2.3 Waste Rock and Mill Tailings Management

2.3.1 Tailings and Waste Rock Characterization

A geochemical testing program has been conducted to characterize the tailings and waste rock materials and to develop a preliminary approach for ARD classification of the waste rock. This geochemical testing program is detailed in Tetra Tech (2007a). The results of the testing program indicate that the majority of the waste rock sampled will be non-acid generating NAG), though ARD potential has been factored into the design.

2.3.2 Waste Rock Management Strategy

2.3.2.1 General

Waste rock will be managed in areas located to the southeast, east and northeast of the proposed open pit, as shown in Figure 2-1. The placement of waste rock on the south and east sides of the waste rock facility will be initiated with perimeter buttresses designed to minimize the visual effects of the project for travelers on SR 83 and for viewers in the surrounding area. The outside face of the buttresses will be revegetated and reclaimed as they are completed. Waste rock in the remaining portions of each phase will then be deposited west and/or north of (behind) these buttresses. Waste rock will also be placed in the dry-stack tailings storage areas to provide structural and erosional stability of the tailings pile. Waste rock may be used for general site grading. Additional discussion of the dry tailings management plan is provided in Section 2.3.3.

Initial development of the waste rock storage area will begin with starter buttresses on the east and south sides. Construction of these buttresses will continue through approximately five years after plant startup and will require about 218 MT of waste rock from open pit operations. The final crest elevations of the perimeter buttresses will be about 5,400 ft, but will step down on the northeast side in a couple of segments (at elevations of 5,150 and 5,050 ft) to meet dry-tailings storage capacity requirements and operational considerations for the oxide heap leach facility.

Concurrent with the starter buttress construction, waste rock will be deposited in lifts internal to the waste rock storage area in the upper Barrel Canyon drainage behind the buttresses. This concurrent development is necessary to minimize congestion and improve safety and equipment productivity in the buttress areas. The waste rock storage area south of the oxide heap leach facility will be filled in to the 5,400 ft elevation (to be level with the perimeter buttress crests) near the end of Year 9. Beginning in Year 10, after three years of leaching, rinsing and drain down of the oxide heap leach stockpile, waste rock will be deposited over the decommissioned oxide heap leach facility. By Year 15, the oxide leach area will be fully buried and new waste rock storage lifts will be constructed at crest elevations of 5,450 and 5,500 ft. The 5,500-ft lift will be short-lived, as waste rock will then be excavated from the upper portions of the waste rock storage area to supply buttressing and capping material for the dry-stack tailings area during Years 16 to 19. The total capacity of the waste rock storage area at the end of mining operations is estimated at 980 million T and the ultimate crest elevation will be about 5,475 ft.

The lower Barrel Canyon area will be reserved for dry tailings storage; however, a significant volume of waste rock will be utilized as buttressing materials to construct the dry tailings stack over the life of the mine. The lower Barrel Canyon storage area will have an ultimate crest elevation of about 5,250 ft.

All of the waste management areas will receive pit-run waste rock consisting largely of limestone and skarn rock types, with some andesite, quartz monzonite porphyry, and arkose. The presence of substantial quantities of limestone and skarn, along with low-sulfide content, will provide a large buffering capacity within the waste rock storage areas to minimize the generation of ARD. Waste rock production from the pit will range from 130,000 tpd to a maximum of nearly 270,000 tpd.

Waste rock will be hauled to the dumping faces along the advancing edges of the waste storage facility. Haul trucks will back up to the dumping face, which is protected by a safety berm, and dump rock over the side. Loads may occasionally be dumped atop the current lift, particularly when another overriding lift or surface regrading is planned for the area. Dozers will be used to maintain safety berms along all waste rock storage facility crests, pushing excess material over the face and maintaining proper surface gradients for drainage.

Previously undisturbed areas affected by advancing waste rock storage facilities will be cleared and grubbed prior to the deposition of pit-run or dry tailings material. Any growth media encountered will be stored for use in future reclamation activities or placed directly into active reclamation areas.

As advancing waste rock faces approach the ultimate limits of the storage facility, setbacks will be used for each lift to approximate a 3:1 (horizontal to vertical) slope. By managing lift widths, the ultimate slope of the waste rock piles, from toe to crest, will be approximately 4H:1V. The final faces will be regraded by pushing down the crests and smoothing the overall slope to the 4H:1V gradient. Growth media will then be spread across the surface, seeded, fertilized and managed as necessary to promote revegetation of the waste rock storage area. Reclamation of these areas will be conducted as soon as the ultimate waste rock facility limits have been reached, which is anticipated to be concurrent with waste rock disposal operations in other parts of the storage facility.

2.3.2.2 Waste Rock Characterization and Control

Waste rock materials will be sorted during mining into acid generating (AG) and NAG categories so that each material can be placed in designated zones. ARD classification of the waste rock will be determined using pre-mining geochemical test results with verification by periodic sampling and assaying on representative blasthole cuttings in the mine. The assay will be performed by total sulfur testing at an on-site laboratory, with potential carbon content analysis to assist in refining waste rock classification. Some samples may have elevated total sulfur contents, but the concomitant presence of high carbonate contents would indicate the rock is likely to behave as NAG material under field conditions. Following laboratory testing, blasted waste materials will be flagged in the field for identification, and haul trucks will be directed to the appropriate location.

AG waste rock will not be used for construction of the perimeter buttresses, tailings starter buttresses, drains, or required channel grading fills. It will be placed in the interior of the waste rock storage areas for burying and isolation.

2.3.2.3 Foundation Preparation and Stability

Portions of the waste rock areas may be required to be cleared and grubbed of organic materials. Suitable foundation materials will be stockpiled for later use in reclamation. The remaining alluvial and overburden soils and rocks following clearing and grubbing (and any foundation stripping) will be considered suitable foundation materials.

The waste rock will be placed with a final inter-bench slope of 3H:1V. In addition, detailed stability analyses will be carried out during final design to ensure that the waste rock piles will be stable during and after placement.

2.3.2.4 Collection and Treatment of Waste Rock Drainage

The waste rock management facilities will be constructed in lifts that will generally not exceed 250 ft in height and will not extend beyond the divide that defines the eastern and southern edges of the Barrel Canyon drainage basin. The top surfaces will be constructed with upward gradients of about 0.5% to the southeast, east and northeast so that stormwater runoff is directed back toward the open pit. The stormwater will be collected along the western toes of the waste rock facilities and allowed to drain through the coarse rock along the bottom. Similarly, surface runoff from the eastern faces will be allowed to collect along the toes and drain through the base of the waste rock storage facilities. This water, along with surface water runoff from the active face of the waste rock storage area will ultimately be collected in a sediment pond located northeast of the tailings storage area. This pond will provide sediment control and water catchment for all of the disturbed areas within the Barrel Canyon drainage system.

Water quality modeling is ongoing, but understanding of the current site suggests that runoff and/or seepage water from the waste rock storage areas will not exhibit elevated concentrations of metals and major ions. The results of the modeling are expected to suggest that drainage from the waste rock facility is suitable for direct discharge into ambient receiving water bodies.

Runoff and seepage from the waste rock facility will be sampled and tested for water quality to verify modeling results. The sediment pond will serve as a final control point for water quality prior to discharge. Suspended sediments will settle out in the collection pond downstream of the waste rock facility, and the clarified water will be released.

2.3.3 Tailings Dry-Stack Facility Design

2.3.3.1 General

The Rosemont dry-stack tailings facility will receive dry tailings from the sulfide ore processing plant at a nominal rate of 73,600 dry tpd. This material will be stacked behind large containment berms constructed from pit-run waste rock. Consequently, this waste rock storage area will be active from late preproduction throughout the life of the mine, presently estimated at 19 years.

2.3.3.2 Design Criteria

Design criteria and objectives for the dry stack tailings storage include:

- Provision of secure, long-term storage of 500 MT of dry tailings, which is sufficient for the ore to be mined and processed during approximately 19 years of project life at a projected rate of 75,000 tpd
- Location within the immediate area of the mine in an approximately 5-mi radius from the proposed mine pit
- Minimization of airborne release of tailings solids to the environment using dust suppression measures
- Minimization of water seepage from tailings into groundwater, in compliance with all applicable regulations including Arizona Aquifer Protect Permit (APP) requirements and associated BADCT standards
- Creation of a site-specific design that accounts for local factors including climate, geology, hydrogeology and seismicity
- Establishment of an effective and efficient reclamation program, with a focus on concurrent reclamation

2.3.3.3 Previous Studies

A siting study to identify the preferred tailings impoundment locations and disposal methods was conducted to evaluate alternatives. (Vector 2006). The evaluation was based on defined design and selection criteria as well as estimated development costs.

This study provided a basis for the decision to advance the dry-stack tailings concept to feasibility-level design. The study considered both conventional (slurry) and dry-stack tailings disposal methods and included:

- Regional screening
- Identification of sites
- Analysis of fatal flaws

- Investigation of remaining sites
- Qualitative evaluation and ranking
- Semi-quantitative evaluation and ranking
- Cost analysis
- Selection of alternatives for detailed investigation

The results of the study indicated the dry tailings option was the most favorable disposal method. Advantages of the dry stack tailings stack method over conventional tailings disposal are: it eliminates the need for an engineered embankment and seepage containment system; it maximizes water conservation and minimizes water makeup requirements; it results in a very compact site that limits disturbance to a single drainage; and, it allows opportunities for concurrent reclamation and dust control.

2.3.3.4 Dry-Stack Operations

A diversion ditch will be constructed upstream of the initial tailings placement area to convey stormwater to an adjacent drainage around the tailings facility (Figure 2-1). An initial buttress will be constructed with waste rock to accommodate approximately one year of tailings storage. The starter buttress is approximately 130 ft high with a top width of 450 ft. Concurrent tailings and waste rock placement will occur throughout the life of the tailings facility. Waste rock will be advanced ahead of the tailings level in successive lifts. The waste rock buttresses will have top widths of 150 ft to accommodate two-way haul traffic and outer slopes of 3H:1V with benches to achieve an overall slope of 3.5H:1V. This configuration will allow visual screening of the tailings placement activities from SR 83 and concurrent reclamation of the lower perimeter buttress slopes.

Dry tailings will be delivered by conveyor from the filter plant down the drainage just below the planned diversion ditch. They will be placed with a radial stacker against the starter buttress. A dozer will be used to spread the dry tailings and provide sufficient compaction for the conveyor and stacker as necessary. When the primary conveyor is inactive due to relocation or maintenance, a second conveyor, constructed along the upper ridge area, will allow temporary disposal of tailings into the upper drainage area for placement with dozers.

The tailings facility consists of two separate areas referred to as the north stack and the south stack. The north stack will operate in Years 1 through 14 and can accommodate approximately 375 MT of tailings. The south stack can store up to 170 MT of tailings during Years 15 through 19. An engineered rock drain will remain between the north and south stacks to convey surface water flow from the drainage above the process plant area to the existing Barrel drainage.

Stormwater runon to the north stack will be limited by diverting the major drainage upstream of the stack area. Stormwater runoff sediments will be initially captured in a sediment pond located downstream of the tailings stack. A rock drain ("central drain") will be constructed starting in Year 6 between the north and south stacks to convey surface water from the drainage above the process plant area. An attenuation pond immediately upgradient of the central drain is designed to temporarily store flows from the 100-year, 24-hour storm event will drain within 30 days. Flows will exit the downstream toe of the tailings facility and pass through a final compliance pond prior to release. The drain will extend to the top of the south tailings stack and allow surface water from the top of the stack to be conveyed through the drain following closure. Material to construct the drain will be from competent and inert waste rock sources.

Stormwater runon to the south stack tailings operations will be controlled at the south limits of the tailings stack area by directing surface water flows from the adjacent waste rock pile away from the tailings area as much as practical. Direct runon from the immediately adjacent waste rock pile slopes will be controlled by temporary waste rock berms to direct surface water flows away from the tailings operation. Potential seepage migration to the south stack tailings operation will be controlled by impounding the water behind the planned haul road which forms the south terminus of the tailings facility and the north terminus of the waste rock pile. Prior to placement of tailings in the south stack area, the south face of the haul road fill will be sealed and covered with drain rock for protection. The drain rock will also promote drainage to the low point at the Barrel drainage where a sump will be constructed. The sump will be covered by the waste rock pile starting in Year 10, prior to tailings placement in the south stack, and the water level will be monitored over the life of the facility.

The tailings surface will be sloped away from the starter buttresses constructed around the tailings stack to limit potential water impoundment against the buttress. Stormwater control for the tailings stack and the overall site is discussed in detail in Section 2.9 of this Plan.

2.3.4 ARD Monitoring

Monitoring will be implemented to confirm that the objectives of ARD prevention and control are being achieved. Monitoring will include the following:

- Water quality sampling and analysis downstream of the waste rock and tailings facilities throughout the life of the mine, closure period, and post-closure period until it is confirmed that there are no deleterious water quality issues. Note that water quality sampling will be completed for more than ARD parameters. See Section 3.1 of this Plan for further discussion.
- Groundwater sampling and analysis at strategically placed points-of-compliance monitoring wells downgradient of the facility. Sampling and analyses will be regulated under the requirements of the APP program in Arizona. See Section 3.1 of this Plan for further discussion.
- Quality control sampling of placed NAG materials to ensure that the waste material control system excludes any AG materials.
- Tracking of waste rock quantities by engineering personnel with respect to predicted and actual AG and NAG materials, including regular updates of relevant site material balances to ensure that the overall plan and strategy are maintained.

- Installing wire piezometers at the base of the dry tailings stack to monitor the existence of phreatic head build-up during placement.