 2023)).

3.2.12 Quantification of potential effects on ONWR

"NPS suggests that effects on ONWR from mine dewatering were not properly quantified" (GSI, 2023-W).

NPS appreciates that GSI re-derived their quantification of potential effects of mine dewatering on flows to ONWR from (GSI, 2022-O) and provided updated results in (GSI, 2023-W). Unfortunately, a different analysis in (GSI, 2023-W) once again quantified impacts to ONWR using the previous erroneous method. An explanation of the different methods is described in detail in Section 2.4.

3.2.13 Effects of re-dredging were not sufficiently modeled

"NPS claims that re-dredging of the soil amendment layer was not taken into consideration. However, additional analysis indicates that the inclusion of re-dredging in the model results in negligible changes in the modeling outcome" (GSI, 2023-W).

NPS appreciates that GSI revised their analysis of hydrologic effects of re-dredged layers. Significant concerns remain that the revised analysis still has critical shortcomings. This is discussed in detail in Section 2.3.

3.2.14 Mathematical errors

"NPS correctly states that there are mathematical errors in some data tables from GSI (2022); however, these do not affect the conclusions of the report and are reissued, here, as Appendix B" (GSI, 2023-W).

NPS appreciates the correction of errors in (GSI, 2022-O) and the reissuance of tables in (GSI, 2023-W).

3.2.15 Modeling and analysis segmentation

"NPS incorrectly claims that modeling and analysis segmentation (i.e., modeling condition changes individually as opposed to modeling them in combination) does not account for combined effects of the boundary condition changes if the changes were made simultaneously. Different boundary condition combinations result in different water flows, however, results between non-mining and post-mining conditions indicate minimal change" (GSI, 2023-W).

It is unclear how the statement '*Different boundary condition combinations result in different water flows*' from GSI's response addresses the concern about modeling and analysis segmentation. For example, GSI modeled the dewatering rates of the mining pit, and (somewhat) modeled effects of increased conductivity of the replaced spoils in the soil column after mining. However, changes in the conductivity of the spoils will affect the rates of dewatering.

The distinction should also be made that water withdrawals from the surficial aquifer (dewatering) and the Floridan Aquifer (pumping) are not planned to be simultaneous, but the *effects* can be simultaneous. This is because the recovery times will overlap. As shown in (Twin Pines Minerals LLC, 2023a), with maximum pumping, the Floridan Aquifer could take many years to recover to its pre-mining levels. The surficial aquifer will recover more quickly, but still the effects of these will overlap in time.

3.2.16 Evaluation of future projects

"NPS wrongly assumes that any future expanded mine project will not be evaluated after permitting for the current demonstration mine" (GSI, 2023-W).

(Bahm & Paudel, 2023) stated "*Approval of the Demonstration Mine application could provide a precedent for future mining, without fully evaluating the cumulative impacts of the full mining footprint and without evaluating the novel impacts from mining other areas*." This statement is different than the one implied by (GSI, 2023-W). The concern stands that cumulative effects of multiple mining permits can add up to a substantial adverse impact, even if the individual permits have small effects. Permitting should always consider cumulative impacts on ONWR natural resources.

4 Conclusions

NPS hydrologists conducted a thorough review of hydrologic modeling documents and analysis related to the 2024 revised Twin Pines Permit application, focusing especially on (GSI, 2023-W), (Zeng, 2023), and (GA-EPD, 2024). This report also provides detailed comments to the responses from GSI Environmental and GA-EPD on several areas of concern.

Both GSI and GA-EPD concluded that the impacts of mining on the ONWR would be small or negligible. However, these conclusions largely depend on modeling and technical analyses that incorporate simplistic assumptions, failing to accurately represent system conditions, especially during extreme events such as droughts and storms. Our key areas of concern include:

1. **Simulation of dry conditions**: The steady-state modeling used recharge rates of 3.5 inches/year, which does not accurately represent dry conditions when recharge would be a negative value and undermines the fidelity of the modeling outcomes.
2. **Modeling/analysis approaches**: The methodologies employed for hydrologic modeling and technical analyses lack sufficiency in assessing the impacts of mining activities adjacent to the ONWR. Concerns encompass the utilization of steady-state models, the appropriateness of employing the Theis solution for aquifer drawdown calculation, and the adequacy of model calibration/validation.
3. **Concerns over simplified assumptions**: Steady-state modeling and level-pool reservoir assumptions are overly simplistic and fail to accurately represent the hydrogeologic system and conditions, particularly under extreme climatic conditions like droughts. This includes the use of constant recharge rates and neglecting the system's natural variability and dynamic nature.
4. **Groundwater withdrawal and dewatering impacts**: Various assumptions made in technical analyses and modeling regarding water withdrawal from the Upper Floridan Aquifer and dewatering during mining operations fail to accurately predict the impacts on the ONWR, particularly during droughts.
5. **Specific technical concerns**: Several specific technical issues exacerbate these concerns, such as the utilization of constant head boundary conditions, use of the MODFLOW drain package for representing streams and wetlands, the repeated failure to account for water in the direct flow path between the proposed mine site and the ONWR, incomplete simulation of re-dredging effects, and no explicit consideration of the surface water modeling when surface water accounts for more than 90% of the water budget.

In summary, many statements made by the GA-EPD and GSI claiming that there will be negligible effects on ONWR are based on extrapolation of modeling beyond the calibration range, making conclusions about complex systems using only average conditions, and quantifying some results using questionable methods.

This report describes several of the authors' concerns regarding the limitations of the modeling and analyses conducted by GA-EPD and GSI and determined that results do not provide a robust and accurate assessment of the potential impacts of mining on the hydrology of the modeled area and the ONWR, especially during dry periods.

Literature Cited

Baalousha, H. (2024). Theis equation revisited: From infinite to finite aquifer and from fully to partially penetrating well. *Groundwater for Sustainable Development, V24, 101069*. doi:https://doi.org/10.1016/j.gsd.2023.101069

Bahm, K., & Paudel, R. (2023). *Independent Technical Review of the Twin Pines Permit Application Hydrologic Modeling.* South Florida Natural Resources Center, National Park Service.

GA-EPD. (2024). Response to Draft MLUP Public Comments 2.9.24. Retrieved March 14, 2024, from https://epd.georgia.gov/twin-pines-mlup-response-comments

Georgia Environmental Protection Division. (2024, 03 18). *GA-EPD: Twin Pines Minerals, LLC*. Retrieved from Georgia Environmental Protection Division Website: https://epd.georgia.gov/twin-pines

GSI. (2021-Na). *Modeling the Groundwater Flow System on Trail Ridge 9-14-2021 (MLUP Appendix N-a).* Irvine, California: GSI Environmental. Retrieved March 14, 2024, from https://epd.georgia.gov/revised-mlup-and-associated-documents

GSI. (2021-Nb). *Modeling the Groundwater Flow System on Trail Ridge 9-14-2021 Figs Tables and Apps (MLUP Appendix N-b).* GSI Environmental. Retrieved March 14, 2024, from https://epd.georgia.gov/revised-mlup-and-associated-documents

GSI. (2022-O). *Addendum to Modeling the Groundwater Flow at The Proposed Twin Pines Mine on Trail Ridge Report 11/9/2022 (MLUP Appendix O).* GSI Environmental. Retrieved March 14, 2024, from https://epd.georgia.gov/revised-mlup-and-associated-documents

GSI. (2023a). *Responses to Georgia EPD Modeling Questions (GA EPD Questions Memorandum 30 November 2023).* GSI Environmental. Retrieved March 14, 2024, from https://epd.georgia.gov/revised-mlup-and-associated-documents

GSI. (2023-W). *GSI Response to Public Comments Regarding the Proposed Twin Pines Mining Project, Charlton County, Georgia (MLUP Appendix W).* GSI Environmental. Retrieved March 14, 2024, from https://epd.georgia.gov/revised-mlup-and-associated-documents

Harbaugh, A. W. (2005). *MODFLOW-2005, The U.S. Geological Survey modular ground-water model—the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16.* U.S. Geological Survey.

Hassan, A. (2004). Validation of numerical ground water models used to guide decision making. *Ground Water (Vol. 42, Issue 2)*.

Holt, R. M., Tanner, M., & Smith, J. (2020-Ma). *Assessing the Impact of Soil Amendments Using Groundwater Flow Models 11-13-2020 (MLUP Appendix M-a).*

Holt, R. M., Tanner, M., & Smith, J. (2020-Mb). *Assessing the Impact of Soil Amendments Using Groundwater Flow Models 11-13-2020 Figs Tables and Apps (MLUP Appendix M-b).*

Holt, R. M., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2019-Ia). *Local Groundwater-Surface Water Hydrology at Twin Pines Mine 11-22-2019 (MLUP Appendix I-a).*

Holt, R. M., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2019-Ib). *Local GroundwaterSurface Water Hydrology 11-22-2019 Figs Tables and Apps (MLUP Appendix I-b).*

Holt, R. M., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2019-Jb). *Climate Data 11-15-2019 Figs Tables and Apps (MLUP Appendix J-b).*

Holt, R. M., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2020-La). *Impact on the Trail Ridge Hydrologic System 1-14-2020 (MLUP Appendix L-a).*

Holt, R. M., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2020-Lb). *Impact on the Trail Ridge Hydrologic System 1-14-2020 Figs and Tables and Apps (MLUP Appendix L-b).*

Holt, R., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2019-E). *Geologic Characterization at Twin Pines Mine (MLUP Appendix E).* TTL.

Holt, R., Tanner, M., Smith, J., Patton, A., & Lepchitz, Z. (2019-F). *Hydrogeologic Field Characterization at Twin Pines Mine (MLUP Appendix F).* TTL.

Johnson, J., & Weimer, D. (1996). Verification of A Groundwater Flow Model Application Using Recovery Data and Infiltration Tests. doi:https://doi.org/10.1520/STP38396S

Kennedy, J. (2020). *Letter to Mr. Stephen C. Wiedl from Dr. James L. Kennedy dated 23 March 2020, submitting comments to TTL's report "Impact of the Proposed Twin Pines Mine on the Trail Ridge Hydrologic System".*

Lake, P. (2011). *Drought and Aquatic Ecosystems: Effects and Responses.* Chichester: Wiley-Blackwell.

Ritchey, J., & Rumbaugh, J. (n.d.). *Subsurface Fluid-Flow (Ground-Water and Vadose Zone) Modeling.* doi:ISBN-10: 0-8031-2021-4

Rolls, R., Leigh, C., & Sheldon, F. (2012). Mechanistic effects of low-flow hydrology on riverine ecosystems: ecological principles and consequences of alteration. *Freshwater Science*. doi:https://doi.org/10.1899/12-002.1

TTL. (2023). *Updated Industrial Groundwater Withdrawal Permit Application 10.2.2023.*

Twin Pines Minerals LLC. (2023a). *Updated Industrial Groundwater Withdrawal Permit Application, Saunders Demonstration Mine, letter to GEPD October 2, 2023.*

Twin Pines Minerals LLC. (2023b). *Sheets MLUP (ID 2073) Final (MLUP 2a).*

Twin Pines Minerals LLC and Wood. (2023-P). *Water Use Managment Plan, October 2, 2023 (MLUP Appendix P).*

Zech et al. (2016). Extending Theis' solution: Using transient pumping tests to estimate parameters of aquifer heterogeneity. *Water Resources Research*. doi:https://doi.org/10.1002/2015WR018509

Zeng, W. (2023). Memorandum from Wei Zeng, GA-EPD, Re: Summary of hydrologic analyses on Twin Pines Mineral's (TP's) Charlton County project, November 16, 2023. Retrieved March 13, 2024, from https://epd.georgia.gov/twin-pines-mlup-response-comments