Twin Pines Minerals, LLC

GEOLOGIC CHARACTERIZATION AT TWIN PINES MINE

Prepared For:

TWIN PINES MINERALS, LLC
PROPOSED HEAVY MINERALS MINE
ST. GEORGE, CHARLTON COUNTY, GEORGIA

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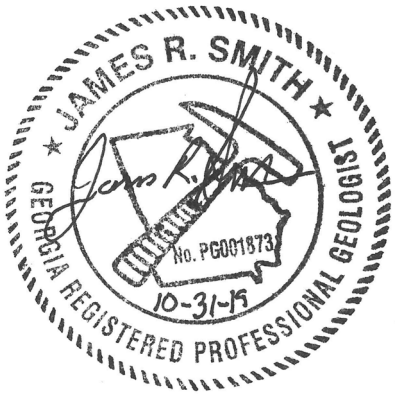
TTL



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INTRODUCTION

On July 3, 2019, Twin Pines Minerals (TPM) submitted an individual permit application to the U.S. Army Corps of Engineers for impacts to water of the United States to develop a heavy mineral sand mine along Trail Ridge in Charlton County, Georgia (Figure 1). The proposed mine is located 3.2 miles west of St. George, Georgia, along Georgia State Highway Route 94. Trail Ridge is a 0.6 to 1.2 mile wide and 99 mile long topographic ridge that separates the Okefenokee Basin and Swamp from the coastal plain of Georgia (Force and Rich, 1979). It represents the crest of a former beach complex and was formed as inland sand dunes near the proposed Twin Pines Mine (e.g., Pirkle et al. 1993). The ridge is underlain by a shallow aquifer, locally known as the surficial aquifer, which forms a hydrologic divide between the Okefenokee swamplands to the west and the Saint Mary's River to the east. At the proposed mine site, the water table is very shallow with water depths of only a few feet. The surficial aquifer is perched on the clays of the upper Hawthorn Group, which is considered to be the upper confining unit to the Floridian Aquifer in the region (e.g., Williams and Kuniansky, 2016))

The proposed permit area is approximately 2,414-acres, located southeast of the Okefenokee National Wildlife Refuge (ONWR) boundary; however, TPM will only mine an approximate 1,268-acre area located about 2.7 miles from the ONWR boundary (Figure 2). The portion of the proposed permit area extending from the western mining boundary to the edge of the permit boundary will be avoided and will provide a buffer to the ONWR.

The project study area consists of approximately 12,000-acres of land located near St. George, Charlton County, Georgia. This area is comprised of five (5) tracts identified as Loncala, Dallas Police & Fire, Keystone, TIAA, and Adirondack. To evaluate the subsurface geology, field activities were performed both within the proposed mining area and on adjacent properties outside of the proposed mining area footprint. Reference to "project study area" in this report refers to activities conducted within the proposed mining area and adjacent tracts.

A variety of subsurface geologic data and surface elevation data were collected and interpreted to provide information to: 1) characterize the pre-mining conditions along Trail Ridge, 2) provide data for models to predict the impact of mining operations on groundwater discharge to streams and wetlands adjacent to the proposed mine, and 3) aid in the evaluation of post-mining hydrogeologic conditions to assist reclamation/restoration efforts. Beginning in August 2018, TTL designed and implemented a number of site characterization activities to accomplish these objectives:

- Subsurface data collection and evaluation, including:
  - Review of 385 boring logs prepared by TPM as part of their mineral exploration field activities (drilling completed prior to project engagement by TTL).
  - TTL's on-site geologist logged an additional 71 tightly spaced borings drilled by Twin Pines within the proposed mining permit area.
  - Advancement of 22 exploratory borings to the top of Hawthorn Group (EB borings).
  - Advancement of 14 borings for the collection of undisturbed soil samples (UD borings).
  - Installation of 86 piezometers for monitoring groundwater within the surficial aquifer.
  - Installation of two deep pumping wells and 22 observation wells.
- Downhole geophysical logging in 15 deep borings to correlate stratigraphic units.
- Survey of borings, piezometers, wells, and staff gauges for northing and easting coordinates and elevation data.
- Aerial LIDAR fly-over survey for topographic coverage of the majority of the project study area.
- Definition of subsurface geologic units.

The purpose of this report is to present the results of these site characterization activities.

DRILLING ACTIVITIES

Drilling activities in the study area took place between February 2018 and July 2019. Drilling activities in the project study area were performed by TPM primarily to evaluate heavy mineral sand concentrations, although 71 TPM borings were logged by TTL personnel. TTL installed 22 exploratory borings through the surficial aquifer and into the upper part of the Hawthorn Group to characterize the deeper parts of the surficial aquifer and identify the elevation of the top of the Hawthorn. TTL also drilled 14 soil borings for collecting undisturbed soil samples. 86 shallow and deep piezometers were installed to provide water-level data for the surficial aquifer. Fourteen (14) soil borings were drilled with a mud rotary drilling rig to collect undisturbed soil samples; later, additional soil borings were drilled near the original locations to characterize the subsurface geology. Pumping tests were conducted at two locations in the project study area; at each location, one pumping well and eleven observation wells were installed. The details of these drilling activities are presented below.

Twin Pines Minerals (TPM) Borings

Between February and December 2018, TPM advanced approximately 385 exploratory borings throughout four tracts (Loncala, Adirondack, Dallas Police & Fire, and Keystone) of the project study area (Figure 3). Table 1 summarizes the boring identifiers shown on Figure 3. These soil borings were drilled as part of Twin Pines' mineral exploration efforts to quantify the abundance, thickness, and depths of economically extractable target minerals. Borings were advanced from 30 to 90 feet below ground surface (bgs) utilizing a Terra-Sonic TSi 150cc Sonic Drill Rig (Terra-Sonic Rig). Lithologic descriptions of the above-referenced borings were logged by Twin Pines' on-site personnel.

Twin Pines provided TTL with field logs for the 385 exploratory borings. TTL personnel then input each field log into Bentley GINT logging software, which was used to create electronic boring logs. A review of the Twin Pines boring data provided an introductory understanding of the subsurface lithology beneath the project study area. Boring logs generated from Twin Pines' mineral exploration drilling are included in Appendix A. A summary of soil boring data for the 385 exploratory borings is included in Table A1 of Appendix A.

In March and April 2019, Twin Pines' drill crew advanced 31 additional soil borings (SA-TIA-19-270 through SA-TIA-19-300) along the eastern portion of the TIAA tract and contiguous to the western boundary of the proposed mining permit area (Figure 4). TTL's on-site geologist was present during drilling activities to describe soils recovered from each boring. Soil samples were collected continuously using a Terra-Sonic Rig. The rig was equipped with 6-inch diameter outer casing and a 4-inch diameter core barrel that collected soil samples in 10-foot intervals. The borings were advanced to depths of 30 to 70 feet bgs.

In June and July 2019, Twin Pines' drill crew advanced 40 additional soil borings (SA-TIA-19-487 through SA-TIA-19-493, SA-TIA-19-495 through SA-TIA-19-524, and SA-TIA-19-527 through SA-TIA-19-529) also along the eastern portion of the TIAA tract and contiguous to the western boundary of the proposed mining permit area (Figure 4). TTL's on-site geologist was present during drilling activities to describe soils recovered from each boring. The soil samples were collected using the same general procedures described for boring data collected during the March and April 2019 sampling activities. These borings were advanced to depths of 30 to 100 feet bgs. Appendix B contains the boring logs from 71 SA-TIA borings and a summary table with other boring data (Table B1 of Appendix B).

Exploratory Borings (EB)

During August and September 2018, TTL advanced eight (8) exploratory borings (EB01 through EB08) into the top of Hawthorn Group (Figure 5). Soil/sediments of the Hawthorn Group underlie the surficial

aquifer beneath the project study area and represents the upper confining unit of the Floridan aquifer system. Drilling depths in these exploratory borings ranged from about 70 to 130 feet bgs. Drilling services were provided by Walker Hill Environmental, Inc. (Walker Hill) utilizing a Geoprobe 8150LS Rotary Sonic Rig to continuously collect soil samples from each exploratory boring. The sonic rig was equipped with 6-inch diameter outer casing and a 4-inch diameter core barrel that collected soil samples in 10-foot intervals. TTL's on-site geologist was present during drilling activities to describe soils recovered from the borings. Field criteria used to determine the top of the Hawthorne Formation was based on the observation high plasticity clays that effervesced when exposed to a diluted concentration of hydrochloric acid. Additionally, the unique greenish gray to light greenish gray color of the soil/sediments of this confining unit, differed from the shallower sandy soils and (often) acted as an indicator for contact with the Hawthorn Group.

From late October through November 2018, six (6) additional exploratory borings (EB13 through EB18) were advanced into the top of Hawthorn Group (Figure 5). Drilling depths of these borings ranged from 60 to 135 feet bgs. Drilling services were provided by Betts Environmental Recovery, Inc. (Betts) using a Terra-Sonic Rig. Soil sampling at each boring was performed using the same general procedures described for boring data collected during the August and September 2018 field activities. In December 2018 exploratory borings OWAEB and OWBEB were drilled to obtain lithologic data in the general vicinity of pumping test wells PWA and PWB. Drilling depths of borings OWAEB and OWBEB were 120 and 130 feet bgs, respectively.

Following the completion of each exploratory boring (with exception of EB16), tremie-piping was used to fill each borehole from termination depth up to ground surface with a Portland cement/bentonite grout mixture. Appendix C includes a site map showing the location of each exploratory boring and boring logs. Exploratory boring EB16 was converted to a piezometer for subsequent downhole geophysical logging. The piezometer was constructed using 2-inch diameter PVC well casing and screened to a total depth of 90 feet bgs. A solid section of PVC riser was installed from 65 to 90 feet bgs. A 10-foot section of 0.010-inch slotted PVC was installed from 55 to 65 feet bgs and PVC riser was installed from the top of the screened interval to land surface. The borehole annulus was backfilled with a natural sand pack from 50 to 90 feet bgs and a two-foot thick bentonite clay seal was placed above the natural sand pack. The remainder of the borehole annulus was filled with a Portland/bentonite grout mixture to ground surface. A flush-mount protective cover was installed at land surface. A total of 16 exploratory borings were drilled throughout 4 of the 5 tracts within the project study area (Loncala, Dallas Police & Fire, Keystone, Adirondack). Logs generated from the exploratory borings are provided in Appendix C. Due to property access restrictions, exploratory borings EB09 through EB12 proposed within the TIAA tract could not be drilled.

From June 27 to July 2, 2019, six exploratory borings (PB05 through PB10) were advanced to evaluate and further correlate depths to the top of Hawthorn Group (Figure 5). These borings were advanced using Twin Pines' Terra-Sonic Rig. Depths of exploratory borings PB05 though PB10 ranged from 70 to 121 feet bgs. Borings PB01 through PB04, which were proposed along the western portion of the TIAA tract, were not advanced due to access restrictions. Boring logs for PB05 through PB10 are included in Appendix C.

A summary of soil boring data from each exploratory boring drilled within the project study area is provided in Table C1 of Appendix C.

Undisturbed Sample Borings (UD)

From November 13 through 20, 2018, TTL advanced fourteen (14) soil borings (designated UD-10, UD-25, UD-34, UD-43, UD-51, UD-65, UD-67, UD-93, UD-126, UD-128, UD-179, UD-231, UD-238, and UD-338) throughout the project study area (Figure 6). Each UD boring was advanced utilizing TTL's

CME-550 all-terrain vehicle (ATV) drill rig for the purpose of collecting undisturbed soil samples. Due to the presence of unconsolidated sands and a high groundwater table, TTL used a mud rotary drilling technique to counter heaving sands within each boring. A Denison Sampler was used for collection of undisturbed soil samples. Because a mud rotary drilling technique was used to drill the borings, the soils from these boreholes could not be described.

During late December 2018 through March 2019, TTL drilled new soil borings adjacent to each of the undisturbed sample borings to provide observations of the subsurface lithology. Drilling services were provided by Betts utilizing a Terra-Sonic Rig to continuously collect soil samples from each boring. The sonic rig was equipped with 6-inch diameter outer casing and a 4-inch diameter core barrel that collected soil samples in 10-foot intervals. TTL's on-site geologist was present during drilling activities to describe soils recovered from the borings. Depths of the 14 UD borings ranged from 55 to 130 feet bgs. Eleven of the 14 borings were advanced to termination depths approximately 10 feet below the top of the Hawthorn Group. However, due to heaving sands, UD borings UD34 (55 feet bgs), UD179 (120 feet bgs), and UD338 (60 feet bgs) were terminated prior to encountering soil/sediments of the Hawthorn Group. A summary of UD boring construction details is provided in Table D1 of Appendix D.

Twelve (12) of the 14 UD borings (excluding UD338 and UD34) were subsequently converted into piezometers for purposes of conducting a downhole geophysical logging survey. Piezometer construction characteristics of each UD boring included placement of 10- or 15-foot sections of 2-inch diameter PVC riser which extended from the bottom of the boring to the top of Hawthorn Group. Next, a 10-foot section of 0.010-inch slotted PVC screen was installed on top of the above-referenced riser and finally PVC riser was installed from the top of the screened interval to land surface. The remaining borehole annulus was backfilled with a natural sand pack to land surface. Boring logs for each UD boring are provided in Appendix D. Piezometer construction details are listed in Table D2 of Appendix D.

Piezometer Installation (PZ)

A total of 86 shallow and/or deep piezometers were installed by TTL as part of the hydrogeologic investigation of the project study area (Figure 7).

During August and September 2018, TTL completed the installation of 27 piezometers (PZ01 to PZ22 and PZ24 to PZ28). Piezometer PZ23 was not installed due to access issues related standing water at the proposed location. The initial 27 piezometers were installed to evaluate subsurface lithology and groundwater beneath the project study area. Drilling services for these piezometers were provided by Walker Hill using a Geoprobe Sonic Rig. The sonic rig was equipped with 6-inch diameter outer casing and a 4-inch diameter core barrel that collected continuous soil samples in 10-foot intervals. TTL's on-site geologist was present during drilling activities to describe soils recovered from each borehole and supervise piezometer installations. Piezometer installation depths ranged from 14 to 45 feet bgs.

Each piezometer was constructed using a 10-foot section of 2-inch diameter 0.010-inch slotted PVC screen and a PVC riser. The remaining annulus of each borehole was filled with a natural sand pack from total depth up to approximately 2-feet above the top of screen. A 2-foot thick bentonite plug was placed on top of the natural sand pack. Tremie piping was used to fill the remaining borehole annulus with a Portland cement/bentonite mixture that extended from the top of the bentonite plug up to about 0.5-foot bgs. Permanent flush-mount protective covers and concrete pads were installed for surface protection at each piezometer.

During November and December 2018, TTL installed 10 partner piezometers adjacent to the existing piezometers. These piezometer clusters were constructed to evaluate lithology and groundwater within the shallow and deeper portion of the surficial aquifer. Drilling services for the installation of these piezometers was provided by Betts using a Terra-Sonic Rig. Depths of the piezometers ranged from 9 to 55 feet bgs. These partner piezometers were assigned the identifiers below:

- Deeper partner piezometers: PZ01D, PZ03D, PZ12D, PZ16D, and PZ25D.
- Shallower partner piezometers: PZ17S, PZ20S, PZ22S, PZ27S, and PZ28S.

To further evaluate the subsurface lithology and groundwater beneath the project study area, twenty-one (21) additional shallow and deep piezometers were installed. Construction depths for these referenced piezometers ranged from 10 to 90 feet bgs. These piezometers were installed from late October through December 2018 and were assigned the following identifiers:

Piezometer Identifier			
PZ23	PZ42	PZ47	PZ52
PZ38	PZ43	PZ48S/D	PZ53
PZ39S/D	PZ44	PZ49	
PZ40	PZ45S/D	PZ50	
PZ41	PZ46	PZ51S/D	

S/D Shallow/Deep Piezometer Cluster

From late April through May 2019, TTL installed 28 additional shallow and deep piezometers clusters along the southern end of the project study area (generally within the TIAA, Keystone and Adirondack tracts). Construction depths for the above-referenced piezometers ranged from about 8 to 50 feet bgs. These piezometers were assigned the following identifiers.

Piezometer Identifier		
PZ29S/D	PZ34S/D	PZ55S/D
PZ30S/D	PZ35S/D	PZ56S/D
PZ31S/D	PZ36S/D	PZ57S/D
PZ32S/D	PZ37S/D	PZ58S/D
PZ33S/D	PZ54S/D	

S/D = Shallow/Deep Piezometer Cluster

The shallow and deep piezometers installed between October 2018 and May 2019 were constructed using the same general procedures described for piezometers installed during the August and December 2018 field activities. TTL's on-site geologist was present during drilling activities to describe soils recovered from each borehole and supervise piezometer installations. A boring database summary of well construction details for the piezometers are provided in Table E1 and E2, respectively of Appendix E. Boring logs generated showing subsurface lithology for all piezometer are provided in Appendix E.

Pumping and Observation Well Installations

In December 2018, TTL subcontracted Partridge Well Drilling Company, Inc. (Partridge) of Jacksonville, Florida to install two (2) pumping wells (PWA and PWB) within the project study area (Figure 8). Partridge used the mud rotary method to drill and construct the pumping wells. The northernmost pumping well on the eastern crest of Trail Ridge was designated PWA and the southernmost pumping well on the western crest of Trail Ridge was designated PWB. The logic for the pumping test locations along Trail Ridge was that the ridge represents a hydrologic divide between drainage to the Okefenokee Swamp to the west and drainage to the St. Mary's River to the east. Since quality samples could not be obtained from the mud rotary drilling, exploratory borings (OWAEB and OWBEB) were

advanced near the proposed pumping well locations to confirm target depths to the top of the Hawthorn Group. Each pumping well was installed to a depth of approximately 115 feet below ground surface (bgs) using a a truck-mounted mud-rotary drilling rig equipped with a 12-inch diameter roller bit and spade. TTL's on-site geologist was present during the drilling activities to supervise well installations for PWA and PWB.

Once each borehole was drilled to a depth of 115 feet bgs, 60 feet of 6-inch diameter, 0.020-inch machine slotted PVC screen was installed from 55 feet to 115 feet bgs. A 6-inch diameter solid PVC casing was installed from the top of the screen to land surface. All screen and solid casing were flush-thread scheduled 40 PVC. A 16/30 silica sand was then placed from the bottom of the borehole to five feet above the top of the well screen (50 feet bgs). A five-foot bentonite plug was placed on top of the sand pack, and the remainder of the borehole annulus from the top of the bentonite seal to land surface was grouted with a cement/bentonite mixture. After grouting, the cement/bentonite mixture was allowed to cure for a minimum of twenty-four (24) hours. Next, each well was developed by Partridge at an approximate rate of 150 gallons per minute (gpm) using an air-lift method. Soil boring logs for the pumping wells are presented in Appendix F.

During November 2018 through January 2019, Betts provided drilling services for the installation of 22 observations wells at the site. Eleven observation wells were constructed adjacent to pumping wells PWA and PWB, respectively. These observation wells were installed to depths and distances from the pumping wells listed in Table F1 of Appendix F.

The observation wells were installed using a Terra-Sonic Rig equipped with 6-inch diameter outer casing and a 4-inch diameter 10-foot long core barrel. Soil samples were collected continuously from each borehole for the observation wells. TTL's on-site geologist was present during drilling activities to describe soils recovered from each boring (soil boring logs are presented in Appendix F) and supervise well installations.

With the exception of OWA3BS, OWA4BS, OWA5BS, OWB3BS, OWB4BS, and OWB5BS, each observation well was constructed with 10-foot sections of 2-inch diameter 0.010-inch slotted PVC screen with attached PVC riser. A natural sand pack was allowed to cave-in around the annulus between the PVC screen and the borehole wall from termination depth to two feet above the top of screen. A 2-foot bentonite plug was placed on top of natural sand pack and a Portland cement/bentonite mixture was placed from the top of the bentonite plug up to about 0.5-foot bgs. Permanent flush-mount protective covers and concrete pads were installed for surface protection at each observation wells. Observation well construction details are provided in Table A2 of Attachment A.

Observation wells OWA3BS, OWA4BS, OWA5BS, OWB3BS, OWB4BS, and OWB5BS were constructed with five-foot sections of 2-inch diameter, 0.010-inch slotted PVC screen with attach PVC riser. A natural sand pack was allowed to cave-in around the annulus between the PVC screen/riser and the borehole wall from termination depth to ground surface. A flush-mounted, steel, protective cover was installed at the surface of each piezometer in a 2-foot by 2-foot concrete pad, and a locking, water-tight cap was placed in the top of each 2-inch casing. Pumping wells and observation are shown on Figures 9 and 10.

Following installation activities, each observation well was developed using a 12-volt submersible pump. Each observation well was developed until its turbidity was less than 10 nephelometric turbidity units (NTU) and/or until the extracted groundwater appeared to be relatively free of sediment. A cumulative of about 1,673 gallons and 2,019 gallons of groundwater were developed from the observation wells at pump areas A and B, respectively.

GEOPHYSICAL LOGGING

On March 18 through 22, 2018, TTL personnel performed downhole geophysical logging at twelve (12) UD borings (UD43, UD238, UD51, UD65, UD67, UD179, UD93, UD10, UD126, UD128, UD231, & UD25), two (2) pumping well locations (PWA & PWB), and one (1) exploratory boring (EB-16). The boring locations were distributed across the site, were some of the deepest borings drilled during the investigation, and typically penetrated the full thickness of the surficial aquifer and a few feet into the underlying Hawthorn Group (Figure 11).

Gamma-ray (natural gamma) and induction (formation resistivity and conductivity) logging was performed at each borehole location. Two geophysical logging probes were rented from COLOG Geophysical in Lakewood, Colorado. These logs were obtained for correlation with geologic descriptions provided by TTL's geologists and verification of TTL's field observations.

Prior to probe downhole deployment, the probe head was zero referenced at the top of each well casing. The probe was dropped downhole at a steady rate of approximately 10 feet per minute to the total depth of each well. The instrument probes were driven by a 12-volt powered electric winch. During the logging process, the sensor head of each probe relayed real-time data to a laptop computer positioned at land surface. Natural gamma was measured in units of counts per second (cps) with induction in units of millisiemens per meter (mS/m) and ohm's per meter (ohm/m). The average rate of logging completion was approximately 3 to 4 well locations per day. Following the field activities, survey data was sent to Nathan Davis (geophysical engineer at COLOG) for data extraction, analysis, and log generation. The geophysical logs for each survey location are provided in Appendix G of this report.

SITE TOPOGRAPHIC SURVEY

As a part of the field data acquisition activities, two separate surveys were conducted within the project study area. Southern Resource Mapping, located in Tuscaloosa Alabama, was subcontracted by Twin Pines Minerals to perform an aerial topographic survey using a Riegl LIDAR 780i (digital ortho) sensor. The LIDAR configuration included an Applanix AP60 IMU coupled with an AirBourne GPS and was affixed to a Cessna 206 fixed-wing aircraft. A flight plan was generated that produced 18 points-per-square meter(s), and was flown at an elevation of 1,700 feet above ground surface (ags). This resulted in a total of 17 flight lines which included one cross line. From the data collected by Southern Resource Mapping, a topographic map layer containing one-foot contour intervals was generated (Figure 12) and used as a workable base map for the majority of the project study area. For areas not covered by the LIDAR survey, digital elevation model (DEM) files were obtained from the U.S. Geological Survey.

G&L Surveying and Mapping, located in Valdosta, Georgia, was subcontracted by TTL to survey the piezometers and soil borings. Each data point included northing and easting coordinates, elevations of the top of PVC casings (piezometers), and ground surface (all data points).

SUBSURFACE GEOLOGY

Geologic characterization activities in the project study area were limited to the subsurface soil/sediments from the land surface to the upper 20 feet of the Hawthorn Group. A list of the subsurface units encountered at the project study area are listed below.

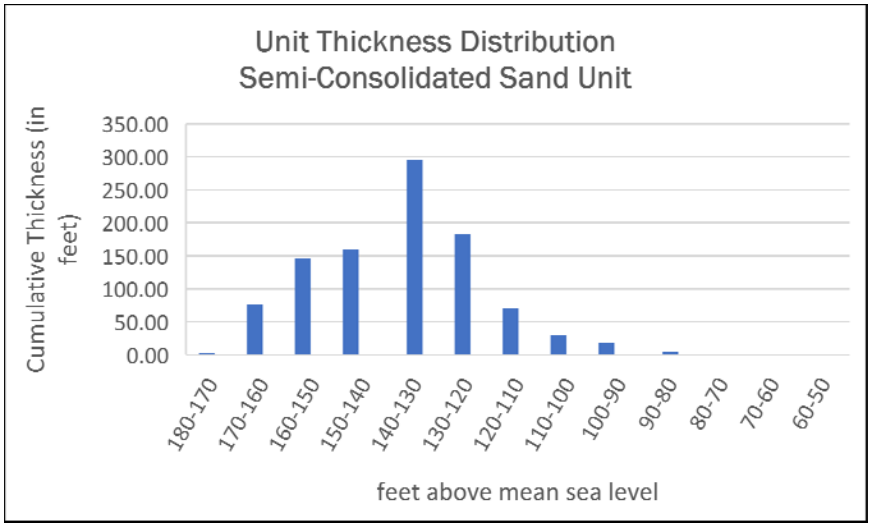
1. Unconsolidated sand unit,
2. Semi-consolidated black sand unit,
3. Consolidated sand unit,
4. Silty-clayey sand unit,

5. Clayey sand unit,
6. Clay unit, and
7. Hawthorn Group (uppermost section)

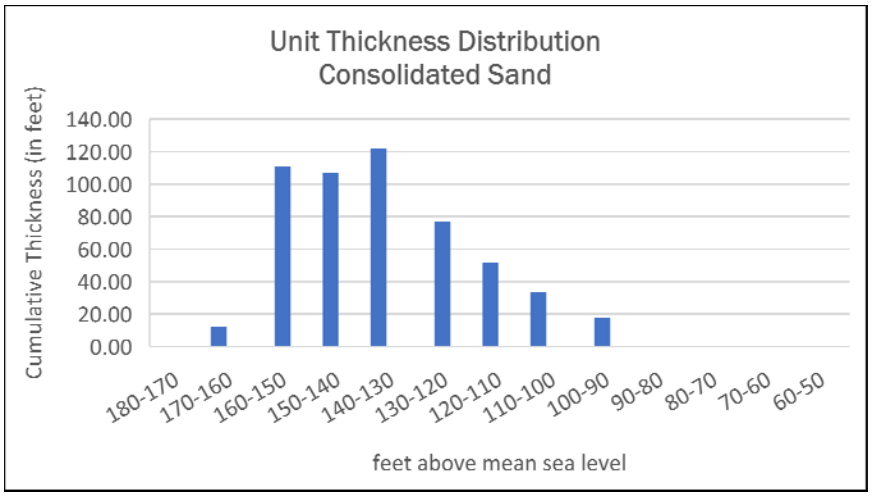
A brief description of each unit is provided below:

Unconsolidated Sand Unit
The unconsolidated sand unit comprises the greatest distribution of soil/sediments beneath the project area and generally consists of silty sands (SM) and well sorted sands (SP) with color descriptions ranging from brown to gray to white. Silty sands (SM) are described as fine- to medium-grained sand and which typically contains greater than five percent silt content. Well sorted sands (SP) are described as fine- to medium-grained sand with little to no silt content. Subsurface boring data collected from the project area indicates that this unit extends from land surface to the top of the Hawthorn Group sediments and is interlayered with laterally discontinuous lenses of the semi-consolidated to consolidated sands, silty-clayey sands, clayey sands and clays.

Semi-Consolidated Sand Unit
The semi-consolidated sand unit generally consists of fine- to medium-grained silty sands (SM) and well sorted sands (SP) and silty-clayey sand (SC-SM) with a color range from black to brown. The general characteristics of semi-consolidated sand unit includes sands that are moderately cohesive due to the presence of minor amounts of humate. The semi-consolidated sand unit was generally encountered from elevations of 100 to 170 feet above mean sea level (amsl). The cumulative unit thickness was greatest within the interval from 110 to 140 feet elevation.



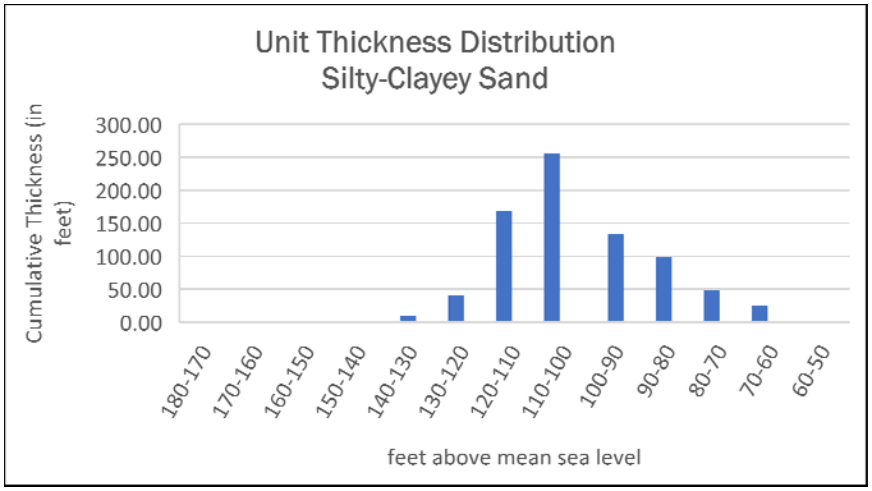
Consolidated Black Sand Unit
The consolidated black sand unit consists of fine- to medium-grained silty sands (SM) and well sorted sands (SP) and generally described as black in color. In many cases, the presence of significant amounts of humate rendered a greasy appearance to the core samples. The general characteristics of the consolidated black sand unit includes sands that are cohesive due to significant amounts of humate. The humate appears to serve as a bonding agent for the sand, which can create local areas of lower permeability soil beneath the study area. The consolidated sand unit was generally encountered from elevations of 90 to 160 feet above mean sea level (amsl). The unit thickness was greatest within the interval from 130 to 160 feet elevation



TTL conducted an extensive drilling program to evaluate the lateral continuity of the consolidated black sands, including the drilling and description of 71 closely-spaced soil cores. This drilling program was completed on July 1, 2019. We found that the consolidated black sands are very discontinuous in the permit area and appear in irregular zones, not layers.

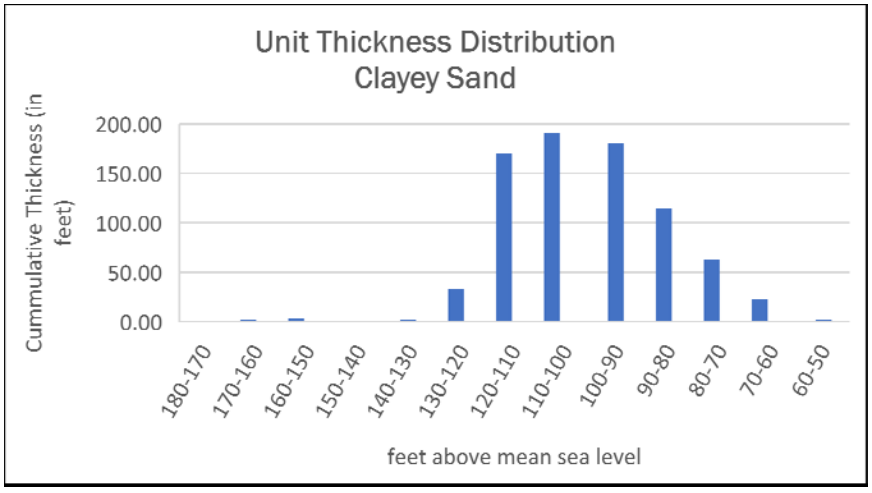
Silty-Clayey Sand Unit

The silty-clayey sand unit generally consists of fine- to medium-grained silty sands, silt, less than five percent clay content, and ranges in color from black to brown to grey. The general characteristics of this unit includes sands that are loosely cohesive due to minor clay content. Within some borings at the site, these soil/sediments were described as black to very dark brown in color and semi-consolidated. The silty-clayey sand unit was generally encountered from elevations ranging from 60 to 130 feet above mean sea level (amsl). The unit thickness was greatest within the interval from 80 to 120 feet elevation.



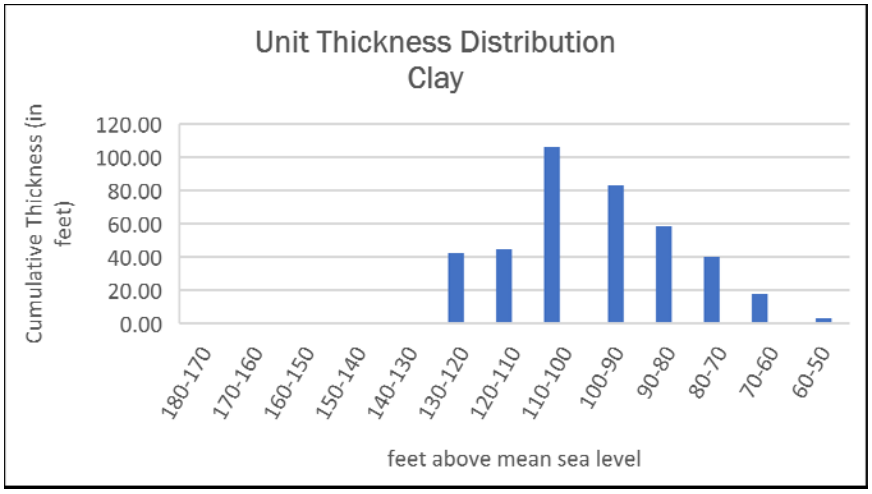
Clayey Sand Unit

The clayey sand unit generally consists of fine-to medium-grained silty sands with clay content between 10 to 40 percent and ranges in color from yellow to brown to gray. The general characteristics of the clayey sand unit includes sands that are cohesive due to moderate clay content. The clayey sand unit was generally encountered from elevations ranging from 60 to 130 feet above mean sea level (amsl). The unit thickness was greatest within the interval from 80 to 120 feet elevation.



Clay Unit

The clay unit consists of silty clays, sandy clays, and fat clays and ranges in color from brown to grey to greenish gray closer to the Hawthorn Group. The gray to greenish gray clays above the Hawthorn Group are reworked material from the upper Hawthorn. The clay is generally firmer and more compact than the surrounding sands units. The clay unit was generally encountered from elevations ranging from 60 to 130 feet above mean sea level (amsl). The unit thickness was greatest within the interval from 80 to 120 feet elevation.



Hawthorn Group

The top of Hawthorn Group within the project area is generally comprised of clayey sands and lean to fat clays that are calcareous and that range in color from greenish gray to grayish green. Field criteria used to determine the top of the Hawthorne Group were based on the observation of high plasticity clays that effervesced when exposed to a diluted concentration of hydrochloric acid. Additionally, the unique color of the sediments of this confining unit, differed from the shallower sandy soils and (often) acted as an indicator for contact with the Hawthorn Group.

These sediments represent the base of the surficial aquifer at the site. As stated previously, the Hawthorn Group is reported to be greater than 300 feet thick and unbreached in the general vicinity of the project area (Williams and Kuniansky, 2016) which is significant since the Hawthorn Group in the geologic literature is defined as the upper confining unit for the Floridan aquifer system.

Review of subsurface data and generalized geologic cross-sections indicates that higher permeability soil/sediments are present in the shallower sandy soils beneath the study. Clay content and lower permeability soil/sediments were observed with increasing proximity to the Hawthorn sediments.

SUMMARY

This report documents the geologic data collected from the Twin Pines project study area. These data were collected to characterize the pre-mining conditions along Trail Ridge, provide data for models to predict the impact of mining operations on groundwater discharge to streams and wetlands adjacent to the proposed mine, and aid in the evaluation of post-mining hydrogeologic conditions to assist reclamation/restoration efforts.

598 soil borings, piezometers, and wells were drilled in the project study area. The majority of these borings were drilled using sonic drilling rigs and were continuously sampled and described. The drilling details, well and piezometer construction history, and geologic data from these borings are presented in this report. Geophysical logs prepared from deep boreholes are included in this report. In addition, surveying activities, including the results of a LIDAR survey of the elevation across the site, are documented. Finally, seven subsurface units have been identified in the subsurface and described herein.

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