Appendix F

Surface-Water Hydrology

Appendix F.1

Letter to DRMS Pertaining to SCS Runoff Curve Numbers

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CC &V

Cripple Creek & Victor Gold Mining Company

A Joint Venture - Pikes Peak Mining Company, Manager

Operations Office
P.O. Box 191, 2755 State Highway 67
Victor, CO 80860
(719) 689-2977 • FAX (719) 689-3254

Englewood Office
P.O. Box 5078, 5251 DTC Parkway, Suite 700
Englewood, CO 80155
(303) 889-0700 • FAX (303) 889-0707

March 4, 1997

SENT CERTIFIED RETURN RECEIPT REQUESTED
P 289 926 512

Mr. Berhan Keffelew
Environmental Protection Specialist
Colorado Department of Natural Resources
Division of Mines and Geology
Office of Mined Land Reclamation
1313 Sherman Street, Room 215
Denver, Colorado 80203

Reference: Cresson Project; Permit M-80-244: Surface-Water Drainage Modifications For Arequa Gulch Overburden Storage Area.

Dear Mr. Keffelew:

The Cripple Creek & Victor Gold Mining Company ("CC&V") submits herewith a revised surface-water drainage plan for the area of Arequa Gulch in which CC&V is placing oxide overburden. The design and computations on which the design is based are attached. The principal reason for submission is the need to place overburden over the diversion ditch initially constructed along the northeast side of the Gulch. The time is now upon us where this temporary diversion no longer serves the purpose for which it was constructed. CC&V needs to divert the runoff from the undisturbed area, as well as the runoff from the disturbed area, into a series of impoundments. All of the principal impoundments are in place and, in fact, currently serve to retain all flows from disturbed areas associated with the Arequa Overburden Stockpile area.

As you will see from the Attachment, CC&V's objective is to retain the flows from the 10-year, 24-hour precipitation events. Three substantial detention ponds, either excavated or created by enhancing a depression with overburden and nearby colluvium, are the principal means of retaining the flow. Two of the detention structures border the northeast side of the existing diversion ditch along the southwest side of the Gulch and one detention structure borders the northwest side of that same diversion in the area from which clayey colluvium was extracted in 1996. All of them are, effectively, excavated ponds.

Thank you for your assistance in this matter

Sincerely,

John E. Hardaway
Manager Environmental Affairs

Attachments (2):

1. NRCS TR-55 computations for Arequa Gulch Overburden Stockpile Area; Plan Views for Temporal Stages of Drainage Management (6 drawings) in "Arequa Gulch Overburden Storage Area Drainage Plan.".
2. Check in the amount of $875 for Technical Revision.

FILE: CC&VSTIP.007

AREQUA GULCH OVERBURDEN STORAGE AREA DRAINAGE PLAN
MARCH 1997

OVERVIEW

The Cripple Creek & Victor Gold Mining Company ("CC&V") has developed a revised surface-water drainage plan for the area of the Cresson Project that is occupied by the Arequa Gulch Overburden Storage Area. The area is located on the east side of the new Highway 67 embankment, and is upgradient of the Cresson Project's Valley Leach Facility. This revision of drainage controls is necessary to allow for the removal of a temporary diversion ditch that bounds the southeast side of the current footprint of the overburden storage area. The revisions modify the existing surface-water drainage control to accommodate construction of the approved overburden storage area. The modifications are shown as they will most likely evolve over time to achieve the post-reclamation drainage. CC&V has, to describe the evolution, divided the time period from late 1996 through to the present to "buildout" into increments and prepared a runoff analysis applicable to the end of each period.

The principles of the surface water drainage control are to divert drainage from undisturbed areas away from those areas that are undergoing disturbance, to trap water and allow solids to settle, to release water from these detention areas in a manner designed to minimize downstream erosion, and to facilitate reclamation of the lands to achieve a stable form through grading and revegetation. The ultimate goal of the drainage plan is to provide for a post-mining drainage system that supports the post-mining land uses and which is self-maintaining. Given the fact that the Arequa Gulch Overburden Stockpile will fill the existing valley, the relatively small undisturbed drainage area above the Stockpile will be directed along a channel that traverses edge of the overburden stockpile rather than around and under the site as currently occurs.

In all cases during construction, all runoff, regardless of whether it crosses disturbed or undisturbed lands, will be caught in a series of detention basins that have adequate capacity to retain the runoff from the 10-year, 24-hour precipitation event.

This Arequa Gulch drainage plan encompasses the area of the Cresson Project between the Cresson Mine and the new State Highway 67 road embankment, which embankment also delineates the east-northeast extent of the Cresson Valley Leach Facility. Other approved drainage controls located upgradient and downgradient of this Stockpile will continue to serve both the Cresson Mine and the Valley Leach Facility, both of which are outside this Arequa Gulch Overburden storage area drainage. These other controls remain as approved in MLRB Permit M-80-244 and the general storm-water runoff permit for CC&V's properties. They are not affected by the drainage design and controls addressed here.

The Arequa Gulch overburden storage area is comprised of oxide mineralized rock of a grade less than the economic cutoff for gold ore and the surrounding "barren" oxide rock, both of which are termed "overburden." The current surface-water drainage system was constructed to divert as much water from undisturbed areas as possible around the disturbed areas during the first years of operations. Now (early 1997) the overburden is encroaching on that drainage system and it is necessary to adjust the drainage controls. This adjustment was anticipated to be required when the Project was designed, but was not designed in detail at that time because of the uncertainty of the topography that would be formed. As noted above, this revised drainage plan has been designed to show its temporal change to adapt to changing topography that reflects the evolution of the overburden storage area from now to completion.

Currently, surface-water diversion of runoff from areas upgradient of the oxide overburden storage area is accomplished upgradient of the southeast side of the Arequa Gulch Overburden storage area. As the oxide overburden volume increases, it is necessary to cover the current diversion and to move diversions farther upslope of the storage area. As the storage area grows, it is necessary to control the runoff from a progressively smaller undisturbed area. As the overburden storage area is progressively reclaimed, the disturbed areas, the potential for erosion, and the sediment control requirements (e.g., detention ponds) will decrease.

CC&V notes that the current diversion system has not experienced any continuous flow to the point of diverted flow reaching receiving waters since its construction in 1994. All flows observed to date have been "discontinuous" in that they infiltrate into the channel bottom shortly after interception by the diversion channel, or they accumulate in shallow pools along the thalweg of the channel and seep and evaporate.

METHODOLOGY

This Plan is comprised of up-gradient diversions that carry water from undisturbed areas around the actively-disturbed areas of the Arequa Gulch Overburden Storage Area, and detention ponds or other temporary containments of runoff from disturbed areas that allow settling of entrained solids. These plans account for the flow velocities and volumes of storm-water runoff that are projected to occur at the site.

The storm-water runoff controls are designed to safely pass the flows from the 100-year, 24-hour precipitation event (3.5"), and, with respect to runoff from the disturbed area, to detain at least the runoff from the 10-year, 24-hour precipitation event (2.4"). For purposes of these computations, and consistent with other storm-water runoff planning for the Project, the precipitation events were assumed to follow a Type II distribution, based on the geographical location. The grading designs were developed, and the computations were performed, by CC&V engineering staff.

Calculations of runoff quantities were performed using the *Softdesk* "Hydrology Tools" computer program. This program is based on the graphical methods described in the Soil Conservation Service's (now the "NRCS") Technical Release Number 55 ("TR 55"). Additionally, the Soil Conservation Service's publication "Procedures for Determining Peak Flows in Colorado" (March 1984) was used for technical reference. The software estimates peak flows, peak flow velocities, and cumulative runoff volumes to provide the basis for sizing and protecting drainage channels and impoundments.

The area of Arequa Gulch overburden storage was divided into subbasins, each controlled by a specific drainage system and a detention "structure." Flow lengths were measured, slopes were determined, and flow regimes were divided into "Sheet," "Shallow," and "Channel" flow types for each of the subbasins. These flow types were assigned based on field observation of the terrain. Using appropriate descriptors of-channel roughness, the computer routine then developed the total concentration time for the subbasin. A composite runoff coefficient was developed for each basin based on the soil types. The Type II 24-hour Storm Hydrograph was applied. The flow was routed to the corresponding control structure (detention pond) and the flow rates and volumes used to determine adequacy of the structures. The flow rates computed along the channels provided the basis to evaluate the capacity of a standard slope channel and any road channel ditch planned for use.

The soil types in the area are listed, and the assignment of runoff coefficients based on these soils and CC&V observations over the past three years is discussed, in the next section.

SOIL TYPES AND RUNOFF CURVE NUMBERS

As is required to use the TR 55 method, the surface runoff characteristics of the drainage area were determined based on the natural and "artificial" soil types in Arequa Gulch. Three soil categories were developed and are designated "original ground," "roads and dumps," and "fill slopes." Original ground, as demonstrated over the past years by the limited runoff, has a relatively low runoff coefficient. Fill slopes, as has been evidenced on site by the lack of runoff off from the slopes, also have relatively low runoff coefficients. Haul roads, which comprise the third category, have high runoff coefficients for most precipitation events as a result of compaction. These three categories are further described below.

Original Ground: Soil Type B (Moderately Low Runoff Potential - e.g., mostly sandy soils and loess). Consists primarily of 4" to 12" of coarse topsoil covered with grass, brush, or trees and underlain by a loose, rocky sandy soil. Viewed as either thin vegetative stand with limited cover (if rangeland or meadow) or with good vegetative cover (if forest land). This category also includes revegetated ground. (Surface area characterized in this manner will initially diminish, but then will reappear as reclaimed surfaces are developed.)

Coefficient: Wooded 66 Grasses 71

Roads and Stockpile Surfaces: Soil Type D (High runoff potential e.g., shallow soils with nearly impermeable subhorizons). Consists of haul roads and horizontal surfaces of overburden storage area. Compacted by haul trucks. (Surface area in this category will generally diminish with time.)

Coefficient: 90

Fill Slopes: Soil Type A (Low runoff potential e.g., deep sands with little silt and clay). Consists of segregated coarse rock overburden faces with high infiltration rate. No runoff is observed from these slopes. (Surface area in this category will remain more or less constant, until completion of the storage area, and will then decrease as the overburden faces are graded and reclaimed.)

Coefficient: 50

These coefficients, upon delineation of the area to which they apply in any one subbasin, were developed into a composite coefficient for each subbasin, based on relative areas, to form a single curve number for each of the drainage subbasins.

AREQUA GULCH OVERBURDEN STORAGE AREA CONSTRUCTION SEQUENCE

Because the Arequa Gulch Overburden storage area is to be constructed over a number of years, the drainage control plan has been developed to accommodate the changes that will occur over time. Five points in time were used to assess and modify the drainage controls. These "configurations" of the storage area are presented in five of the six plan views accompanying this documentation (see Attachments). The five plans show approximations of the topographic configurations that would likely develop as the storage area is built. This allows delineation of the drainage areas that will develop and incorporates the changes in surface type as the undisturbed land is disturbed and then revegetated. Field-adaptation of the drainage facilities depicted will occur, given the need to be responsive to changes in the construction or construction sequence. Therefore, the times shown on these plans are for demonstration purposes only. All plans show the same geographical area at the different points in time. The external boundaries of the area are defined by existing topography and other diversions that do not contribute to the area shown.

The sixth plan view of the Arequa Overburden Storage Area provided as an Attachment shows, in a summary manner, the locations of the detention ponds that now exist or which will be developed as the storage area is constructed. Not all of these detention structures exist at any one time (however, most of them are present for the majority of the period through to reclamation). The combination of those structures that exist at any particular time is shown on the respective temporal configuration (i.e, on one of the five other plan views). **All drainage from the disturbed Arequa Overburden Storage Area is directed to one or more of these ponds.** Pond sizes are listed both on the plan view and in the summary report in pond-specific sheets. The summary of the computations lists the pertinent subbasins and the flow routing destinations in the table labelled "Arequa Drainage Routing."

In summary form, the Tables titled "Arequa Drainage Routing" also list the cumulative flow volumes for each of the five configurations and compare this amount to the total capacity of the detention and retention structures (the tabulation lists "capacity" based on survey data and "runoff volume"). In every case but one, the combination of ponds provide more than adequate volume to **completely contain the 10-year, 24-hour precipitation event.** The exception, Pond SP-3, is a water detention pond for an upland diversion that is not designed to hold all runoff from a 10-year, 24-hour event that enters it. Therefore the objective to slow flow rather than to contain it. In some cases, the impoundments will also contain the computed runoff from the 100-year, 24-hour precipitation event. The ponds will be constructed with spillways designed to safely pass the peak flow from the 100-year, 24-hour from the structure, just as the contributing ditches are so designed.

The temporal "Configurations" of the drainage that are depicted in the plan views are individually discussed next.

TEMPORAL DRAINAGE CONFIGURATIONS

Configuration #1 represents the topography as of late 1996 and shows the start of the first lift of the overburden storage area, as well as the existing drainage controls. While at present, in early 1997, Configuration #2 more accurately represents the drainage status of the area, Configuration #1 is provided for continuity. The diversion structure constructed in 1994, which is shown in operation at this stage (this structure is designated "A-B" in the drawing), is the one to, ultimately, be replaced. Runoff from the disturbed area of the Arequa Gulch overburden storage area located downgradient of this diversion currently enters, in almost its entirety, Ponds SP-1, SP-2, SP-4, and the "Sump." Upgradient detention areas assist in limiting the inflow to these depressions, and, when combined, these downstream depressions completely contain flows from the 10-year, 24-hour event. This containment occurs prior to those flows reaching the current diversion channels. At this point in time, a portion of the upland flow (clean water) from undisturbed lands that formerly drained to diversion A-B is diverted through the small detention pond SP-3 as a management practice (see drainage between subbasins B1-6 and B1-7).

Drainage from the western border outside the Cresson Mine is directed to three smaller sumps, a small area draining part of the "ready line" area is drained to Pond SP-12, a small area south of, and separate from, the secondary crusher (B1-9) drains across the clean water diversion buried culvert to Pond SP-1, and the remainder of the Crusher Area (B1-10 and B1-11)) is drained to the recently completed clay pit sump, designated Pond SP-13. Throughout the time periods represented by all of the subsequent Configurations, the drainage from the Crusher area will drain into Pond SP-13, in accordance with the drainage routes documented in this plan.

Configuration #2 represents early 1997 and essentially the current drainage system. There are a limited number of changes in the drainage subbasins compared to the previous Configuration #1. All changes relate to the changing nature of the surface and topography as the overburden approaches the sump and, therefore, the changes modify the amount, and direction, of runoff from the subbasins. The drainage area changed is, in large part, the overburden storage area surface. The B1-3 subbasin of Configuration #1, which this change affects, is expanded to incorporate much of subbasin the Configuration #1 B1-5 subbasin and it becomes subbasin B2-1 for this Configuration #2. The remaining part of the B1-5 subbasin is re-designated as the B2-2 subbasin. Configuration #2 shows the completion of the first lift of the storage area. CC&V currently plans to initiate revegetation of the first face of the Stockpile in this Configuration.

Configuration #3 depicts the storage area later in 1997, at the stage when the western face of the first lift is filled, graded, and revegetation activity on the face of the first lift is completed, and as the second lift is constructed, At this time, the northeast edge of the storage area remains outside the southern limits of the Mine area. In this Configuration, the drainage channel G-H, which conveys water from the small watershed located upgradient of the overburden storage area, is developed early in the sequence to lead to Pond SP-1. Subbasin B2-1 of Configuration #2 changes again, this time to a larger subbasin B3-2, by incorporating much of subbasin B1-6 (which remained through Configurations #1 and #2). Subbasin B2-2 of Configuration #2 is enlarged to become subbasin B3-3 as the final grading is accomplished on the face of the first lift. The rest of subbasin B1-6 becomes subbasin B3-1 because the overburden storage area grows to form a drainage divide. Drainage remains directed into the ponds and sumps. At this stage, the existing diversion ditch is terminated upstream of Pond SP-2. This termination allows additional activity in this area. However, the remainder of the diversion ditch remains with its design capacity unaffected.

Configuration #4, for a time period sometime in 1999 (approximately), represents the overburden storage area at about the point the second lift has been constructed to its ultimate elevation. At this time, new subbasin B4-1 has consumed a number of earlier subbasins such as B3-1, B3-2, B1-1, and B1-2. Subbasins B1-4 and B1-7 remain the same, as does B3-3. Runoff remains directed to ponds.

Configuration #5, for the year 2000 (approximately), represents the storage area with slope reductions completed up to this point and the surface "topsoiled" and revegetated. The storm-water runoff at this stage of progression and reclamation is considered equivalent to runoff from undisturbed areas. The principal drainage channel, G-H, carries much of the runoff flow, if runoff should occur. Drainage is directed to the current storm-water diversion system located downgradient of the Arequa Gulch overburden storage area (at and downgradient of the Secondary Crusher area).

DRAINAGE-CHANNELS AND STABILITY

Mine construction techniques, which include overburden storage area construction, create roadway drainage ditches that are oversized for the flows projected for this area. This large size is a result of crowning the haul roads to drain toward the berms along the side of the roads and the wide width of the blade equipment constructing drainage-ways beside the roads. When riprap is required to maintain stability of the channels, standard run-of-mine rock may be used and this material will also serve as the foundation for many drainage channels, thus negating the need for additional riprap.

The computation sheets accompanying this description provide peak discharge computations for the downstream end of the subbasins (which, in all cases, lead to a detention or retention structure that further controls erosion). CC&V has selected two channel designs to carry all flows. As depicted on the "Channel Cross Section" figure, cut-slope Channel cross sections are to have a 48" minimum bottom width and a 48" depth, with 3H:1V slopes, or a design of appropriate capacity for the contributing area. Road channel cross section show the 12" wide by 38" deep ditch that is incorporated in the road design. The capacity of these channels is depicted as a function of slope and depth of flow in the two graphs provided. Each of the computed channel velocities for the peak flows from the 100-year, 24-hour precipitation event, for each subbasin, was compared with the design capacities of the channels. In all cases, the design capacities are at least capable of carrying the flows.

Riprap computations are provided in the attached summary report. Riprap in the area of the Arequa Gulch overburden storage area will be the oxide rock comprising the overburden. While CC&V will examine areas as they are constructed and operated to assess the need for riprap, most channel areas will already be covered by sufficiently coarse rock to control excessive erosion, as we noted above. Computations based on the projected channel flow velocities and reported in the summary report show the largest D_{50} that may be needed is 0.24 feet, or about 3 inches. The oxide overburden material being placed will normally meet or exceed this size distribution.

Because all of these channels, with the exception of channel G-H, are temporary and lead to sedimentation ponds, control of channel erosion with riprap is only required to prevent significant silting of drainage structures, that is, siltation that jeopardizes short-term retention capacities. Ponds that are developed to contain the runoff from the 10-year, 24-hour precipitation event, or which serve as detention basins along upstream flow paths, will assist in controlling sediment.

CONCLUSION

This Plan documents the basis for designs of storm-water runoff controls for the Arequa overburden storage area. The designs are based on safely passing the flows resulting from the 100-year, 24-hour precipitation event and containing the runoff from the 10-year, 24-hour precipitation event when that runoff is from disturbed areas that have not been reclaimed. The methodology documented in TR 55 has been used to compute flows and volumes. The requisite impoundments that serve to contain and detain runoff exist and are currently used for storm-water runoff control. Thus, the principal construction requirements remaining for the evolution of the storage area will be sloping of surfaces and development of the drainage ditches leading to impoundments, followed by soil placement and revegetation..

Attachments:
(1) Summary of Storm-Water Runoff Computations
(2) Plan Views of Arequa Gulch Overburden Storage Area (5 plans)
(3) Plan View of Detention Structures Serving Arequa Gulch Overburden Storage Area.

FILE: AREQUA.DNG