OTTER CREEK MINE
EXHIBIT 313D: RECLAMATION OF DRAINAGE BASINS

1.0 Introduction

Reclamation of drainage basins is an integral component of designing the post-mining topography (PMT) with the overall objective of minimizing disturbances to the prevailing hydrologic balance at the mine site and in adjacent areas (82-4-231(10)(k), MCA). The process is guided by pre-mining drainage basin characteristics. Post-mining topography is shown on Map 12.

2.0 Design of Reclaimed Drainages

Design of reclaimed drainage basins considers the following components:

- Blending with the undisturbed drainage systems above and below the reclaimed area
- Location of drainage divides
- Drainage pattern
- Drainage basin area
- Drainage density
- Drainage gradient
- Geomorphic habit, specifically meander belt width to promote channel development over time

These design components naturally fall into two groups – landscape level, or qualitative attributes, and design factors, or quantitative attributes. These are addressed in detail below:

2.1 Landscape Level Drainage Basin Attributes

Landscape level drainage basin attributes include blending with the undisturbed drainage systems above and below the reclaimed area, location of drainage divides and drainage pattern. Plate 1 is a copy of the PMT map with pre-mining drainage divides and channels overlain. Pre-mining drainage channels are second order and greater; first order drainages vary in the degree of development and interpretation is necessarily subjective.

There are 15 drainage basins in the area to be mined and reclaimed; drainage basin numbers correspond to sediment pond numbers. In the post-mining configuration, there are 14 drainage basins, with one very small pre-mining basin – number 13 - eliminated. Drainage divides in the PMT correspond well with pre-mining divides, and tie in with undisturbed drainage divides. Similarly, drainages blend upstream and downstream and display similar drainage patterns.

2.2 Drainage Basin Design Factors

Quantifiable factors include drainage basin area, drainage density, drainage gradient and meander belt width. Table 1 summarizes pre- and post-mining drainage areas, drainage densities, elevations and slopes within the mining area. Pre-mining drainage basin areas range from 4.7 to 2093 acres. Three drainages – 5, 7 and 15 - exceed one square mile with basin area areas of 1.03, 3.27 and 1.01 square mile respectively. Because post-mining drainages incorporate meander belts to promote natural meander development, drainage densities are based on down-valley distance of second order and higher drainages rather than channel distance.

Plate 2 shows comparisons of drainage profiles for pre-mine and reclaimed drainages. Drainage profiles utilize straight line distance between contours rather than channel distance to provide valid comparisons. Drainage profiles also show transitions to downstream, and where applicable, upstream undisturbed drainage channels. Although post-mine gradients are slightly shallower due decreased elevation, downstream transitions are facilitated by gentle natural gradients. The configuration of the mine plan minimizes transitions to upstream channels, but where they occur cutting into the highwall to smooth and avoid over-steepened channel sections is the only option.

Drainage channel development in ephemeral drainageways is a combination of erosional and depositional processes whereby soil materials are eroded from upland areas and deposited downstream. The downstream result is a flattened drainage bottom landform comprised of unconsolidated material constituting a zone where channel meanders can develop, hence the term "meander belt."

Meander belt width can be expected to increase downstream with increasing contributing drainage basin area and decreasing valley slope and channel gradient. To address the question of meander belt width in reclaimed drainages, four pre-mining drainages representing the range of drainage basin sizes – drainages 2, 4, 7 and 15 - were selected for examination. Each drainage was broken down into zones approximately 2500 feet in length starting at the divide progressing downstream and roughly corresponding to stream order. Within each zone, belt width measurements were made using the measurement function of Google Earth. Plate 3 shows the drainage zones and the location and magnitude of each measurement. Depending on drainage length, the number of zones ranged from two to five. For each zone, the slope and drainage basin area were calculated to develop a relationship with meander belt width. As shown on Plate 3, the relationships between drainage area, drainage slope and average belt width are very strong.

Belt widths were quite variable, with a standard deviation typically about 50 percent of the mean within each zone. Using limits of plus or minus 50 percent, Plate 4 shows post-mining meander belt width based on drainage area. Belt widths range from 100 feet (plus or minus 50 percent) at the mouth of the largest drainage (Drainage 7) to a nominal width of 10 feet in the upper reaches.

3.0 ARM 17.24.634 Reclamation of Drainage Basins

(1) Reclaimed drainage basins, including valleys, channels, and floodplains will be constructed to:

(a) comply with the PMT map (Map 12);

(b) meet the requirement of approximate original contour;

(c) exhibit an appropriate geomorphic habit or characteristic pattern consistent with 82-4-231(10)(k), MCA;

(d) allow the drainage channel to remain in dynamic equilibrium with the drainage basin system without the use of artificial structural controls unless approved by the department;

(e) provide separation of flow between adjacent drainages and safely pass the runoff from a six-hour precipitation event with a 100-year recurrence interval, or larger event as specified by the department;

(f) provide for the long-term relative stability of the landscape. The term "relative" refers to a condition comparable to an unmined landscape with similar climate, topography, vegetation and land use;

(g) provide an average channel gradient that exhibits a concave longitudinal profile;

(h) establish or restore a diversity of habitats that are consistent with the approved post-mining land use, and restore, enhance where practicable, or maintain natural riparian vegetation as necessary to comply with ARM subchapter 7; and

(i) exhibit dimensions and characteristics that will blend with the undisturbed drainage system above and below the area to be reclaimed and that will accommodate the approved revegetation and post-mining land use requirements.

(2) Any permanent structure placed or constructed within a perennial or intermittent stream will be certified by a qualified licensed professional engineer as meeting the performance standards and any design criteria specified by the department.