REPORT

Emma Project Closure/Closeout Plan

Freeport-McMoRan Tyrone, Inc.

Submitted to:

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21476949-003-R-Rev0

November 12, 2021

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List of Acronyms and Abbreviations

°C	degree Celsius
ABA	acid-base accounting
ANP	acid-neutralizing potential
APP	Abatement Plan Proposal
ARD	acid rock drainage
BER	Basic Engineering Report
BMI	Borrow Materials Investigation
CCP	Closure/Closeout Plan
CQA	Construction Quality Assurance (Construction Quality Assurance/Construction Quality Control Plan)
CQAR	Construction Quality Assurance Report
Current	Assumes End of Year 2026 Mine Configuration unless otherwise noted
CY	cubic yards
DBS&A	Daniel B. Stephens and Associates, Inc.
DP	Discharge Permit
DSM	dynamic system model
ETS	Evaporative Treatment System
Emma	Emma Expansion Project
EnviroGroup	EnviroGroup Limited
EOY	end of year
EPA	U.S. Environmental Protection Agency
ft amsl	feet above mean sea level
ft/d	feet per day
ft/ft	feet per feet
G.O.	Tyrone General Office
Golder	Golder Associates Inc.
gpm	gallons per minute
HDPE	high density polyethylene
HDS	high-density sludge
M3	M3 Engineering & Technology Corp.
MA	mining area
MF	microfiltration
Mg/L	milligrams per liter
mm	millimeters
MMD	Mining and Minerals Division
MPO	Mine Plan of Operations
NAG	Net Acid Generation
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMMA	New Mexico Mining Act

NMWQA	New Mexico Water Quality Act
NMWQCC	New Mexico Water Quality Control Commission
NPAG	non-potentially acid generating
NPDES	National Pollutant Discharge Elimination System
NPR	Neutralization Potential Ratio
O&M	Operation and Maintenance
OPSDA	Open Pit Surface Drainage Area
PAG	potentially acid-generating
PDTI	Phelps Dodge Tyrone, Inc.
PLS	pregnant leach solution (economic copper-bearing leach solution)
PMLU	post-mining land use
RCM	reclamation cover material
RO	reverse osmosis
SDF	sludge disposal facility
SPCC	Spill Prevention Control and Countermeasures
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution and Prevention Plan
SX/EW	solution extraction-electrowinning
TDS	total dissolved solids
TTS	Tyrone Treatment System
Tyrone	Freeport-McMoRan Tyrone, Inc.

1.0 INTRODUCTION

Freeport-McMoRan Tyrone, Inc. (Tyrone) is an open pit copper mine located just off State Highway 90, approximately 10 miles southwest of Silver City in Grant County, New Mexico (**Figure 1-1**). As part of this Closure/Closeout Plan (CCP), Tyrone is proposing to expand the existing Tyrone Mine Permit and Design Limit Boundary to account for several of the facilities associated with the Emma Project. The proposed Emma Project area is located along the southern boundary of the Tyrone Mine and will include the development of a new open pit and two non-discharging waste rock stockpiles, one soil stockpile, construction of new haul roads, and installation of various infrastructure to support the project (**Figure 1-2**).

The proposed Emma Pit, portions of the EMW Waste stockpile, Soil Stockpile, Southern Emma Haul Roads and various supporting infrastructure will be located outside the Tyrone Mine Permit and Design Limit Boundary currently approved by the Mining and Minerals Division (MMD) of the Energy, Minerals, and Natural Resources Department. These proposed Emma Project features will increase the existing mine permit area and design limits by approximately 337 acres, and this area is referred to herein as the “Emma Expansion area”. The remaining facilities associated with the proposed Emma Project include the 6HW Waste stockpile, northern portions of the EMW Waste stockpile, Northern Emma Haul Road, and other supporting infrastructure will be located entirely within the current approved Tyrone Mine Permit and Design Limit Boundary. The proposed Emma Project will incorporate all of the facilities listed above into the Discharge Permit 396 (DP-396) permit area.

1.1 Purpose of Plan

The purpose of this CCP is to present a reclamation plan (technical scope of work) consistent with all applicable federal and state regulatory requirements and permit conditions so that a financial assurance cost estimate can be calculated to meet the financial assurance requirements of Part 19.10.12 NMAC and DP-1341. Applicable requirements for the Tyrone Mine area in general include the conditions of Tyrone’s permits issued under the Mining Act and the Mining Act Rules, GR010RE, and Tyrone’s Supplemental Discharge Permit for Closure, DP-1341. Portions of the mine area are subject to additional conditions related to revisions and modifications of GR0010E and other applicable discharge permits. The permit conditions are based upon the requirements of the Mining Act Rules, 19.10 NMAC, and the Water Quality Control Commission Rules, 20.6.2 NMAC. The reclamation plan will demonstrate, where required, that the disturbed area will be reclaimed to a condition that allows for the re-establishment of self-sustaining ecosystem as well to meet the closure requirements of Section 20.6.7.33 NMAC.

The reclamation (closure) design drawings associated with the Emma Project are included in **Appendix A**. A cost estimate for the purpose of determining the value of the financial assurance performance bond for the earthwork portion of this CCP was prepared by Telesto Solutions, Inc. and is included in **Appendix B** along with the Earthwork Cost Estimate Summary report. A detailed scope of work for the proposed Emma water management and treatment system is provided in **Appendix C** along with the financial assurance cost estimate associated with this component of the CCP.

1.2 Plan Organization

This section describes the purpose and scope of the CCP and its overall organization. The main body of the CCP consists of the following sections:

- **Section 1.0** provides an overview of the CCP for the Emma Project;

- **Section 2.0** describes the existing facilities and current environmental setting at the Tyrone Mine and the Emma Project area, and permits associated with the mine;
- **Section 3.0** describes the proposed Emma facilities;
- **Section 4.0** describes the proposed reclamation design criteria and performance objectives for surface reclamation and water management;
- **Section 5.0** provides details on the reclamation plans for the individual facilities associated with the Emma Project;
- **Section 6.0** describes the closure and post-closure monitoring plans for Emma along with contingency plans and reporting schedules;
- **Section 7.0** provides details of the proposed post-mining land uses for Emma and the associated requirements for the individual facilities;
- **Section 8.0** presents a summary of the basis for development of capital cost estimates associated with the proposed reclamation and post-closure monitoring plans presented in Sections 5.0 and 6.0, and the basis for development of operating and maintenance costs associated with the proposed reclamation and post-closure monitoring plans;
- **Section 9.0** presents the proposed reclamation schedule associated with this CCP;
- **Section 10.0** is the signature page for the CCP; and
- **Section 11.0** lists the references used in preparation of this CCP.

The following appendices are also included in the updated CCP:

- **Appendix A** includes the reclamation (closure) design drawings that illustrate the Emma CCP;
- **Appendix B** includes the Earthwork Cost Estimate Summary Report;
- **Appendix C** includes the proposed Emma Water Management and Treatment Plan and cost estimate for water management and treatment;
- **Appendix D** includes the Characterization of Suitable Soils and Overburden and Soil Salvage Plan for Emma; and
- **Appendix E** includes the Stockpile Stability Analysis for the EMW Waste and 6HW Waste stockpiles.

1.3 Regulatory Authority

The New Mexico legislature enacted the New Mexico Mining Act (NMMA) requiring that closeout plans be put in place for applicable mines within the State in 1993. Rules to implement the requirements of the NMMA were promulgated in 1994. This CCP was prepared to comply with applicable regulations and requirements stipulated in the NMMA and NMAC Title 19, Chapter 10, Part 5, New Mexico Water Quality Act (NMWQA), and the New Mexico Water Quality Control Commission (NMWQCC) Regulations (NMAC Title 20, Chapter 6, Parts 2 and 7).

The requirements of those laws are addressed in the conditions of Tyrone's permits GR0010RE and DP-1341. In 2013, the New Mexico Environment Department (NMED) adopted new rules for the copper mining industry.

Applicable conditions of these new rules (Copper Mine Rule Section 20.6.7 NMAC) have been addressed in this CCP. Additionally, Tyrone submitted a permit renewal and modification application for DP-396 to the NMED on October 22, 2021 (Tyrone 2021a) to authorize development of the Emma Project. **Table 1-1** provides a summary of the closure and post-closure requirements in the Copper Rule and the associated sections of this CCP for which they are addressed.

1.4 Description of CCP

The MMD and NMED require that existing mines prepare a CCP and the entity responsible for the mine must post financial assurance "*sufficient to assure the completion of the performance requirements of the permit, including closure and reclamation, if the work had to be performed by the director or a third party contractor.*"

This plan is a "snapshot in time" that reflects the most expensive closure scenario within the 5-year period covered by this CCP based on the Emma mine plans, site conditions, and other new facilities. The facility characteristics and reclamation designs presented in this CCP are referenced to conditions during year 5 of Emma Project (representing the end of year 2026). The end of year (EOY) 2026 Emma mine plan represents the year with the greatest volume of regrading and cover placement required between 2022 and 2026 and is the year with the most complex water management requirements within the Emma Pit. If mining activities were to cease between the years 2022 and 2026, the highest reclamation cost scenario would be associated with the EOY 2026 conditions. Details of the highest reclamation cost evaluation were presented in a technical memorandum submitted to the agencies on September 13, 2021 (Golder 2021a). The proposed reclamation and post-closure monitoring plans for the principal mine facilities associated with the Emma Project are described in Sections 5.0 and 6.0.

1.5 Proposed Modifications to Mine Permit and Design Limit Boundary

As part of this CCP, Tyrone is proposing to modify and expand the existing Tyrone Mine Permit and Design Limit Boundary by approximately 337 acres to account for several of the facilities associated with the Emma Project and associated disturbances (**Figure 1-3**). Tyrone is making these proposals to comply with NMMA 19.10.5.502 and 19.10.5.505.B. (1) that pertain to permit modifications and revisions. Under this plan, the proposed expanded Tyrone Mine Permit and Design Limit Boundary are consistent with one another. Further details of the proposed mine permit and design limit boundary changes are presented in Section 6.0.

1.6 Development of CCP Cost Estimate

This CCP provides the basis for a third-party financial assurance cost estimate of the proposed reclamation, closure, and post-closure under 19.10.12.1205 NMAC, Permit GR010RE and DP-1341. The Emma CCP includes descriptions of the scope of work to be performed, reclamation schedule, federal and state permit requirements, topographic maps of the current and future surface conditions, monitoring schedules, and other pertinent information required by specific rules and permit conditions. The CCP is in support of and relies on the knowledge and experience of site-specific studies, reports, and MMD and NMED permit applications recently submitted to the agencies associated with the Emma Project (Tyrone 2021a and 2021b). Capital costs, operating costs, and maintenance costs for post-closure/closeout care have been developed for this CCP and are outlined in Section 8.0. These costs are further detailed in the Earthwork Cost Estimate Summary report provided in **Appendix B**, and the Emma Water Management and Treatment Plan cost basis document and associated cost estimate provided in **Appendix C**.

2.0 EXISTING SITE CONDITIONS

The following sections describe the site-specific characteristics of the proposed Emma Project area. In addition, pertinent permits and operational DP information are summarized herein.

2.1 Description of EMMA Project Area

Section 2.1 describes the proposed Emma Project features at the EOY 2026. The proposed Emma Project facilities occur both inside and outside the existing Tyrone Mine Permit and Design Limit Boundary approved by the MMD of the Energy, Minerals, and Natural Resources Department. Thus, the proposed change in operations constitutes an expansion of the current approved Tyrone Mine Permit and Design Limit Boundary. The proposed Emma Expansion area will increase the existing Tyrone Mine Permit and Design Limit Boundary by approximately 337 acres. This increase will allow for the construction of the proposed Emma Pit, majority of the EMW Waste stockpile, Soil Stockpile, Southern Emma Haul Roads, and various supporting infrastructure outside the current mine permit and design limit boundary. The 6HW Waste stockpile, northern portion of the EMW Waste stockpile, Northern Emma Haul Road, and other supporting infrastructure will also be constructed as part of the Emma Project but will be located entirely within the existing Tyrone Mine Permit and Design Limit Boundary. Approximately 9 acres of the EMW Waste stockpile will lay within the existing Tyrone Mine Permit and Design Limit Boundary, and the remaining 45 acres of the stockpile will fall outside the existing Tyrone Mine Permit and Design Limit Boundary. **Figure 2-1** depicts the primary elements of the Emma Project that will be present at the EOY 2026, including the projected EOY 2026 configurations for the Emma Pit, EMW Waste and 6HW Waste stockpiles, dewatering pipeline, and haul roads. A total of approximately 255 acres of new unit disturbances and approximately 142 acres of existing unit disturbances are associated with the Emma Project. These facilities are further described in Section 3 of this CCP.

All exploration holes in the Emma Project area have been abandoned in accordance with State Engineer plugging requirements. Currently, three groundwater monitoring locations exist near the proposed Emma Expansion area: 396-2021-01 (a borehole), and monitor wells 396-2021-02 and MB-44. The three monitor wells will remain as part of the DP-396 groundwater monitoring network.

2.2 Past and Current Land Uses

Surface lands in and adjacent to the mine have historically been used for mining, livestock grazing, timber and fuel wood harvesting, recreation, and wildlife habitat. Ponderosa pine was logged in the Big Burro Mountains south of the Tyrone Mine, and fuel wood has been cut from woodlands in this area for at least a century. Recreation in the area includes camping, picnicking, hunting, off-road vehicle use, hiking, horseback riding, and bicycling. Current surrounding land uses include private residences, grazing, mining, and recreation. Grazing is the predominant land use surrounding the Emma area.

2.3 Environmental Setting

The following sections present various aspects of the Emma Project area, including its topography, geology, climate, hydrology, soils and vegetation, wildlife, and material characteristics.

2.3.1 Topography

The Tyrone Mine area straddles the Continental Divide between the Big Burro and Little Burro Mountains. The mine is located on the northeastern slopes of the east end of the Big Burro Mountains, a northwest-southeast trending range approximately 22 miles long and 4 to 12 miles wide. The Little Burro Mountains are situated northeast of the Big Burro Mountains and are separated from the Big Burro Mountains by the mine and the Mangas Valley (**Figure 2-2**).

The topography in the vicinity of the Tyrone Mine reflects the relatively gentle northeastern slopes of the Big Burro Mountains. Burro Peak, on the Continental Divide, rises to an elevation of 8,035 feet above mean sea level (ft amsl). The trace of the Continental Divide is to the northeast through the Tyrone Mine, crossing the Mangas Valley at an elevation of 5,825 ft amsl. The Divide separates Mangas Wash from the southeasterly-draining Brick Kiln Gulch and Oak Grove Wash. The Continental Divide crosses the Little Burro Mountains northwest of Tyrone Peak at a maximum elevation of 6,439 ft amsl. The northernmost extent of the Emma Expansion area lies approximately 1,000 feet south of the Continental Divide. The Emma Expansion area is bisected by Oak Grove Wash, an ephemeral wash that periodically flows during summer monsoonal storm events.

2.3.2 Geology

DBS&A (2021b) prepared a hydrogeologic report in support of environmental permitting for the Emma Project. The report describes the geology and hydrology within the Emma Expansion area based on information presented in published reports, as well as site-specific data obtained through exploration borehole drilling and a groundwater investigation conducted in 2021 (DBS&A 2021a). The following geologic discussion is taken from DBS&A (2021b).

The geology at the Tyrone mine and surrounding area has been described by Edwards (1961), Gillerman (1964), Kolessar (1982), and Mach (2008), and is summarized in geologic maps prepared by Hedlund (1978a,b,c,d). DBS&A (2017b) also provides a comprehensive description of the geology. The primary rock types and their geographic extents at Emma are illustrated in **Figure 2-3**. **Figures 2-4 and 2-5** provide generalized geologic cross sections. The fault systems shown in **Figure 2-3** are based on results of detailed geologic mapping conducted by Tyrone in support of mining at Emma and may differ slightly from those presented in published reports, such as Hedlund (1978c).

2.3.2.1 Rock Units

Precambrian and Tertiary rocks, as well as Quaternary deposits, are present at the land surface in the area of Emma (**Figure 2-3**). Most of the proposed pit area consists of pink to gray Burro Mountain Granite (Precambrian granite). The granite can sometimes weather to an orange and brown color. This usually equigranular granite is composed of varying percentages of biotite, microcline, oligoclase, and quartz. Iron oxides are sometimes present on the quartz grains and fracture planes. Silica overprinting, silica veins, and disseminated pyrite are also present within the granite. Mineralization of sulfides increases with increasing depth. An aphanitic aplite of similar composition to the Precambrian granite is found in spots throughout the pit area. In addition to the main Precambrian units, there are also a few outcrops of pegmatite to the east and diabase to the northwest of the pit area. The diabase is dark gray to black to green in color, fine to medium grained, and has a general composition of biotite, hornblende, magnetite, plagioclase, and pyroxene (Mach 2008).

The Tertiary age rocks in the Emma Pit area are igneous rocks, usually of porphyritic texture. A light gray, medium-grained granodiorite is exposed to the west (**Figure 2-3**). Hedlund (1978c) tends to map these rocks as quartz monzonite. The granodiorite can have an equigranular or a porphyritic texture, with a composition of biotite, orthoclase, plagioclase, and quartz. A light gray, medium grained quartz monzonite is exposed in the northern portion of the proposed area of the pit (**Figure 2-3**). The quartz monzonite also can have an equigranular or a porphyritic texture, with a composition of biotite, hornblende, oligoclase, orthoclase, and quartz (Mach 2008). There are also several quartz monzonite porphyry dikes with a texture and composition like the quartz monzonite.

The dikes strike primarily east to west. As shown in **Figure 2-4**, these dikes are near vertical. At the Little Rock mine, these types of dikes tend to act as impediments to groundwater flow (DBS&A 2014), and the predominant groundwater flow direction is parallel to them rather than across them.

Gila Conglomerate is a Tertiary-Quaternary rock unit exposed to the east of Emma (**Figure 2-3**). It mostly consists of consolidated and unconsolidated conglomerates with interbedded sandstones, basalts, andesites, and rhyolites. The conglomerate contains lithic fragments eroded from older units in the surrounding area; therefore, the color varies from red/brown/tan to gray/white. Quaternary alluvial deposits overlie the older rock units. These deposits are present in the drainages near Emma, including Upper Oak Grove Wash and Cherry Creek (**Figure 2-3**). They contain round to angular fragments of the surrounding rock units, which varies the color. The alluvial deposits can be mistaken for weathered Gila Conglomerate (Gillerman 1964).

2.3.2.2 Geologic Structures

There are two major faults near Emma: (1) the Sprouse-Copeland Fault to the north; and (2) an unnamed fault to the south (**Figure 2-3**). Tyrone mapped the trace of the Sprouse-Copeland Fault shown in **Figure 2-3**; the location of the unnamed fault is from Hedlund (1978c).

The Sprouse-Copeland Fault is a southwest-northeast striking fault with an approximately 80-degree dip to the southeast. It is a Laramide age fault that exhibits hundreds of feet of displacement (Mach 2008). Along the north side of the proposed open pit, it crosscuts Precambrian granite (**Figure 2-4**). Tyrone conducted a site reconnaissance in the area north of Emma to confirm the presence of the fault and map its trace. The delineation of the fault shown in **Figure 2-3** is based on this site reconnaissance. Field evidence used to map the surface trace of the Sprouse-Copeland Fault included gouge zones, slickenlines (scratches on fault surfaces resulting from shear motion), and exposure of cataclasite (fault breccia) in deeply cut drainages.

Along the southeast side of the Tyrone Mine near the reclaimed 1C Waste Rock stockpile, the Sprouse-Copeland Fault appears to be an impediment to groundwater flow based on differences in groundwater elevations at monitor wells located on opposite sides of the fault (DBS&A 2017a). The predominant groundwater flow direction in this area is parallel to the fault rather than across it.

The second major fault near Emma is unnamed. The unnamed fault is located to the south of the proposed area of the open pit. It is a west-east striking fault of unknown age that crosscuts Precambrian granite and dips 75 degrees to the north (Hedlund 1978c).

Tyrone continues to refine the geologic understanding at Emma.

2.3.3 Climate

The Emma Project area is located in a semiarid region in southwestern New Mexico, with land surface elevations ranging from about 6,000 to 6,650 ft amsl. The climate at Tyrone is warm and dry, with annual evaporation far exceeding annual precipitation. Tyrone maintains several meteorological stations at various locations throughout the Tyrone and Little Rock Mines (DBS&A 2017b). Mean annual precipitation recorded at the Tyrone General Offices (G.O.) meteorological station is 16 inches, falling primarily as rain during the monsoon season from July through October. Snow may fall between November and March. The G.O. meteorological station period of record includes precipitation data from 1990 to present.

Estimated mean annual open water evaporation for the area is 56.5 inches (DBS&A 2014). This estimate was calculated using the FAO-56 monthly Penman-Monteith method (Allen et al. 1998) and climate data for the period 1981 through 2010.

2.3.4 Hydrology

DBS&A (2021b) describes the surface-water and groundwater hydrology within the Emma Project area. The following hydrologic discussions are taken from DBS&A (2021b).

2.3.4.1 Surface-Water Hydrology

The Emma Expansion area is located on a topographic high situated between two major drainages (**Figure 2-6**). Upper Oak Grove Creek (a.k.a. Upper Oak Grove Wash) is located to the north and Cherry Creek is located to the south. These drainages are ephemeral washes that flow only in response to precipitation events and are not perennial surface water features. The drainages originate in the Big Burro Mountains located to the west and are tributary to Lower Oak Grove Wash located to the east. Upper Oak Grove Wash and Cherry Creek naturally divert stormwater originating in the Big Burro Mountains around the Emma Expansion area (**Figure 2-6**).

The existing terrain within the Emma Expansion area slopes predominantly to the east. Because the Emma expansion is located on a topographic high, small, upland drainages originate on or very near the site. Many of these drainages become more distinct to the east (near Highway 90) as they merge with other drainages, and are tributary to Lower Oak Grove Wash. There is one drainage that originates just west of the proposed open pit that flows across the northwest end of the pit boundary. This drainage is tributary to Upper Oak Grove Wash (**Figure 2-6**). Springs do not exist at Emma.

In September 2021, Tyrone installed automated surface water samplers in some of the ephemeral drainages at Emma. The automated samplers were placed west (upgradient) of Emma to determine background water quality of stormwater flowing across and near the site. **Figure 2-6** shows the locations of the automated samplers. Water quality samples were retrieved from the EMSW-1 and EMSW-3 automated samplers on September 27 and 28, 2021, as stormwater had collected in them during recent rains. Locations EMSW-2 and EMSW-4 contained insufficient water, precluding the collection of water quality samples. Tyrone submitted the water quality samples to SVL Analytical, Inc. in Kellogg, Idaho for analysis of major ions and metals. The laboratory results are summarized in the hydrogeologic report for the Emma Expansion project (DBS&A 2021b), and generally show the water quality meeting applicable surface water standards, with the exception of total selenium at EMSW-1.

Mining at Emma will create a 500- to 600-foot depression (the Emma Pit) that will cover approximately 116.3 acres. Surface water at Emma will consist of stormwater runoff generated from rainfall within this area. The stormwater will be hydrologically contained within the perimeter of the open pit. The proposed configuration of the Emma open pit will create five catchments where stormwater is expected to collect. Two of these catchments are located at the bottom of the open pit (Main North and Main South), and the other three are located at higher elevations along the north, east, and south sides of the open pit (Upper North, Upper East, and Upper South). Tyrone intends to backfill the Main South, Upper North, Upper East, and Upper South catchment areas during mining operations for water management purposes. The backfill will be graded to direct stormwater to the bottom of the Main North catchment area, where water will be pumped from a water management sump and conveyed to the Tyrone Mine (**Figure 2-1**). This effort will minimize the amount of accumulated water. The water will be conveyed from the Emma Pit sump through a new pipeline to the existing 1C Seepage and 7A Seepage Collection Systems, which reports to 1A PLS Collection Tank.

Tyrone will construct a haul road across Upper Oak Grove Wash to allow for the transportation of ore and potentially acid-generating (PAG) waste rock from the Emma Pit to the Tyrone Mine. The haul road will be elevated above the grade of the wash. Culverts will be installed at the base of the haul road to allow stormwater to flow beneath it. The haul road will be constructed of non-acid-generating materials to avoid impact to surface water quality.

Proposed mining operations at Emma, including advancement of the open pit and construction of the EMW Waste stockpile and haul roads, will have minimal impact on the hydrologic balance as defined in 19.10.5.508 NMAC. Stormwater flows in Upper Oak Gove Wash and Cherry Creek will continue around the Emma Expansion area, as they do today, and all stormwater generated within the open pit will be hydrologically contained within the pit perimeter, including stormwater that contacts exposed sulfides and may become impacted.

The proposed location of the Emma Pit is not within a Federal Emergency Management Agency (FEMA) flood zone. Upper Oak Grove Wash and Cherry Creek are not recognized as flood zones in the vicinity of the Emma Project area; however, sections of them several miles downstream and east of Emma are recognized as flood zones. The proposed haul road will cross Upper Oak Grove Wash and will be constructed and maintained to allow stormwater to flow beneath it without jeopardizing its integrity.

2.3.4.2 Groundwater Hydrology

The primary water-bearing rock in the Emma Expansion area is Precambrian granite. Groundwater flow within the granite and other igneous rocks near Emma is governed by secondary permeability (joints and fractures). Currently, three groundwater monitoring locations exist near Emma: 396-2021-01 (a borehole), and monitor wells 396-2021-02 and MB-44. Depth to water ranges from approximately 168 feet (396-2021-01) to approximately 332 feet (MB-44). The groundwater level is approximately 200 feet above the proposed bottom of the Emma Pit (**Figures 2-4 and 2-5**). The groundwater flow direction in the Emma Expansion area is to the northeast, and the magnitude of the hydraulic gradient is 0.05 feet/feet (ft/ft) (**Figure 2-7**). The groundwater flow direction is consistent with regional groundwater mapping presented in Trauger (1972). Groundwater flows from the Big Burro Mountains (located to west) toward the area beneath Oak Grove Wash (located to the east).

Pumping tests were conducted at the three groundwater monitoring locations in May 2021. They demonstrate that the hydraulic conductivity of the water-bearing rocks is low, especially to the south at 396-2021-01. Hydraulic conductivity values range from 6.2×10^{-5} feet/day (ft/d) (396-2021-01) to 7.1×10^{-2} ft/d (MB-44), with a geometric mean of 3.5×10^{-3} ft/d. Higher transmissivity and hydraulic conductivity values are observed at the two monitor wells located closer to the Sprouse-Copeland Fault (i.e., 396-2021-02 and MB-44). But in general, the values are low, indicating that the water-bearing granite is low yielding. It should be noted that the transmissivity and hydraulic conductivity values measured at individual wells are indicative of the permeability of specific fracture zones, as well screens are set across water-yielding fractures. Consequently, the measured values are likely greater than aquifer-scale "bulk" permeability values that incorporate the entire volume of porous media (i.e., both fractured and unfractured rock).

Groundwater quality within the Emma Expansion area is variable. Water quality samples have been collected from 396 2021-01, 396-2021-02, and MB-44. While groundwater quality at 396-2021-02 is good, meeting Section 3103 standards, groundwater quality at 396-2021-01 is poor, exceeding Section 3103 standards for fluoride, manganese, sulfate, and total dissolved solids (TDS) (**Table 2-1**). Water quality at monitor well MB-44 is good, meeting Section 3103 standards with a few exceptions, and has been steady since the well was installed in 2002. The few exceptions appear to be outliers. The elevated constituent concentrations at 396-2021-01 appear to be natural, as there are currently no mining activities at Emma and the groundwater flow direction at the Tyrone Mine, located to the north, is to the north/northeast. Continued groundwater monitoring at 396-2021-01 and 396-2021-02 will establish baseline groundwater quality at Emma.

2.3.5 Soils and Vegetation

The soils in Grant County were previously mapped by the Forest Service and Soil Conservation Service (Parnham et. al. 1983). Site-specific soil and vegetation surveys were conducted at Tyrone in 1997 as part of the closure/closeout studies (DBS&A 1997c), and more recently within the Emma Expansion area (Golder 2021b; WestLand Resources, Inc. 2021). The distribution of soils at the Tyrone Mine is controlled by the climate, geology, age of the land surfaces, and physiography of the area. The vegetation is indicative of the regional climate modified by soil and topographic factors. The distribution of the existing vegetation is locally complex and reflects the influence of both environmental gradients and land management practices. The vegetation communities in the proposed Emma Expansion area are locally and regionally extensive. No threatened or endangered plant species are recognized as occurring in the Tyrone Mine permit area. A vegetation survey of the Emma area conducted in October 2020 indicated that no special-status or rare plants occur in the area (WestLand Resources, Inc. 2021).

Three major plant communities are present in the Emma Expansion area. These include the alluvial grassland, piedmont scrub savanna, and mountain slope mixed evergreen woodland plant communities described below (**Figure 2-8**).

Alluvial Grasslands: This plant community occupies the nearly level to gently sloping floodplains and alluvial terraces of Oak Grove Wash and its tributaries in the proposed permit area. The dominant soils in the alluvial grassland include coarse-loamy and sandy families of ustic mollisols and entisols (DBS&A 1997c). The soils are very deep, nonsaline, nonsodic, and coarse-textured and were formed in thick, alluvial deposits composed predominantly of mixed igneous rocks. The existing vegetation is dominated by tarragon (*Artemisia drunculoides*), a variety of annual forbs and a low density of warm season grasses including sideoats and blue grama (*Bouteloua curtipendula* and *B. gracilis*) and purple three-awn (*Aristida purpurea*). Apache plume (*Fallugia paradoxa*) and California bricklebush (*Brickellia californica*) are important shrubs with Emory Oak (*Quercus emoryi*) the dominant tree along the active floodplain.

Piedmont Scrub Savannas: The scrub savanna plant community occurs on the gently sloping to steep pediments and fan terrace deposits from the Big Burro Mountains along eastern portions of the EMMA project area. Soils are loamy- and clayey-skeletal to fine families of ustic mollisols and alfisols (DBS&A 1997c). The soils are moderately to very deep, nonsaline, nonsodic, and medium- to fine-textured. The scrub savanna vegetative community is characteristic of the transition between an open grassland and mixed evergreen woodland. Deeper soils in valleys tend to be dominated by sideoats, blue, and hairy grama (*B. hisuta*) and other warm-season grasses. Important shrubs include beargrass (*Nolina microcarpa*), broom snakeweed (*Gutierrezia sarothorae*), and catclaw mimosa (*Mimosa biuncifera*). In areas with slightly steeper slopes and shallower soils, Pinyon pine (*Pinus edulis*) one-seed (*Juniperus monosperma*) and alligator junipers (*J. deppeana*), and Emory oak become more prevalent.

Mountain Slope Mixed Evergreen Woodlands: This plant community occupies the strongly sloping to very steep backslopes and ridges of the Big Burro Mountains on shallow soils formed in residuum and colluvium. Soils are mostly loamy-skeletal ustic mollisols and alfisols that are shallow, noncalcareous, and medium- to coarse-textured with moderate to high amounts of coarse fragments (DBS&A 1997c). Vegetation within the mountain slope mixed evergreen woodland is dominated by a relatively open stand of pinyon pine and evergreen oaks with one-seed and alligator juniper subdominant. Mixed grama and associated grasses are dominant in the sparsely vegetated understory with mountain mahogany (*Cercocarpus montanus*), point-leaf manzanita (*Arctostaphylos pungens*), and beargrass being important shrub components. Ponderosa pine (Pinus ponderosa) and Gambel oak (Quercus gambelii) are locally important subordinates that may occur in sheltered topographic positions.

2.3.6 Wildlife

Wildlife species in the vicinity of the Tyrone Mine are representative of those communities that are found in southwestern New Mexico pinyon-juniper-oak woodlands. Surveys conducted in the area of the Tyrone Mine indicate that there is a healthy diversity and abundance of vertebrate species using the habitat around the mine. At least 18 mammals, 79 bird species, and 5 reptiles have been documented in the vicinity of the Tyrone Mine (DBS&A 1997c; Metric Corporation 1993 and 1996; Dames & Moore 1994).

WestLand Resources, Inc. recently completed Biological Evaluation Surveys that provide screening analyses to determine the potential to occur of special-status species, designated or proposed critical habitat in the Emma Expansion area, and analyze effects of the project to such species and/or their habitats. Of the 57 special-status species evaluated, 35 species have no potential to occur, five are possible, 17 species are unlikely, and no special-status species are known to be present in the Emma Expansion area. There is no designated or proposed critical habitat present in the Emma Expansion area, and no special-status or rare plants were observed during pedestrian surveys of the Emma area (WestLand Resources, Inc. 2021).

2.3.7 Material Characteristics

Waste material types expected to be generated from the Emma Pit have been characterized to evaluate their long-term environmental behavior, primarily their propensity for acid rock drainage (ARD) and metals leaching. Material characteristics and the proposed plan for material management are briefly summarized in the sections that follow. More complete descriptions of material characteristics and management plans are provided in reports that have been submitted by Life Cycle Geo, LLC (LCG) to NMED (LCG 2021a, b).

2.3.7.1 Material Environmental Behavior

Tyrone ore, waste rock, and overburden have been characterized to assess their long-term environmental behavior according to requirements as set forth in the Copper Mine Rule (20.6.7 NMAC). The analytical testing program consisted of a basic static testing program that included acid-base accounting (ABA) (Sobek 1978), NAG pH (AMIRA 2002), meteoric water mobility procedure (MWMP, ASTM E2242 2013), quantitative mineralogy (X-ray diffraction), as well as kinetic testing to evaluate sulfide oxidation and acid neutralization rates using humidity cells (ASTM 2018).

The material characterization tests were conducted on waste material from the Emma Expansion area over the past year and a half (with humidity cell testing still ongoing). Additional details of the characterization program, including criteria for selection of representative samples, have been documented in detail in a static test Sampling and Analysis Plan (LCG 2020) and a kinetic test Sampling and Analysis Plan (LCG 2021c), both of which have been presented to NMED.

The overall ARD potential for waste rock is largely a function of material sulfur content, with roughly 80% of samples indicating total sulfur concentrations at or near laboratory detection levels (<0.1 wt. %), as indicated in **Figure 2-9.** Sulfide sulfur concentrations are somewhat lower than total sulfur concentrations (**Figure 2-9**); the 20% of samples with non-negligible sulfide sulfur have concentrations ranging from ~0.2 to 1.2 wt. %. Samples with higher sulfide sulfur concentrations largely represent the Precambrian granite lithology.

Two bulk ARD parameters including Neutralization Potential Ratio (NPR; a combination of material acid-generating and acid-neutralizing potential) as well as Net Acid Generation (NAG) pH (AMIRA 2002) are provided in **Figure 2-10** in the context of total sulfur concentration. The figure indicates that samples with 1) NAG pH below the AMIRA threshold for acid generation (<4.5), 2) NPR below the threshold for PAG (<1) materials, and 3) higher total sulfur concentrations (≥0.2 wt. %) generally overlap.

Characterization results indicate that NPR, NAG pH and total sulfur are all roughly equally predictive of materials with long-term ARD potential. These findings have not yet been confirmed by the kinetic testing (humidity cell) program as no samples have become acidic within the timeframe of testing. The purpose of humidity cell testing is to evaluate 1) whether samples classified as Uncertain based on static testing results are likely to become acid-generating or not, 2) the timing to acidic conditions for PAG samples, and 3) leachate water quality associated with samples that become acid-generating. The most recent humidity cell test results are provided in **Figure 2-11**.

No humidity cells have become acidic to date; the group of eight cells includes four sulfide zone samples (whose sample IDs start with 'S') classified as PAG that have NPR values below 1, NAG pH values below 4.5 and total sulfur values ranging from ~0.4 to 1.4 wt. %. These cells are expected to become acidic at some point, although perhaps not within the duration of testing. Two of the sulfide zone cells currently have leachate pH values below 5.5 and relatively low calcium/sulfate ratios suggesting that they are likely to become acid generating before the other cells. Depletion calculations suggests that timing to acid generation is likely to range from ~1-2 to 10 years for the PAG cells.

Although humidity cell testing is not complete, results to date suggest that samples classified as PAG based on static test results will eventually become acid generating, whereas samples classified as Uncertain based on static test results are highly unlikely to ever become acid generating. LCG recommends that these samples be reclassified as non-potentially acid generating (NPAG). The humidity cell results to date also suggest NAG pH, NPR and total sulfur thresholds are equally useful for segregating PAG and NPAG materials, and that these materials exist in roughly 20% and 80% proportions, respectively.

2.3.7.2 Material Segregation and Handling

The characterization program conducted for Emma waste materials indicates that PAG and NPAG materials can be effectively segregated using NPR, NAG pH or total sulfur criteria. LCG (2021a) has proposed a total sulfur threshold of 0.2 wt.% to segregate PAG from NPAG materials, which is deemed appropriate for the following reasons:

- Total sulfur results in a slightly more conservative classification (higher number of samples classified as PAG) than NPR or NAG pH at Emma;
- The threshold is based on total sulfur, not sulfide sulfur, which is also conservative;
- The threshold does not account for material acid-neutralizing potential (ANP). If a sample has measurable ANP, but its total sulfur concentration is above 0.2 wt. %., it will still be classified as PAG; and
- Other studies (Price 1997; Lapakko and Antonson 2002) indicate that below a sulfide sulfur threshold of 0.2 wt. %, a sample is highly unlikely to become acid generating.

The proposed total sulfur threshold of 0.2 wt. % will effectively segregate any samples that have the potential to become acidic in the long-term from samples with very low ARD (and metals release) potential. Current estimates indicate that as much as 10 million tons of NPAG rock could be deposited to the two Emma non-discharging stockpiles (EMW Waste and 6HW Waste stockpiles), although the actual tonnage is likely to be lower. The proposed sulfur threshold will effectively prevent sulfide waste (PAG) material from being placed on either non-discharging stockpile. PAG waste will be on existing stockpiles at Tyrone that are permitted to receive PAG materials.

Furthermore, a small proportion of NPAG waste rock will be routed to the Emma Pit to be used as limited backfill for purposes of covering exposed PAG material in pit wall surfaces and for pit water management. This material will be identified using the same proposed sulfur threshold. Further details of the proposed material characterization and handling procedures for the Emma Project can be found in the recently completed plan by LCG (2021b) that was included as Attachment IID-2 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a).

2.3.7.3 Borrow Materials

Agency approved borrow material will be used as reclamation cover material (RCM) and will meet all regulatory requirements listed in permit GR010RE and section 20.6.7.33.F of the Copper Mine Rule. Potential RCM identified for Emma include native soils, alluvium, in-situ Gila Conglomerate, and Precambrian granite and other NPAG overburden materials from the Emma Pit that will be stored at the EMW Waste stockpile.

Golder conducted a soil survey field investigation within the Emma area between July 26 and 29, 2021 (Golder 2021b) and the report is included as **Appendix D** to this CCP. The soil investigation involved the examination of 18 soil profiles in shallow backhoe-excavated pits in the project area, and twenty-two additional observations were taken along road cuts and shallow hand excavations to confirm the soil-landscape relationships. As part of the proposed operations for Emma, Tyrone plans to salvage the pedogenic A and B horizons of native soils from areas scheduled to be disturbed with mine development. Because most of the soils are shallow and have thin A horizon, Tyrone proposes to mix the entire soil profile during salvage operations. Any underlying C or R soil horizons will also be salvaged and incorporated into the EMW Waste and 6HW Waste stockpiles which will also be utilized as RCM in the future.

Tyrone intends to salvage as much native soil material as can be safely and practicably be recovered. The volume of suitable cover materials is the product of the area of each soil map unit within the facility footprints and the assigned depth of the suitable material in that unit. The average salvage depth for individual map units ranges from 21 inches to 3 feet. Thus, the estimated volume of salvageable soil materials by soil map unit for Emma is approximately 547,600 cubic yards (CY) (Golder 2021b).

Soil salvage will be performed ahead of mining activities as to not adversely impact the quantity and quality of native soil resources. Prior to soil salvage, large diameter trees and shrubs will be grubbed. To the extent that it doesn’t interfere with soil salvage operations, small diameter woody plants, herbaceous vegetation and roots would be salvaged to minimize the loss of organic matter of the soil materials. Soil salvage will be completed by dozers that will remove the recommended depth and push to load out areas where front-end loaders will load haul trucks. Soil salvage will be undertaken during throughout the year when soils are dry. Soil salvage will not be conducted in the days following snow or heavy rain events until the soils are sufficiently dry to avoid compaction. To minimize compaction, equipment traffic patterns in salvage areas will be minimized.

The RCM requirement for Emma is approximately 320,720 CY based on the current permit requirements. Sufficient materials are expected to be available for this purpose between the salvaged topsoil and RCM derived from the Emma Pit. Any excess RCM will be available for mine reclamation on the south side of the Tyrone mine.

2.4 Permits and Discharge Plans

Tyrone currently conducts its mining operations pursuant to numerous state and federal regulations covering groundwater, surface water, air, solid and hazardous wastes. **Table 2-2** lists all federal and state permits, and permit numbers required for the CCP. The proposed Emma Expansion area will be incorporated into operational DP-396 through a permit renewal and modification application that was submitted by Tyrone to the NMED on October 22, 2021 (Tyrone 2021a). Tyrone also submitted a permit revision application to mining act permit GR010RE to the MMD on October 22, 2021 to incorporate the Emma Project (Tyrone 2021b).

3.0 PROPOSED EMMA PROJECT CONFIGURATION

The following sections provide details of the site-specific Emma Project features that will exist at the EOY 2026.

3.1 EMMA Pit

The proposed Emma Pit is anticipated to encompass up to approximately 116.3 acres of private land at the EOY 2026 (**Figure 2-1**). Tyrone has included an additional “pit buffer” area to allow for slight deviations in the pit configuration that may occur in actual construction and minor mine management utilities. This pit buffer area is referred to as the “Proposed Emma Open Pit Boundary” on **Figure 2-1**. The total area within the Proposed Emma Open Pit Boundary is approximately 200 acres (including the pit itself). The open pit will be mined in 50-foot benches, creating a terraced/benched pit wall that will ultimately extend to a depth of approximately 5,700 ft amsl and have one or more flat bottoms. Approximately 6.3 acres of the upper north area of the pit will be covered over with the EMW Waste stockpile in 2026. It is anticipated that regional groundwater will be encountered as the pit is advanced from a level of approximately 6,000 ft amsl at the EOY 2025 to a level of approximately 5,700 ft amsl at the EOY 2026. As part of the Emma Pit water management plan (Golder 2021c), NPAG waste rock mined from the Emma Pit will be placed within the upper bench areas of the pit (Upper North, Upper South and Upper East areas) and within accessible portions of the South Main area during mine operations to promote surface water runoff toward the pit sump. An additional one-foot thick layer of soil from the Soil Stockpile will be placed over the NPAG waste rock backfill and revegetated in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications in the Upper East area during operations. The remaining areas receiving the NPAG waste rock backfill during operations (Upper North, Upper South, and South Main) will receive an additional one-foot of soil cover and be revegetated during closure.

A dewatering system will be installed near the bottom of the Emma Pit that will pump surface water and ground water that accumulate within the pit sump during operations, which will allow the mine to operate during normal activities within the open pit and during rain events. During operation and throughout the post-closure period collected waters will be pumped from the pit sump and conveyed to the existing 1C Seepage and 7A Seepage Collection Systems via a new 4-inch diameter DR-11 HDPE Pipeline (the Emma pipeline) (**Figure 2-1**). From the 1C Seepage and 7A Seepage Collection Systems, the collected water is conveyed to the 1A PLS Collection Tank and then used in the Tyrone Mine process water management system during operations. During the post-closure period, the conveyed water will be incorporated into the Tyrone Mine closure mine water management and treatment system (Golder 2020b) as described in **Appendix C**. The post-closure pit water management sump (or collection) is designed to minimize the size of the water surface, but still allow effective water management at all times (including large storm events).

Details of water balance and geochemical modeling performed in support of the Emma Project are provided in the following sections.

3.1.1 Water Balance and Geochemical Modeling

DBS&A (2021b) developed a water balance model for the Emma Pit, using the GoldSim simulation software package and the EOY 2026 pit configuration. The purpose of the water balance model was to evaluate expected water accumulation (quantity and quality) within the open pit during operations and post-closure. This analysis was an important step that led to Tyrone's decision to not allow a pit lake to form at closure, but rather utilize the pit water management techniques described above.

Sources of water inflow to the open pit considered in the modeling included the following:

- Groundwater inflow (Main North only);
- Direct precipitation on the ponded water surface; and
- Runoff generated from within the perimeter of the open pit.

Water outflow from the pit included evaporation from the water surface if a pit lake were allowed to develop post-closure.

Tyrone intends to backfill the Main South, Upper North, Upper East, and Upper South catchment areas during mining operations for water management purposes. The backfill will be graded to direct stormwater to the bottom of the Main North area. The entire stormwater catchment area of the Emma Pit is 116.3 acres (**Figure 2-1**).

3.1.1.1 Water Balance Modeling Results

The water balance model is set up as a 100-year simulation designed to predict closure conditions based on the EOY 2026 pit configuration and with the hypothetical assumption that nothing is done to manage water accumulation (i.e., a hypothetical pit lake is allowed to form). The model simulation period is from January 1, 2027 through December 31, 2126.

Sources of water to the open pit include stormwater and groundwater. Historical precipitation records of the Tyrone G.O. meteorological station (1990 through 2021) were used to develop a 100-year synthetic series of daily precipitation values for the water balance model. The synthetic series maintains seasonal precipitation patterns with a mean annual precipitation rate (16.1 inches per year [in/yr]) that is comparable to the observed rate (16.0 in/yr). Direct precipitation is calculated as daily precipitation depth multiplied by the lake surface area. Stormwater runoff is calculated with the SCS curve number method (SCS-CN method) (NRCS 2004a,b), using a curve number value of 80, the 100-year synthetic series of daily precipitation values, and 116.3-acre catchment area for the Emma Pit (minus the lake surface area). DBS&A (2021b) conducted numerical groundwater flow modeling to predict groundwater inflow to the Emma Pit during active mining and at closure. Estimated groundwater inflow rates steadily decrease over time. At closure, the groundwater inflow rate decreases from 13.8 to 9.0 gallons per minute (gpm). The time series of estimated groundwater inflow rates for the closure period were used as the groundwater inflow rates in the water balance model.

Evaporation is the only outflow considered in the water balance model. The climate is warm and dry, with annual evaporation exceeding annual precipitation. The water balance model uses a potential annual evaporation rate of 56.5 in/yr. This estimate was calculated using the FAO-56 monthly Penman-Monteith method (Allen et al., 1998) and climate data for the period 1981 through 2010 (DBS&A 2014). The annual evaporation rate is multiplied by monthly distribution factors calculated from Tyrone 1X tailing dam pan evaporation data to determine monthly evaporation rates that reflect seasonal evaporation patterns at the mine. The monthly evaporation rates are then used to estimate daily evaporation rates. Evaporation from lake surfaces is calculated as the daily evaporation rate multiplied by the surface areas of ponded water.

The water balance model results show that initially, stormwater and groundwater inflow to the Main North area exceeds evaporation, resulting in the accumulation of water and formation of a perennial lake (assuming dewatering stopped). Once the surface area of the lake reaches approximately 6.9 acres, stormwater and groundwater inflow are balanced by evaporation and the water level of the lake stabilizes at an elevation of approximately 5,770 ft amsl (70-foot water depth). The pit lake appears to be an evaporative sink, as the simulated water level elevation of the lake is below the interpolated groundwater level elevation along the east side of the Emma Pit. The interpolated groundwater level elevation along the east side of the Emma Pit is at approximately 5,800 ft amsl, which is 30 feet higher than the simulated pit lake water level elevation of 5,770 ft amsl.

A summary of simulated water inflow rates to the North Main pit lake follows:

- The average annual groundwater inflow rate is initially 21.9 acre-feet per year (ac-ft/yr) (13.6 gpm), and steadily decreases to 14.6 ac-ft/yr (9.0 gpm) after 100 years, averaging 16.4 ac-ft/yr (10.2 gpm);
- Average annual stormwater inflow (direct precipitation and stormwater runoff) is 16.0 ac-ft/yr (9.9 gpm);
- Average annual total inflow rate is 32.4 ac-ft/yr (20.1 gpm);
- Maximum annual total inflow rate is 56.2 ac-ft/yr (34.8 gpm); and
- Maximum daily total inflow rate is 3,956 gpm.

3.1.1.2 Geochemical Modeling Results

Pit lake water quality modeling was conducted by LCG as part of the Water Quality Predictions for the Proposed Emma Pit (2021d) to provide predicted concentrations of various dissolved constituents that will accumulate within the Emma Pit sump during operations and throughout the post-closure period. The operations and post-closure water quality estimates presented in the LCG report (2021d) were designed to meet two primary objectives:

- Operational period: estimate water quality of the Main North area (Emma Pit sump) to evaluate whether there will be any exceedances of NMAC surface water standards during mining operations and to support operational water management practices such as stormwater collection and water treatment.
- Post-closure period: estimate water quality of the Main North area (Emma Pit sump) during a 100-year post-closure period. The objective of water quality predictions for this scenario are to evaluate whether there will be any exceedances of NMAC surface water standards in post-closure and to estimate long-term water treatment costs.

Details of the water quality inputs and assumptions can be found in the Water Quality Predictions for the Proposed Emma Pit report (LCG 2021d), which describes the conceptual model, pit water balance (from DBS&A), mass load calculations, acid-generation timing and implementation, lab to field scaling, geochemical model development, model calibration (with site analogs), and sensitivity and uncertainty evaluation in detail. Results of the modeling effort indicate the following:

- For the scenario representing operations water quality in the Emma Pit sump, water quality is expected to meet typical water quality standards that may be of interest for comparison (see **Table 3-1**).
- For the scenario representing post-closure water quality in Main North, water quality will not meet typical standards for comparison purposes. In this scenario sulfide oxidation is observed to impact water quality. Exceedances of surface water are observed for trace metals and pH (see **Table 3-2**).

As the result of these water quality predictions, the entire Emma Pit hydrologic capture zone will be managed as a terminal sink that will not flow through to the surrounding groundwater. Operational practices will be implemented to manage any water that accumulated within the Emma Pit sump to prevent people and animals from contacting the water. Tyrone proposes that during mine operations, the Upper North area, Upper East area, Upper South area, and Main South area will be backfilled and graded toward the Main North area (Emma Pit sump) for water management purposes.

In summary, the following high-level conclusion are made from the water quality modeling:

- For the scenario representing operations water quality in the Emma Pit sump, water quality is expected to meet typical water quality standards that may be of interest for comparison.
- Water pumped from the Main North area in post-closure is likely to be of poor quality (pH <5; elevated metals concentrations > 10-100 mg/L of base metals).

The water quality estimates support the conclusion that the Emma Pit should be managed as a terminal sink (e.g., flow-through conditions not allowed) and practices implemented to minimize the volume of water allowed to collect within the Emma Pit sump and manage the area appropriately during post-closure to minimize access by wildlife (e.g., fencing, netting, bird balls). Furthermore, Emma Pit sump water quality will be monitored at regular intervals in accordance with the requirements in DP-396 during operations, and as described in Section 6.3 during the closure/post-closure period.

3.1.2 Predicted Open Pit Capture Zone and Open Pit Surface Drainage Area

DBS&A (2021b) conducted numerical groundwater flow modeling to predict the extent of the groundwater capture zone from dewatering at the Emma Pit sump. This sump will be used during active mining and at closure to collect groundwater and stormwater and pump these fluids to the Tyrone Mine. The numerical groundwater flow modeling was the same as that used to estimate potential drawdown due to dewatering and to predict groundwater inflow to the bottom of the Emma Pit. The modeling was performed using MODFLOW and a 103-year simulation period. The 103-year simulation period represents 3 years of active mining followed by 100 years of closure. The extent of the groundwater capture zone from dewatering at the Emma Pit is shown in **Figure 3-1** and was used to help define a predicted open pit surface drainage area (OPSDA). **Figure 3-2** presents the predicted OPSDA.

3.2 EMW Waste Stockpile

The proposed EMW Waste stockpile will be constructed with NPAG waste rock from the Emma Pit. The proposed EMW Waste stockpile at the EOY 2026 is presented on **Figure 2-1**. The stockpile will cover approximately 54 acres prior to reclamation, including approximately 6.3 acres of the northern portion of the EMMA Pit. This configuration is larger than needed to store the expected quantity to be generated in the Emma Pit. The reason for this is to allow flexibility if more waste material is encountered than currently estimated. Approximately 8 acres of the EMW Waste stockpile will lie within the existing Tyrone Mine Permit and Design Limit Boundary, and the remaining 46 acres will be outside the existing Tyrone Mine Permit and Design Limit Boundary. The EMW Waste stockpile is bounded by the Emma Pit to the west/southwest, reclaimed 1C Waste and 7A Waste stockpiles and Oak Grove Wash to the north, and undisturbed land to the east. At the EOY 2026 the top of the stockpile will be at an elevation of up to 6,360 ft amsl. The EMW Waste stockpile will be a non-discharging unit, consisting primarily of Precambrian granite and other NPAG overburden materials and will be conditionally exempt from the engineering design, construction, and operational requirements of the Copper Mine Rule and the Water Quality Act during operations and at closure. While non-discharging overburden stockpiles such as this are exempt from regulation under the water quality act; Tyrone acknowledges that it is subject to a material handling plan to ensure that it will be a non-discharging unit. The associated Material Characterization and Handling Plan was prepared by LCG (2021b) and was included in Attachment IID-2 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a). The stockpile will be constructed by end dumping in lifts approximately 30 to 50 feet high. The outslope of the stockpile will be built at angle of repose (see Section 4.0). This stockpile will be used as a source of RCM for both Emma closure/closeout material needs and for the Tyrone mine in the future.

3.3 6HW Waste Stockpile

The proposed 6HW Waste stockpile will be constructed entirely within the existing Tyrone Permit and Design Limit Boundary with NPAG waste rock mined from the Emma Pit. The proposed 6HW Waste stockpile at the EOY 2026 is presented on **Figure 2-1**. The stockpile will cover approximately 54 acres prior to reclamation, including approximately 5.9 acres of outslope area within the Conditional Waiver Area associated with the EOY 2026 mine plan year topography. The 6HW Waste stockpile is located within an area previously approved for stockpile development, and is bounded by the 6B Leach stockpile to the north, reclaimed 7A Waste stockpile to the south, 7B Leach stockpile to the west, and the Gettysburg Pit to the east. At the EOY 2026 the top of the stockpile will be at an elevation of up to 6,640 ft amsl.

The 6HW Waste stockpile will consist primarily of Precambrian granite and other NPAG overburden materials and will be conditionally exempt from the engineering design, construction, and operational requirements of the Copper Mine Rule and the Water Quality Act during operations and at closure. The 6HW Waste stockpile will be developed in accordance with the Material Characterization and Handling Plan that was prepared by LCG (2021b) and included in Attachment IID-2 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a). The stockpile will be constructed by end dumping in lifts approximately 30 to 50 feet high. The outslope of the stockpile will be built at angle of repose (see Section 4.0).

3.4 Soil Stockpile

Topsoil will be salvaged during mining operations where feasible, and the salvaged material will be temporarily stored within the Emma Expansion area at the Soil Stockpile, immediately west of the Emma Pit for future use as RCM **(Figure 2-1**). The surfaces of the Soil Stockpile will be shaped after construction with overall slopes of 2.7 to 3H:1V or shallower to minimize soil loss. To further minimize erosion and the establishment of undesirable weeds, the Soil Stockpile will be seeded with the interim seed mix listed in **Table 3-3**. Interim seeding would be conducted prior to the growing season. The stockpile will be shaped and Best Management Practices (BMPs) such as silt fences may be used as needed, to prevent outslope erosion from overland flow. BMPs such as silt berms created from grubbed brush and rock to capture sediment and reduce soil loss from the stockpile as described in the DP-396 Water Management Plan (Golder 2021c), which is included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone

2021a). The salvaged soil within the Soil Stockpile is anticipated to be completely consumed for use as RCM at Emma and Tyrone.

3.5 EMMA Haul Roads

The proposed Northern Emma Haul Road and Southern Emma Haul Roads (collectively referred to as the Emma Haul Roads) will be located north of the Emma Pit (**Figure 2-1**). The Southern Emma Haul Roads will be located outside the existing Tyrone Mine Permit and Design Limit Boundary. The Northern Emma Haul Road will cross the Oak Grove Wash and will be located entirely within the existing Tyrone Mine Permit and Design Limit Boundary. The channel of Oak Grove Wash will be re-routed and a temporary culvert system will be installed at this crossing and covered with NPAG fill material. The temporary channel re-routing and culvert designs are provided in Attachment 5 of the GR010RE Permit Revision application submitted to the MMD on October 22, 2021 (Tyrone 2021b). The temporary structures are designed for flows induced from a storm with a 10-year return interval and a 24-hr duration (i.e., design storm), and the fill and infrastructure in Oak Grove Wash will be removed during reclamation.

These haul roads will be constructed of local, near surface NPAG materials – constructed and maintained to be non-discharging units. If additional fill is required in the cut and fill areas, it will be obtained from agency-approved RCM stored on the CSG Waste stockpile or 5A Waste stockpile from Mohawk in 2018 and 2019. The Northern Emma Haul Road is situated entirely within the existing Tyrone Mine Permit and Design Limit Boundary, and will cross over portions of the Reclaimed 7A Waste stockpile and Oak Grove Wash.

Although the Emma Haul Roads will be constructed in a non-discharging fashion, portions of the Northern Emma Haul Road will be located on top of the existing Reclaimed 7A Waste stockpile. The north portion of the Northern Emma Haul Road (station 28+00 to 40+00, approximately) may require cut into the Reclaimed 7A Waste stockpile (see drawing set in Appendix A-2). This cut operation may expose PAG material during construction. Tyrone will open a repository for the excavated PAG material on the top surface of the Reclaimed 7A Waste stockpile, to the east of the cut area. Tyrone will salvage and store up to two feet of the existing reclamation cover from the cut sections and the PAG repository nearby to be re-used as cover. They will haul any additional cover needed from approved areas of the CSG Waste stockpile or 5A Waste stockpile.

Tyrone will manage haul road construction to ensure that PAG materials are capped with approved cover material to prevent discharges of impacted water. To ensure that no discharge occurs during construction of this portion of the haul road Tyrone commits to:

- Construct the road and place cover from station 28+00 to 40+00 only during dry weather;
- Cover exposed PAG cut sections of the haul road with a minimum of three feet of cover prior to any wet weather event;
- Expose no more than 200 feet of the road segment at a given time;
- Stockpile sufficient volume of cover for at least 200 feet of road segment with three feet of cover adjacent to the project site at all times while working from station 28+00 to 40+00; and
- Document and retain, for quality assurance review, a daily record of weather conditions and construction activities (including a record of station segments with exposed PAG) between Stations 28+00 to 40+00.

Remaining portions of the Northern Emma Haul Road will be constructed using native materials from the Oak Grove area and agency-approved RCM stored on the CSG Waste stockpile and 5A Waste stockpile from Mohawk in 2018 and 2019. Four samples representing native Oak Grove materials were collected by Tyrone along the alignment of the Northern Emma Haul Road in 2021 to quantify their ARD potential. All four samples have low total sulfur concentrations (0.02 to 0.16 wt. %), below the total sulfur threshold proposed for segregating acid from NPAG materials (LCG 2021b), indicating that the native Oak Grove materials are NPAG.

The proposed Southern Emma Haul Roads will be situated outside the existing Tyrone Mine Permit and Design Limit Boundary immediately south of the existing Tyrone Road/Burro Mountain Road, and will be constructed as a non-discharging unit. The Southern Emma Haul Roads extend from the Emma Pit to the EMW Waste stockpile and connect to the Northern Emma Haul Road (**Figure 2-1**). These haul roads will be constructed of local, near surface NPAG materials. If additional fill is required for construction of the Southern Emma Haul Roads, it will be obtained from agency-approved RCM stored on the CSG Waste stockpile and 5A Waste stockpile from Mohawk in 2018 and 2019. Emma Haul Road designs are included in Appendix A-2 of this CCP.

3.6 Supporting Infrastructure

In addition to the major mine components identified above, there are a number of key ancillary facilities and infrastructure dispersed across the area that will support the Emma Project. The ancillary facilities will include: electrical power transmission lines and substations; storm water structures for drainage, diversion, and sediment control; fencing; pit dewatering pump(s) and a new 4-inch diameter DR-11 HDPE pipeline running from the Emma Pit sump to the existing 1C Seepage and 7A Seepage Collection Systems (the Emma pipeline); and fencing.

Utilities and infrastructure that will help support the Emma Project will be located both within and outside the existing Tyrone Mine Permit and Design Limit Boundary and include:

- Powerlines
- Power poles
- Substation
- Pipelines
- Concrete slabs

A dewatering system consisting of barge pumps and the Emma pipeline will be installed within the Emma Pit as the pit is developed to pump surface and ground water that may accumulate. The dewatering system will pump surface water and ground water that accumulates in the Emma Pit during operations, which will allow the mine to operate during normal activities within the open pit and during rain events. The dewatering system will continue to pump surface water and ground water that accumulates in the pit sump located at the bottom of the open pit during operations and throughout the post-closure period. The extracted water will be conveyed to the existing 1C Seepage and 7A Seepage Collection Systems via the Emma pipeline. From the 1C Seepage and 7A Seepage Collection Systems, the collected water is conveyed to the 1A PLS Collection Tank and then used in the Tyrone Mine process water management system during operations (**Figure 2-1**). During the post-closure period, the conveyed water will be incorporated into the Tyrone Mine closure mine water management and treatment system (Golder 2020b). Details of the Emma water management and treatment plan are provided in **Appendix C** of this CCP. Post-closure water quality monitoring is addressed in Section 6.3 of this CCP.

4.0 RECLAMATION PERFORMANCE OBJECTIVES AND DESIGN CRITERIA

This section presents the reclamation performance objectives and design criteria for closure/closeout of the Emma facilities. The CCP that is proposed for Emma is intended to reclaim newly disturbed areas and achieve compliance with applicable state and federal regulations on mine reclamation and water quality protection. The CCP supplies sufficient detail to estimate financial assurance activities including estimate capital and operating costs in the unlikely scenario that the mine will close under a forfeiture scenario. The reclamation plan and associated design criteria conform to the closure requirements described in DP-1341 and the Copper Mine Rules, closeout requirements described in MMD Permit GR010RE and in NMAC Sections 19.10.5.506 through 19.10.5.508. The reclamation will provide for the establishment of a self-sustaining ecosystem consistent with the designated post-mining land uses and life zone of the surrounding area, which for Emma is wildlife habitat.

The performance objectives presented herein for closure closeout of the facilities were developed based upon the current requirements of Permit GR010RE, DP-1341, and the Copper Mine Rule, with the intent of meeting rules and requirements associated with the NMWQA, NMWQCC Regulations, Copper Mine Rule, and the NMMA. This plan ensures that stormwater and sediment are managed appropriately during and following reclamation in accordance with 20.6.7.33.E NMAC and the DP-396 Water Management Plan (Golder 2021c), which is included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a).

The primary performance objectives for closure closeout of the Emma Project area include: limit access to highwalls and hazards for safety, establish an efficient pit water accumulation and management system that minimizes the size of the North Main sump (Emma Pit sump) water surface and remains functional for the long term, exclude wildlife from the Emma Pit sump water surface, re-establishment of a self-sustaining ecosystem; stabilize the reclaimed areas, and to control discharges of process waters. The following sections present the performance objectives and reclamation design criteria for the major facilities associated with the Emma Project. A summary of the key design criteria for the facilities to be closed is presented in **Table 4-1**.

4.1 EMW Waste and 6HW Waste Stockpiles

The performance objectives for the CCP of the stockpile areas located outside the OPSDA's[1] and Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography include: re-establishment of a self-sustaining ecosystem; stabilization of the reclaimed areas to minimize erosion, and; control of runoff. There is only one, very small (approximately 6 acres) part of the 6HW stockpile that is inside of the OPSDA[1] and Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography. That area will be treated like other Tyrone stockpiles in those conditions and the performance objectives at closure are similar to those listed in the Tyrone CCP and associated permits for such conditions.

The 6HW Waste stockpile and the EMW Waste stockpile will both consist of NPAG materials and will be non-discharging units. The stockpiles will be developed in accordance with the Material Characterization and Handling Plan that was prepared by LCG (2021b) and included in Attachment IID-2 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a), but they are exempt from

[1] For the Emma Project there are two OPSDA's that apply to the CCP: 1) the Tyrone Mine OPSDA and the Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography; and 2) the predicted Emma Pit OPSDA developed from numerical groundwater flow modeling (DBS&A 2021b).

the engineering design, construction, and operational requirements of the Copper Mine Rule and the NMWQA during operations and at closure. Furthermore, the materials in the stockpiles are valuable resources of RCM that will be available for use in reclamation of the southern mine areas of Tyrone in the future. The reclaimed configurations shown are conceptual to provide flexibility (in case more NPAG material is encountered than presently estimated), but the stockpiles are likely to be smaller than shown (the EMW Waste stockpile in particular could be much smaller).

A summary of the key design criteria for the EMW Waste stockpile and 6HW Waste stockpile facilities is presented in **Table 4-1**. The reclamation plan for the EMW Waste stockpile and 6HW Waste stockpile is described in Section 5.1.

Structural Stability

The EMW Waste stockpile and 6HW Waste stockpile will be composed of blasted rock placed on 30-to-50-foot high lifts through end-dumping at angle of repose that results in benches with overall slopes less than angle of repose with catch benches on each lift. The gross stability of the stockpiles at Tyrone was previously determined to be adequate and is expected to remain stable under post-closure conditions (Golder 2006a, 2006b, 2006c, 2007a, 2007b, 2007c, and 2020a).

The EMW Waste stockpile and 6HW Waste stockpile will be reclaimed in a manner that ensures that the slope stability requirements listed in Section 20.6.7.33.B NMAC and Permit GR010RE are met. Tyrone recently completed a stockpile stability analysis associated with the current reclamation plan for the EMW Waste stockpile and 6HW Waste stockpile and the report is included in **Appendix E**. The results of this analysis indicate that the stockpiles are stable for long-term conditions reflecting the post-closure stockpile configurations and strength conditions (**Table 4-2**).

Stockpile Erosion and Drainage Control

For the stockpile surfaces located outside OPSDAs and Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography, the surfaces will be graded to direct non-impacted water to designated discharge areas. Storm water will be controlled using conventional terrace channels integrated to downdrains. Run-off drainage and erosion control for the stockpiles will be achieved by storm water conveyance channels, stable outslopes, adequate coarse materials in the material itself and revegetation in accordance with 20.6.7.33.A NMAC. Additional details of the stockpile erosion and drainage controls that will be implemented at the Emma Project are included in the DP-396 Water Management Plan (Golder 2021c), which is included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a).

For the approximate 6 acres of interior outslope area of the 6HW stockpile located inside the Tyrone Mine OPSDA and the Conditional Waiver Area associated with the EOY 2026 mine plan year topography, the outslope area will remain at/near angle-of-repose.

Stockpile Cover and Revegetation

The recently completed reclamation designs presented in **Appendix A** and the associated Earthwork Cost Basis Document included in **Appendix B** indicate that the RCM requirement for Emma Project is approximately 320,720 CY. More than 547,600 CY of salvageable topsoil stored in the Soil Stockpile west of the Emma Pit, and approximately 4 to 7 million CY of Precambrian granite and other NPAG overburden material mined from the Emma Pit and stored within the EMW Waste stockpile have been conservatively identified for use as RCM and backfill at Emma (Golder 2021b). Since the material placed in both the 6HW Waste stockpile and EMW Waste stockpile is a valuable segregated resource for potential future RCM, Tyrone proposes to treat these stockpiles similar to the 9AX stockpile at Tyrone and the performance objective and design criteria would be the same until the stockpile material is adequately evaluated and MMD has accepted the material as RCM. This means that the stockpiles at closure would be graded for revegetation and that only 1 foot of the local salvaged RCM would be placed as additional cover for FA purposes. Tyrone proposes this to facilitate a faster approval of this plan, though Tyrone believes that there is adequate evidence that this material (similar to 9AX material) can successfully be utilized as cover by itself. Thus, the total volume of RCM designated for Emma is more than that needed to cover these facilities. Under this CCP, the borrow sources for stockpile cover is assumed to be in-situ topsoil salvaged from the Emma Pit and EMW Waste stockpile footprint areas prior to construction and stored at the Soil Stockpile.

Revegetation of the stockpile top surfaces and outslopes located outside the OPSDA[1] and Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography will be achieved by seeding with a variety of native and adapted grasses, shrubs, and forbs in accordance with Appendix C of the MMD Permit and applicable modifications. The planned seed mix is discussed in Section 7.2.

Stockpile Surface Water and Sediment Containment

In accordance with Tyrone's 2021 Multi-Sector General Permit (MSGP), the Tyrone Storm Water Pollution Prevention Plan (SWPPP) mandates the implementation of BMPs during construction, such as berms, catchment basins, road grading, and wattles. These BMPs will be implemented for new facilities being constructed as part of the Emma Project. The SWPPP also mandates stormwater management and control during operations. The SWPPP establishes monitoring and inspection requirements, control measures, and BMPs to stormwater discharges. Potential sediment releases from the Emma facilities will be managed during construction, throughout operations, and throughout the closure and post-closure periods in accordance with Tyrone's MSGP and SWPPP. Recent experience associated with the Cobre haul road construction project have provided additional proven methods of reducing sediment loads in stormwater runoff waters. The method involves the placement of slash and rock piles associated with initial clearing and grubbing operations at the downstream toes of constructed facilities. These methods will also be employed at Emma as a stormwater BMP. Additional details of the stockpile surface water and sediment controls that will be implemented at the Emma Project are included in the DP-396 Water Management Plan (Golder 2021c), which is included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a).

4.2 Emma Pit

The performance objectives for closure/closeout of the Emma Pit include: limiting access to highwalls and hazards for safety; establishment an efficient pit water accumulation and management system that minimizes the size of the Emma Pit sump water surface and remains functional for the long term; excluding wildlife from the Emma Pit sump water surface; re-establishment of a self-sustaining ecosystem; stabilization of the reclaimed areas; and to control discharges of process waters. The pit configuration at the EOY 2026 will encompass approximately 116.3 acres. Segregation of waste materials generated from mining operations will be conducted in accordance with the Material Characterization and Handling Plan developed by LCG (2021b) and included in Attachment IID-2 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a).

As part of the Emma Pit water management plan (Golder 2021c), NPAG waste rock mined from the Emma Pit will be placed within the upper bench areas of the pit (Upper North, Upper South and Upper East areas) and the South Main area during mine operations and graded to promote surface water runoff toward the pit sump (**Figure**

2-1). An additional one-foot thick layer of soil from the Soil Stockpile will be placed over the NPAG waste rock backfill and revegetated in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications in the Upper East area during operations. The remaining areas receiving the NPAG waste rock backfill during operations (Upper North, Upper South, and South Main) will receive an additional one-foot of soil cover and be revegetated during closure.

A summary of the key design criteria for the Emma Pit is presented in **Table 4-1**. The NPAG waste rock fill within the South Main area will also be designed to cover exposed PAG material and allow for reclamation of the area that does not have PAG highwalls above it. The Upper North, Upper South, and Upper East areas will have an additional design criteria to provide for access to these areas so that they may be revegetated completely. The reclamation plan for the Emma Pit is described in Section 5.2.

4.3 Emma Haul Roads

Performance objectives for the reclaimed portions of the Emma haul roads, include creation of a self-sustaining ecosystem, erosion, and stormwater control. The proposed Emma haul roads will not be discharging facilities for purposes of the Water Quality Commission Ground Water Discharge Permit Regulations because the haul roads will either be constructed on reclaimed stockpiles or on native ground, and will be constructed with NPAG material. A summary of the key design criteria for the Emma haul roads is presented in **Table 4-1**. The reclamation plan for the Emma haul roads is described in Section 5.3.

4.4 Infrastructure and Other Miscellaneous Facilities

Performance objectives for disturbed areas associated with the ancillary facilities and infrastructure, not needed during post-closure, include creation of a self-sustaining ecosystem, erosion, and stormwater control. A summary of the key design criteria for the ancillary facilities and infrastructure is presented in **Table 4-1**. The reclamation plan for the ancillary facilities and infrastructure is described in Section 5.4.

4.5 Borrow Areas

Performance objectives for disturbed areas associated with the borrow areas (including the Soil Stockpile) include creation of a self-sustaining ecosystem, erosion, and stormwater control. Tyrone’s experience with cover excavation and placement on the tailing impoundments, Reclaimed 1 Leach, Reclaimed 1C Waste, and Reclaimed 7A Waste stockpiles revealed that flexibility in materials handling is critical to achieving quality control objectives and efficient management of cover soil resources. A summary of the key design criteria for the Emma borrow areas is presented in **Table 4-1**. The reclamation plan for the borrow areas is described in Section 5.5.

4.6 Water Management and Treatment Performance Objectives

The proposed Emma water management and treatment plan is provided in **Appendix C** to this CCP and was developed in accordance with Section 20.6.7.33.H NMAC. The primary performance objectives for water management and treatment at Emma is to establish an efficient pit water accumulation and management system that minimizes the size of the Emma Pit sump water surface and remains functional for the long term, maintains a terminal sink within the Emma Pit area, excludes wildlife from the Emma Pit sump water surface, and controls discharges of process waters. A summary of the key design criteria for water management and treatment is presented in **Table 4-1**. The plan for water management and treatment at Emma is described in Section 5.6.

5.0 RECLAMATION PLAN

The reclamation plan was developed with consideration of the site-specific conditions that will exist at Emma at the EOY 2026. The general setting of the Emma Project area is shown on **Figure 1-3** (existing features) and **Figure 2-1** (EOY 2026 features), and the closure or reclamation designs are depicted in the drawing sets provided in **Appendix A**. The reclamation proposed for each of the major facilities is discussed in Sections 5.1 through 5.5. The proposed plan for the management and treatment of process water throughout site reclamation activities and for a duration of 100 years following cessation of mining operations is described in Section 5.6. The plans and methods developed herein represent conceptual designs for reclamation of the facilities based on an anticipated configuration. More specific plans will be developed and submitted prior to mine closure in accordance with Permit GR010RE. A final construction quality assurance (CQA) plan for reclamation and closure will be prepared by Tyrone for submittal to and approval by the State of New Mexico at least 180 days prior to commencement of reclamation. The CQA plan will provide a detailed description of the work proposed to be performed to close the site.

The closure designs were developed to provide enough information to calculate the financial assurance cost estimate. The reclamation practices proposed within this CCP are intended to meet the objectives described in Section 4 and provide protection of air and water resources consistent with state and federal laws. As previously described in Section 1.4, the conceptual reclamation designs are based on the EOY 2026 mine plan for Emma. Final designs, technical specifications, and construction quality assurance plans for each facility will be prepared when mining ceases.

5.1 Stockpiles

A total of three stockpiles will be present at Emma at the EOY 2026, including the EMW Waste stockpile, 6HW Waste stockpile, and the Soil Stockpile (**Figure 1-2**). The EMW Waste stockpile and 6HW Waste stockpile will both be composed of NPAG overburden waste rock. The Soil Stockpile will contain the soil salvaged from the footprints of the Emma Pit and EMW Waste stockpile prior to construction and will be fully consumed in closure for use as RCM at Emma and Tyrone. The stockpiles will be constructed above the surrounding terrain; therefore, run-on controls are not required for these facilities. The following sections describe the specific components to be closed at the EOY 2026, and the components that will be retained for further use during the closure/post-closure period.

5.1.1 Operational Components That Will Be Used for Post-Closure Purposes

The operational closure components and related engineering controls associated with the Emma stockpiles and stockpile areas that will be used for post-closure purposes include:

- Operation and Maintenance (O&M) of existing ground water monitoring wells 396-2021-01, 396-2021-02, and MB-44; and
- O&M of stormwater BMP’s described in the DP-396 Water Management Plan (Golder 2021c), and included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a) during operations.

5.1.2 Planned Closure/Closeout Activities

The construction design criteria for the stockpiles and monitoring wells are summarized in **Table 4-1** and the planned approaches for closure of these facilities are described below. Reclamation design drawings for the facilities are presented in **Appendix A-1**. The Soil Stockpile will be fully consumed for use as RCM in closure and the planned reclamation of this area is to grade the disturbed area to drain, rip the surface to a depth of 18 inches, and seeding the ripped surface to reestablish vegetation in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications. The planned approaches for closure of the EMW Waste and 6HW Waste stockpiles include:

5.1.2.1 General Stockpile Reclamation Activities

- Grading of the stockpile outslopes down to interbench slopes of 3.0H:1V;
- Construction of 32-foot wide terrace benches on the outslopes at maximum slope lengths of 200 feet;
- Construction of surface water conveyance channels on the outslopes to direct surface water off the stockpile surfaces and to the exterior of the mine (except south/southwestern outslope of EMW outslope which gets directed to the Emma Pit sump) in accordance with Section 20.6.7.33.A NMAC;
- Placement of 12 inches of salvaged RCM from the Soil Stockpile over the graded surfaces to be reclaimed (for FA purposes only);
- Ripping of stockpile top surfaces and outslopes to a depth of 18 inches;
- Seeding of covered top surfaces and outslopes to reestablish vegetation in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications;
- Energy dissipation structures may be constructed at channel outlets if engineering designs warrant them to reduce erosive velocities where necessary. Where possible, channels will be constructed to incorporate existing topography, grade controls, and exposed inert bedrock thus, promoting long-term integrity of the structures; and
- Temporary erosion control measures may be provided during the construction and early vegetation establishment periods for the reclaimed stockpile areas. These measures may include, but are not limited to, berms, mulch, straw bales, silt fences, and minor corrective regrading.

5.1.2.2 Conditionally Waived Area

Approximately 5.9 acres of the 6HW Waste stockpile outslope area lies within the Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography, this outslope area will remain at approximate angle of repose.

5.2 Emma Pit

The Emma Pit configuration at the EOY 2026 is shown on **Figure 1-2** and reclamation designs are depicted in the drawing set provided in **Appendix A-1**. The operational closure components and the planned closure activities for the Emma Pit are described below.

5.2.1 Operational Components to be used for Post-Closure Purposes

The operational components and related engineering controls associated with the Emma Pit that will be used for post-closure purposes include:

- O&M of Emma Pit dewatering system (barge pump(s), sump, and associated electrical distribution and piping systems);

- O&M of the reclaimed Upper East area;
- Maintenance, sampling, and reporting of monitoring wells;
- Monitoring of the pit sump water quality; and
- Construction and maintenance of access roads within open pit for operation of water management facilities and post-closure reclamation monitoring.

The operational Emma Pit dewatering and stormwater management systems (sump, pump[s], electrical distribution and pipeline systems) will continue to be operated and maintained to efficiently accumulate both surface and groundwater and transfer impacted groundwater and surface water to the Tyrone CCP site-wide water management and treatment system.

5.2.2 Planned Closure/Closeout Activities

The design criteria for the Emma Pit are summarized in **Table 4-1** and the planned approaches for closure are described below. Reclamation design drawings for the Emma Pit are presented in **Appendix A-1**. The planned approaches for closure of the Emma Pit include:

- Placement of NPAG waste rock fill in the North Main pit water management sump to facilitate efficient water management and minimizes the surface of the water in the sump, yet allowing efficient storm water and ground water management for the long term. This fill will not be revegetated; it is strictly placed to shape the water accumulation area for these purposes;
- Finish grading of the NPAG waste rock fill within the Upper North, Upper South, and South Main areas to maximum interbench slopes of 3.0H:1V;
- Placement of an additional one-foot thick layer of soil from the Soil Stockpile over the NPAG waste rock fill in the Upper North, Upper South, and South Main areas (i.e., to be treated like the 9AX Stockpile at Tyrone) and revegetate in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications;
- Maintaining a 30-foot wide corridor of the pit haul road for access to the pit sump and reclaimed South Main area for O&M activities;
- Ripping remaining portions of the pit haul road that do not have PAG highwalls above them to a depth of 18 inches;
- Seeding of ripped portions of the pit haul road to reestablish vegetation in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications;
- Construction of a 6-foot high continuous chain-link security fence and bird balls to restrict wildlife from the pit sump area;
- Removal of all aboveground electrical systems and infrastructure, including outdoor lighting and transmission lines, not used in the PMLU or not necessary for site O&M, including water management and treatment; and
- Seeding of approximate 25-foot-wide disturbance area used to construct the chain link fencing, and approximate 100-foot-wide disturbance area used to construct the berm to reestablish vegetation in accordance with MMD Permit GR010RE and applicable modifications.

The existing and planned berms, sumps, collector pipes, and groundwater and surface water pump-back systems will be integrated into a new overall system to control releases to surface water and groundwater. During operation and throughout the post-closure period collected waters will be pumped from the pit sump and conveyed to the existing 1C Seepage and 7A Seepage Collection Systems via a new 4-inch diameter DR-11 HDPE Pipeline (the Emma pipeline) (**Figure 2-1**). From the 1C Seepage and 7A Seepage Collection Systems, the collected water is conveyed to the 1A PLS Collection Tank and then used in the Tyrone Mine process water management system during operations. During the post-closure period, the conveyed water will be incorporated into the Tyrone Mine closure mine water management and treatment system (Golder 2020b).

Temporary erosion control measures will be provided during the construction and early vegetation establishment periods. The backfilled and covered areas of the pit will be graded in a manner that ensures positive drainage from the areas to be backfilled, covered, and revegetated, and to eliminate, to the extent practicable, ponding on final backfill and cover surfaces.

5.3 Haul Roads and Access Roads

The haul roads and access roads that will be present at the EOY 2026 are shown on **Figure 2-1** and reclamation designs are depicted in the drawing set provided in **Appendix A-2**. The existing closure components and the planned closure activities for the haul roads and access roads are described below.

5.3.1 Operational Components to be used for Post-Closure Purposes

The operational components and related engineering controls associated with the haul roads and access roads that will be used for post-closure purposes include:

- O&M on a 30-foot width of the Northern and Southern Emma haul roads for post-closure access to reclaimed areas, pit dewatering system and reclamation monitoring areas;
- O&M of access roads to reclaimed facilities and post-closure monitoring stations (wells, flow samplers, pit sump, etc.); and
- O&M of storm water control structures located along post-closure haul roads and access roads.

5.3.2 Planned Closure/Closeout Activities

The design criteria for the haul roads and access roads to be closed are summarized in **Table 4-1** and the planned approaches for closure include:

- Ripping of roads and/or portions of roads to be closed to a depth of 18 inches;
- Seeding of ripped and covered areas to reestablish vegetation in accordance with MMD Permit GR010RE and applicable modifications;
- Removal of temporary culverts along the Oak Grove Wash crossing and disposal of them in an approved manner;
- Removal of fill within the Oak Grove Wash channel;
- Removal of other culverts along the haul roads unless they serve a post-closure purpose and disposal of them in an approved manner; and

- Reestablishment of the Oak Grove Wash channel downstream of the removed culverts back to its original alignment.

5.4 Infrastructure and Other Miscellaneous Facilities

Reclamation of the disturbed areas associated with the ancillary facilities and infrastructure not needed post-closure purposes will be accomplished by removing or burying utility and structure foundations, pipelines, power lines, power poles, and temporary buildings and providing erosion and drainage control and revegetation. The existing closure components and the planned closure activities for the ancillary facilities and structures not needed post-closure purposes are described below.

5.4.1 Operational Components to be used for Post-Closure Purposes

The operational components and related engineering controls associated with the ancillary facilities and infrastructure that will be used for post-closure purposes include:

- O&M of the Emma Pit dewatering system (barge pumps, sumps, and associated electrical distribution and piping systems); and
- O&M of the powerlines running to the Emma Pit dewatering system.

5.4.2 Planned Closure/Closeout Activities

The design criteria for the ancillary facilities and infrastructure not needed post-closure purposes are summarized in **Table 4-1** and the planned approaches for closure include:

- Flushing of sections of the pipelines replaced on the post-closure period to remove residual solutions. These sections of pipeline will be buried or removed and disposed of in an approved manner;
- Removal of electrical distribution system, including the substation, transmission lines, and power poles not needed for post-closure purposes;
- Removal of any temporary, portable operations and maintenance facilities used to support mining and not needed for post-closure purposes;
- Ripping of non-impacted disturbed areas to a depth of 18 inches; and
- Seeding of disturbed and covered areas to reestablish vegetation in accordance with MMD Permit GR010RE and applicable modifications.

The Emma Pit sump will be an integral part of the post-closure water management system at the mine. The few auxiliary structures not needed to operate this system (unused power lines and pipelines) will be removed and salvaged or buried upon closure. Reclamation of the disturbed areas associated with the ancillary facilities and infrastructure will be accomplished by removing or burying utility and structure foundations, pipelines, power lines, power poles, and temporary buildings and providing erosion and drainage control and revegetation. Pipeline corridors located outside the regrade footprint of stockpiles will be inspected and characterized for evidence of past spills that could potentially cause exceedances of water quality standards of Section 20.6.1 NMAC and Section 20.6.2.3103 NMAC. If replaced sections of pipeline do not constitute a source of contamination (defined as exceedances of standards), they can be left in place and buried after they have been rinsed and capped if they contain contaminated materials in accordance with Section 20.6.7.33.J NMAC.

Temporary erosion and drainage control practices may include but are not limited to rough grading and installation of water bars, minor diversions, sediment containment structures, mulching, straw bales, and silt fences. The need for these practices will be evaluated on a site-specific basis at closure. The seed mix to be used is presented in Section 7.2.

5.5 Borrow Areas

Soil salvaged from the footprint of the Emma Pit and EMW Waste stockpile footprint prior to mine development and stored in the Soil Stockpile, and Precambrian granite and other NPAG overburden material mined from the Emma Pit and stored within the EMW Waste stockpile are the two primary sources of RCM for this CCP. The EMW Waste stockpile and the soil stockpile will have low-angle side slopes (3H:1V max.) as a result of the specified excavation plans. The salvaged soil within the Soil Stockpile is anticipated to be completely consumed for use as RCM at Emma and Tyrone. The closure/closeout activities planned for these areas consist of:

- Grading of borrow areas to create positive drainage from them;
- Installation of storm water controls with slopes not steeper than 3H:1V;
- Ripping of the borrow area bottoms and slopes, and the top surface and slopes of the EMW Waste stockpile to a depth of 18 inches, when necessary;
- Covering of the top surface and slopes of the EMW Waste stockpile with 12 inches of salvaged soil;
- Seeding of covered and disturbed areas to reestablish vegetation in accordance with Appendix C of the MMD Permit and applicable modifications; and
- If practical, incorporation of the borrow pits into the post-closure water management system.

The exact location and configuration of the EMW Waste stockpile borrow areas will ultimately be determined during the final design and construction phases of the reclamation. Any additional borrow areas that may be utilized in the future, will have borrow pits with 3H:1V maximum side slopes as a result of the specified excavation plan. Borrow pit side slopes and bottoms will be ripped where required and revegetated with a variety of native and adapted grasses, shrubs, and forbs in accordance with Appendix C of the MMD Permit and applicable modifications.

5.6 Water Management and Treatment Plan

The dewatering system within the Emma Pit utilized during operations will continue to pump surface water and ground water that accumulates in the pit sump located at the bottom of the open pit throughout the post-closure period. The extracted water will be conveyed to the existing 1C Seepage and 7A Seepage Collection Systems via the Emma pipeline (**Figure 2-1**). From the 1C Seepage and 7A Seepage Collection Systems, the collected water is conveyed to the 1A PLS Collection Tank and then used in the Tyrone Mine process water management system during operations **(Figure 2-1**). During the post-closure period, the conveyed water will be incorporated into the Tyrone Mine closure mine water management and treatment system (Golder 2020b). The proposed Emma water management and treatment plan is provided in **Appendix C** to this CCP and was developed in accordance with Section 20.6.7.33.H NMAC. The plan provides an engineering document that describes the processes and methods that will be used at Tyrone for long-term management and treatment of waters that accumulate in the Emma Pit sump. The plan includes an analysis of the expected operational life of each water management and water treatment system throughout the post-closure period. The plan describes the proposed water management and water treatment systems in detail, including locations of key components, expected operational life, material take-offs, and the basis for which capital, operational, and maintenance costs were prepared for financial assurance.

Surface water and groundwater that accumulates within the Emma Pit sump during the closure/post-closure period will be conveyed to the Tyrone CCP water treatment system via the Emma pipeline and pump station. The estimated average annual total inflow (surface water and groundwater) rate to the Emma Pit sump is estimated at approximately 20.1 gpm, and the estimated maximum annual total inflow rate is approximately 34.8 gpm (DBS&A 2021b). For planning purposes, Golder has assumed that 20.1 gpm of water from the Emma Pit would be added to the Tyrone closure water management and treatment system over the 100-yr closure/post-closure period. The dewatering system will be sized to handle 40 gpm to allow for management stormwater pulses that may occur.

The water surface within the Emma Pit will be minimized to the extent practicable given that the major contributing water source to the sump being stormwater flows. Under normal operating conditions, the water surface will be maintained at a stage of approximately 10 feet (5,710 ft amsl) to allow for operation of the floating barge pump and associated intake piping. The water surface area associated with a pit sump stage of 5,710 ft amsl is approximately 0.62 acres. The maximum estimated water surface stage within the pit sump is estimated to be approximately 5,716 ft amsl and is associated with stormwater runoff volumes from a 100-year 24-hour storm event estimated by (DBS&A 2021b) entering the pit sump under normal operating conditions (5,710 ft amsl). The water surface area associated with a pit sump stage of 5,716 ft amsl is approximately 0.85 acres. The waters associated with these storm events will be pumped down at a higher rate (up to approximately 35 gpm) to reduce the amount of time the pit sump water stage is above normal operating levels.

6.0 CLOSURE & POST- CLOSURE MONITORING, REPORTING, AND CONTINGENCY PLANS

Closure and post-closure monitoring will be conducted at Emma to ensure that the closed facilities are performing as designed, are protective of water quality, and will allow for the establishment of a self-sustaining ecosystem. Closure and post-closure monitoring, reporting, and contingency planning will be conducted in accordance with the Copper Mine Rule, Section 20.6.7.33.L NMAC, Section 20.6.7.35 NMAC, DP-1341, DP-396, and MMD Permit GR010RE. The costs associated with the closure and post-closure monitoring are included in **Appendix B** using an assumed third party to complete all the monitoring listed in Sections 6.0 through 7.0.

All the closure and post-closure groundwater, surface water, pit dewatering system, and piezometer monitoring data will be reported in accordance with 20.6.7.35 NMAC and DP-1341. Additionally, as specified in Section 20.6.7.35.D NMAC, Tyrone will submit to the NMED and MMD semi-annual reports summarizing reclamation and post-closure activities each year. Tyrone will also prepare potentiometric maps that include data from all monitoring wells, extraction wells, and piezometers and submit them annually to the NMED in accordance with Section 20.6.7.35.B NMAC.

MMD guidelines also require monitoring of revegetation during the bonding period to evaluate revegetation success, and NMWQCC Regulation 3107.A.11 requires the development of post-closure monitoring and contingency plans that are consistent with the terms and conditions of the applicable DP (DP-396). Additional monitoring and reporting requirements associated with public health and safety, wildlife, meteorology, erosion, revised conditional waiver area and revised OPSDA, and CQA/construction quality control (CQC) plans are specified in MMD Permit GR010RE. The following sections summarize the general approach that will used to meet all of these requirements. All associated costs assume work will be completed by a contractor for Financial Assurance (FA) purposes.

6.1 Erosion and Drainage Control Structures

All closure components requiring a cover system will be visually inspected for signs of excessive erosion and significant erosion features that may compromise the functional integrity of the cover system or drainage channels in accordance with 20.6.7.35 NMAC and Section 9.R.1 of the MMD Permit. In accordance with Section 20.6.7.35.C NMAC, a contractor will conduct inspections and submit reports of the reclaimed facilities monthly for the first year following submission of the final CQA/CQC for the unit, and quarterly thereafter until the end of post-closure monitoring, provided the department may approve a schedule allowing less-frequent monitoring. Additional erosion inspections will also be conducted after a one inch or more precipitation event within a 24-hour period.

Evidence of excessive erosion and/or structural failures will be reported to the appropriate agencies (MMD and NMED) in a timely manner. A written report detailing the nature and extent of the problem and a corrective action plan will be developed after the problem is identified in accordance with Sections 20.6.7.30.I and J NMAC.

As specified in 20.6.7.35.C NMAC and Section 9.N.1 of the MMD Permit, a contractor will routinely inspect and maintain all drainage channels, diversion structures, retention impoundments, and auxiliary erosion control features in accordance with professionally recognized standards, such as the Natural Resources Conservation Service.

6.2 Groundwater and Surface Water Control Facilities

Tyrone maintains several state and federal permits to protect surface water and ground water and to ensure adherence to applicable water quality standards as mandated by the NMWQA and the NMWQCC regulations (NMAC 20.6), Sections 401 and 404 of the Clean Water Act, and the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) MSGP. DP-1341 has been issued by NMED to address operational, closure and post-closure water quality issues at the Tyrone Mine and will ultimately include Emma through the DP-396 Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a). In addition, Tyrone maintains a SWPPP and a Spill Prevention, Control, and Countermeasure (SPCC) plan that will ultimately include Emma and serve to protect water quality. BMPs will be employed throughout the post-closure period at Emma to protect water quality, capture sediment and reduce soil loss from the reclaimed facilities as described in the DP-396 Water Management Plan (Golder 2021c), which is included in Attachment IID-1 of the DP-396 Permit Renewal and Modification Application.

DP-396 and DP-1341 include operational plans, corrective action plans, contingency plans, and closure plans. Collectively, these plans provide the mechanisms for the regulatory agencies to collect ongoing and real-time data related to mine operations; continuously monitor, model, and prevent potential impacts to the environment; document compliance; and mitigate these potential impacts where conditions warrant.

In accordance with DP-1341, 20.6.7.35.A NMAC, Section 9.N.2 of the MMD Permit, and for FA purposes a contractor will perform quarterly inspections and annual evaluations of all groundwater abatement systems, including the Emma Pit dewatering system, and perform maintenance as necessary to ensure that all water contaminants are managed in a manner that is protective of groundwater quality. Monitoring of site water quality will be accomplished through sampling and analysis of potentially impacted water at site locations in accordance with the DP-396 Facility Monitoring Plan (DBS&A 2021c), which is included in Attachment IID-4 of the DP-396 Permit Renewal and Modification Application (Tyrone 2021a).

Contingency Plans and Emergency Response Plans have been prepared that present details for addressing potential failures of individual components of the Emma closure plan, including an increase in the extent or magnitude of ground water and/or surface water contamination, potential failures associated with Emma Pit dewatering system, and potential failures of various components of closed lands. The emergency response plan outlines operational parameters and contingencies to address operation failures at Emma associated with pumping water from the open pit sump that may contain affected water. Accordingly, a contractor will verify any potential discharges not approved in DP-396 and DP-1341. If an unapproved discharge is identified, a contractor will perform appropriate corrective actions in accordance with 20.6.7.30 NMAC.

Sampling of the Emma Pit sump will be conducted over the 100-year closure/post-closure period in accordance with the DP-396 Facility Monitoring Plan (DBS&A 2021c), which is included in Attachment IID-4 of the DP-396 Permit Renewal and Modification Application (Tyrone 2021a). For each sampling event, one composite sample of water from the Emma Pit sump will be shipped to an independent analytical laboratory for analysis of contaminants of concern. A report will be prepared to document the sampling and analysis for review and recording by site management and review by regulatory authorities in accordance with 20.6.7.35.C NMAC. Costs associated with the sampling, analysis, and reporting of the Emma Pit sump water are included in the FA cost estimate in **Appendix B**.

6.3 Post-Closure Monitoring of Ground Water and Surface Water

In accordance with Condition 40 of DP-1341 (NMED 2003), post-closure monitoring of ground water and surface water will continue for a minimum of 100 years after completion of final closure construction activities and Certification of Closure. The monitoring will be conducted in accordance with monitoring and reporting requirements specified in Section 9.R.2 of the MMD Permit and in the DP-396 Facility Monitoring Plan (DBS&A 2021c), which is included in Attachment IID-4 of the DP-396 Permit Renewal and Modification Application (Tyrone 2021a).

In addition to surface water monitoring and analyses required in DP-396, DP-1341, the SWPPP and SPCC Plan serves to protect water quality. Monitoring will be conducted in accordance with 20.6.2.3107 NMAC. Tyrone may request a reduction in monitoring frequency, change in location, and change in analytical parameters for NMED approval after two years of quarterly monitoring. Each monitoring report will contain monitoring well laboratory analyses, surface water analyses, water level data, potentiometric surface maps, seepage water analyses, spring and seep discharge rates, and summaries of daily weather data. The monitoring reports will be submitted to NMED in accordance with the approved discharge permit.

6.3.1 Ground Water Monitoring Network:

Groundwater quality will be monitored throughout the post-closure period within the three existing ground water monitoring wells at the Emma Expansion area (396-2021-01, 396-2021-02, and MB-44), and in any new monitoring wells installed after closure for compliance monitoring purposes. For FA purposes, it is assumed sample collection will be done under contract by an environmental contractor. The intent of the groundwater monitoring is to evaluate the effectiveness of the closure plan and demonstrate compliance with applicable regulations and standards. The monitoring will be conducted in accordance with the DP-396 Facility Monitoring Plan (DBS&A 2021c). The analytical results will be reported to the NMED as specified in DP-396, DP-1341 and 20.6.7.35.B NMAC.

6.3.2 Surface Water Monitoring Network:

Post-closure surface water monitoring locations within and around Emma include the following points:

- Depth and water quality of the Emma Pit sump;
- Flows from the Emma Pit dewatering system reporting to the existing 1C Seepage and 7A Seepage Collection Systems; and
- Water quality from two surface water samplers (Emma East 1 and Emma East 2).

Sampling will be conducted over the 100 year closure/post closure period in accordance with the DP-396 Facility Monitoring Plan (DBS&A 2021c). For FA purposes, it is assumed that sample collection will be done by an environmental contractor. Samples will be shipped to an analytical laboratory for analysis. A report will be prepared to document the sampling and analysis in accordance with DP-396, DP-1341, and 20.6.7.35.B NMAC for review by regulatory authorities.

6.4 Revegetation Success Monitoring

The reclaimed areas will be monitored in accordance with 20.6.7.35.C NMAC and Section 9.R.3 of Revision 09-1 of the MMD Permit after the final grading and the initial establishment of vegetation on the reclaimed lands. Tyrone will conduct vegetation monitoring of both volunteer revegetation and re-seeded areas in accordance with MMD permit conditions. The revegetation monitoring will be conducted to meet statistical adequacy under the vegetation monitoring schedule prior to bond release. Revegetation monitoring will include canopy cover, plant diversity, and woody stem density as specified in Section 9.R.3 of the MMD Permit (MMD 2021).

Vegetation establishment monitoring will be conducted during the third year after seeding, with the objective of determining the adequacy of reseeding efforts. The vegetation establishment monitoring (Year 3) will be semi-quantitative and the results will be provided to MMD. Quantitative revegetation monitoring will be performed at the 6th year after planting, and for at least 2 years of the last 4 years, starting after the 8th year of the 12-year monitoring period.

Revegetation monitoring will include, at a minimum, canopy cover, plant diversity, and woody stem density. The revegetation monitoring will be conducted to meet statistical adequacy for the monitoring conducted during two of the last four years prior to financial assurance release. The canopy cover and woody stem density surveys will be conducted using vegetation monitoring techniques approved by MMD for the Tyrone Mine. The vegetation monitoring plan is quantitative, using the same techniques for the reclamation area and the reference area for each monitoring event and from year to year during the monitoring period. Any changes to the approved vegetation monitoring plan will be submitted to the MMD for approval at least 90 days prior to a monitoring event. Areas where vegetation has not been successfully established will be reseeded or inter-seeded.

6.5 Wildlife Monitoring

Pursuant to Section 9.N.3 of Revision 01-1 of the MMD Permit, Tyrone submitted a wildlife monitoring plan for post closure in December 2005 (Golder 2005). This plan was approved by the MMD and New Mexico Department of Game and Fish February 15, 2006. The monitoring plan provides a description of the proposed reclamation plan as it applies to wildlife and wildlife habitat, an overview of the existing species and wildlife habitat within the vicinity of the Tyrone Mine, and the proposed methods for deer pellet group counts and bird surveys.

Tyrone will perform wildlife monitoring within the Emma Project area in accordance with the approved wildlife monitoring plan and Section 9.R.4 of the MMD Permit (MMD 2021). The wildlife monitoring program will include annual deer pellet group counts and bi-annual bird diversity surveys in year 6, and in 2 years of the last 4 years prior to release of FA. Results of the monitoring will be evaluated to determine wildlife use trends during re-establishment of a self-sustaining ecosystem.

6.6 Public Health and Safety

Pursuant to Section 9.R.5 of Revision 09-1 of the MMD Permit (MMD 2021), Tyrone will submit written details and maps showing the locations of berms and fences that will be placed to restrict access to the Emma facilities by unauthorized personnel and provide for public safety within 180 days of cessation of operations. However, the plan is to maintain the perimeter fence that Tyrone will construct for operations which will have appropriate no trespass and hazard signage on it. Annual visual inspections of the interface of conditionally waived 6HW Waste stockpile area and the non-waived EMW Waste and 6HW Waste stockpile areas, and quarterly visual inspections of the stability of the Emma Pit walls will be conducted to identify potential failure areas which may adversely impact the environment and public health or safety. Tyrone will report areas of instability or failure, which may adversely impact the environment or public health no later than 24 hours after discovery and will propose mitigation measures within 30 days of identification for MMD approval. Any evidence of stockpile instability that could potentially result in a slope failure or an unauthorized discharge will be reported to the NMED as soon as possible, but not later than 24 hours after discovery and corrected pursuant to 20.6.7.30.I NMAC.

6.7 Adjustment of OPSDA and Conditional Waiver Area

In accordance with DP-1341 and 20.6.7.35.B NMAC, Tyrone will prepare potentiometric maps annually. Tyrone proposes to include an updated delineation of the OPSDA (NMED) and associated MMD's conditional waiver area (pursuant to Sections 9.S of Revision 09-1 of the MMD Permit) at Emma with the annual submittal of the potentiometric maps.

6.8 Construction Quality Assurance Plan

Pursuant to Sections 9.C of Revision 09-1 of the MMD Permit and 20.6.7.34.A, 20.6.7.34.B and 20.6.7.34.F NMAC, Tyrone will submit a final design and CQA/CQC Plan to the NMED and MMD for approval no less than 180 days of submission of a notice of intent to implement the Emma closure plan and 60 days prior to construction. In accordance with 20.6.7.34.G NMAC, a CQA/CQC report will be supplemented with a Construction Quality Assurance Report (CQAR) to be submitted to the MMD within 180 days after completion of construction.

6.9 Alternative Abatement Standards

In accordance with DP-1341 and 20.6.2.4103 NMAC, Tyrone may submit a petition for alternative abatement standards. The petition will be prepared in accordance with Section 20.6.2.4103.F NMAC. Tyrone's petition will identify proposed alternative abatement standards for constituents that are predicted to exceed the abatement standards in 20.6.2.4101.B and 4103.A and .B NMAC after implementation of approved closure measures and schedules.

7.0 POST-MINING LAND USE DESIGNATION

This section provides the PMLU for the EMMA Project area and the associated site-specific revegetation guidelines based upon the requirements of the MMD Permit, NMMA Section 69-36-11.6, and Subparts 507.A, 507.B, and 508 of the NMMA Rules (MMD 1996). The proposed wildlife habitat PMLU area for Emma is shown on **Figure 7-1**.

7.1 Wildlife Habitat Post-Mining Land Use

The wildlife habitat PMLU is specified in Sections 9.D.4 and 9.E.4 of Revision 09-1 of the MMD Permit. The selection of the wildlife habitat PMLU for purposes of the NMMA does not preclude multiple beneficial uses (e.g., grazing, recreation, and watershed) in the post-closure period by the surface landowners. Reclamation of the Emma Project area will improve the character of the mined area to achieve the wildlife habitat post-mining land use. Successful implementation of the proposed reclamation plan will result in the development of an early-stage grass/shrub community within a larger plant community that is dominated by a mixed-evergreen woodland community. The areas of cliffs and talus associated with the pit walls will provide features that are consistent with the local topography in the steep slope areas of Emma. The reclaimed area will provide a locally important increase in community level diversity that will benefit the broad range of wildlife adapted to the area. The pit's topographic relief is expected to present desirable nesting and perching sites for birds. Highwalls provide a variety of cliff habitats including high ledges, potholes, small cavities, fissures, deep crevices, and talus slopes that are important to many wildlife species (Benson 2002). Cliff-dwelling raptors including prairie falcons, golden eagles, American kestrels, common barn owls and great horned owls use ledges, potholes and small cavities as nesting and roosting. Many raptor species also prefer the high rimrock habitat that provides a broad, unobstructed view. Common ravens and other small birds (e.g., loggerhead shrikes, bluebirds, cliff swallows, and various wrens) will use these cliff features for both nesting and feeding. Narrow fissures are used by several bat species and small rodents while deeper and wider crevices are preferred by small mammalian predators. Talus, the accumulation of rock at the base of a cliff, is also important habitat for reptiles and small mammals (e.g., western skink, rattlesnakes, ground squirrels, mice, chipmunks, and woodrats) for cover, feeding, and reproduction. Larger mammals including porcupine, badger, and fox will feed in and around the talus areas. Highwalls also provide habitat for various pollinating insects such as wasps and bees.

Native vegetation will be established on the reclaimed areas at Emma resulting in increased erosion protection and direct habitat improvement, and reduced percolation of water into the underlying materials relative to current conditions. Proposed reclamation seed mixes and seeding rates for Emma are presented in **Table 7-1** and are in accordance with Appendix A of Revision 09-1 of the MMD Permit (MMD 2021). These species have broad ecological amplitudes and provide structural diversity. **Table 7-2** lists some of the major functional attributes of the primary vegetation selected for use at Emma.

The proposed seed mix was selected to provide a long-term sustainable ground cover, erosion control, and diversity in growth forms. The species selected for Emma have been successfully used in mine reclamation and range improvement projects in many parts of New Mexico, including the Tyrone Mine. The primary reclamation seed mix proposed for the wildlife habitat PMLU areas at Emma include native and adapted grasses, shrubs, and forbs. Depending on availability, alternate species may be substituted for the primary species. The vegetation will provide forage, seeds, and cover for reptiles, small mammals, and birds. The reptiles, small mammals, and birds common to the area will benefit from the increased insect populations that are likely to accompany revegetation of the site. The shrubs, grasses, and forbs selected for use at Emma will provide nutritious forage and browse for large mammals (e.g., deer). In addition, the seed mix includes a number of valuable forage grasses that are absent or occur at a low frequency outside the permit area, thus, improving the range condition locally. Tyrone is assessing the opportunity to refine the plant species composition in the reclaimed areas to support local priorities for habitat enhancements consistent with the surrounding life zone. The seed mixes were designed for application prior to the summer rains.

7.2 Site-Specific Revegetation Success Standards

As previously noted, Tyrone is proposing to modify both the existing Tyrone Mine Permit and Design Limit Boundary to account for the Emma Project (Section 1.5). The proposed Mining Area Design Limit combines the estimated extent of disturbed areas and the projected LOM open pit configuration as shown on **Figure 2-1**.

New disturbances located outside the current Tyrone Mine Permit and Design Limit Boundary that are to be backfilled, covered with topdressing, and revegetated will meet the reclamation standards set forth in 19.10.5.507 NMAC and will also comply with the new unit standards set forth in 19.10.5.508.E NMAC. Disturbances located within the current Tyrone Mine Permit and Design Limit Boundary are considered existing mine units and will meet the reclamation standards set forth in 19.10.5.507 NMAC. The existing and proposed changes to the Tyrone Mine Permit and Design Limit Boundary, projected extent of the Emma Pit, and associated new unit and existing unit disturbance areas are presented in **Figure 7-2**. A total of approximately 255 acres of new unit disturbances and approximately 142 acres of existing unit disturbances are associated with the Emma Project. Site-specific revegetation success guidelines for each of these areas are described below.

The MMD recognizes that replication of the pre-mining plant communities after mining is not practical (MMD 1996). The intent of the reference area characterization is to provide a site-specific, quantitative basis for determining revegetation success. More importantly, the reference area provides an “ecological barometer” that integrates normal climatic variations to aid in the evaluation of temporal changes or trends in the reclaimed ecosystem. Thus, the reference areas do not represent model plant communities that will be replicated in detail, but rather local indications of the ecological potential of the reclaimed plant communities.

The reclamation success guidelines required by the MMD vary depending on the PMLU and whether the area to be reclaimed is an existing disturbance or an existing mine new unit disturbance. Canopy cover, shrub density, and vegetation diversity are the revegetation success guidelines that are typically used to judge revegetation success on lands designated as wildlife habitat. The vegetation success guidelines include numerical standards to address the canopy cover and shrub density requirements of the NMMA.

The plant diversity guidelines are addressed through a technical standard and are complemented by a qualitative assessment of plant colonization and regeneration to corroborate the establishment of a self-sustaining ecosystem. A detailed description of the vegetation success guidelines for reclaimed existing disturbance areas is included in DBS&A (1999). The guidelines for revegetation success that apply to the Emma Project area are discussed in Sections 7.2.1 through 7.2.3.

7.2.1 Canopy Cover

Because of its broad implications for erosion control and ecologically based PMLUs, canopy cover is one of the primary criteria for determining reclamation success. Tyrone has a proportional success standard for total canopy cover equal to 70 percent of the measured reference area value to within a 90% statistical confidence for existing unit disturbance areas. The proportional standard was determined based on the interpretation of the community structure and ecological conditions in the reference area. The proportional standard reflects the view that the typical 12-year bond release period does not allow enough time for full maturation of the reclaimed plant community relative to the native sites. The numerical standard derived from the proportional standard will vary over time to account for temporal differences in canopy cover associated with climatic variations. Thus, the numerical standard may increase or decrease based on reference area measurements, but the proportional standard will remain fixed.

For the new unit disturbance areas (**Figure 7-2**), the proportional success guideline for total canopy cover will be equal to 90 percent of the measured reference area value to within a 90% statistical confidence in accordance with Appendix A of Revision 09-1 of the MMD Permit (MMD 2021). The ground cover of living perennial plants shall be adequate in both the existing and new unit disturbance areas to control erosion.

7.2.2 Shrub Density

Shrubs are important components of many reclaimed landscapes. A proportional success guideline of 60 percent (of the reference area) to within an 80% statistical confidence has been accepted by the MMD for shrub density in the reclaimed areas associated with the existing disturbance areas. For the new unit disturbance areas, the proportional success guideline for shrub density will be equal to 80% of the reference area to within an 80% statistical confidence in accordance with Appendix A of Revision 09-1 of the MMD Permit (MMD 2021). As with canopy cover, the shrub density standards are determined based on the interpretation of the ecological conditions of the reference areas.

7.2.3 Plant Diversity

Species diversity is commonly thought to increase the stability of plant communities. The perceived enhancement of ecological stability is related to the buffering effect that species with different ecological amplitudes provide in response to environmental stresses. A technical, rather than proportional, standard will be proposed for plant diversity.

The plant diversity standards for Emma are based on the assumption that site stability is improved by establishing plants with different ecological amplitudes to buffer seasonal and annual fluctuations in climate. Tyrone understands that creating a monoculture on the reclaimed lands is not desirable, while at the same time, recognizing that the benefits of increased diversity diminish beyond subjective threshold levels that are defined by the reclamation objectives. Thus, the diversity guideline for Emma was developed from a functional perspective, whereby site stability, erosion control, and establishment of vegetation that is supportive of wildlife habitat are primary performance objectives. In addition, these guidelines were developed in recognition of the limitations associated with the sampling and statistical evaluation of plant communities whereby minor components are often not represented in the monitoring data.

The proposed numerical diversity standards for the Emma are listed in **Table 7-3**. The current diversity standard would be met if the reclaimed area contains at least three warm season grasses and two shrubs, with individual cover levels of at least 1 percent, and two perennial forbs with a minimum cover level of 0.1 percent. The perennial forb and shrub standard is unqualified with respect to seasonality.

Species diversity on the reclaimed areas is expected to increase with time; however, this process is likely to be slow. Successful colonization depends on the convergence of a seed source and the proper weather conditions; however, even with such an ideal convergence, inter-specific competition, predation, and dispersion mechanisms may limit the establishment of new plants on the reclaimed area. Because of the strong climatic influence on seed production and plant establishment, the rate of colonization is expected to be erratic and potentially slow for many species, with the highest rates of colonization expected to be concentrated in the reclaimed/undisturbed ecotone.

Evidence of colonization will complement the numerical diversity standards listed in **Table 7-3**. No numerical guideline is proposed for colonization, which would be demonstrated by increases in the number of species recognized in the reclaimed area. Information on colonization will be collected and reported to provide evidence of the ability of the reclaimed landscape to support native plants from the surrounding communities. Secondarily, observations of colonization provide evidence of regeneration and thus help demonstrate the establishment of a self-sustaining ecosystem required in the NMMA.

The intent of the colonization standard is to provide evidence of the ability of the reclaimed landscape to support plants from the surrounding communities. In addition, observations of colonization provide evidence of regeneration and thus demonstrate the establishment of a self-sustaining ecosystem. Colonization will be demonstrated by increases in the number of species recognized in the reclaimed area. This information will be obtained from the relative cover data or documented observations of volunteer plant species particularly along the margins of the reclaimed areas during periodic inspections and vegetation monitoring events.

8.0 CAPITAL AND OPERATION AND MAINTENANCE COST ESTIMATES

This section provides a brief description of the material take-offs and factors that were applied in the capital and O&M cost estimates associated with the Emma reclamation plan. Detailed cost estimates for the purpose of determining the value of the FA performance bond were prepared for the Emma Project and are included in **Appendix B** (Earthwork) and **Appendix C** (Water Management and Treatment) of this CCP. The earthwork reclamation cost estimate developed by Telesto Solutions Inc. (Telesto) and included in **Appendix B** is based on a template originally created by the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division (MMD 1996). The estimate includes reclamation earthwork and site O&M costs and is based on the reclamation designs for Emma included in **Appendix A.**

The NMED and the MMD regulations require that FA be posted for facilities that have to be reclaimed at closure (New Mexico Administrative Code NMAC 20.6.7.29 and NMAC 19.10.12, respectively). The Earthwork Cost Basis Document in **Appendix B** describes the base assumptions and approach that was used to determine the FA earthwork reclamation cost estimate (RCE) for Emma. O&M cost assumptions are also included in the Cost Basis Document.

A detailed scope of work, cost basis, and cost estimate for the proposed Emma water management and water treatment plan is also provided in **Appendix C** and serves as the FA cost estimate associated with this component of the CCP. Both the earthwork and the water management and treatment cost estimates incorporate changes to indirect rates and other costing resolutions under the Agreement with the FA Work Group. The FA Work Group involved representatives of Freeport-McMoRan New Mexico Operations (FNMO), MMD, NMED, and Gila Resources Information Project (GRIP).

8.1 Basis for Capital Cost Estimates

The material takeoffs for reclamation of the Emma Project area were prepared in accordance with standard engineering practice. The basis for the capital cost estimate details associated with water management and treatment are provided in the Tyrone CCP water management and treatment system cost estimate (Golder 2020b) and updated for the Emma Project in **Appendix C**. No additional modifications to the Tyrone CCP water treatment system are required due to the excess capacity in the system being able to handle the additional approximate 20 gpm influent stream from Emma. The material takeoffs for the major reclamation earthwork components are summarized in the table below.

Earthwork Material Take-Off Summary		
Item	**Quantity**	**Units**
Earthwork		
Stockpile & Pit Reclamation Stockpile Reclamation Only	187.14 145.36	acres acres
Stockpile Grading	7,569,700	cubic yards
Stockpile Bench Grading	26,638	feet
Stockpile Soil Cover Material	234,513	million cubic yards
Stockpile Revegetate	145.36	acres
Stockpile Surface Water Conveyance Channels and Downdrains	28,744	feet
Open Pit Backfill and Grading	76,780	million cubic yards
Open Pit Soil Cover Material	62,444	cubic yards
Open Pit Revegetate	38.70	acres
Disturbed Areas[1]	249.24	acres
Culvert Demolition	800	feet

Note:

[1] – Includes additional 10 acres of area that is included in the reclamation cost estimate for allowance for additional disturbed areas within the Emma Project area.

8.2 Basis for Indirect and Operation and Maintenance Cost Estimates

A summary of the basis for developing O&M cost estimates along with supporting documentation are provided in **Appendix B** (earthworks) **and Appendix C** (water management and treatment) and summarized below.

O&M costs related to periodic erosion control, water quality monitoring, road maintenance, and vegetation maintenance are assumed to diminish with time and are allocated over time periods of years 0 to 19, 20 to 39, and 40 to 99, coinciding with Tyrone Mine O&M.

- *Capital Indirect Costs:* Total indirect costs of 30% are applied to the capital direct costs based on discussions involving the FA Work Group completed in December 2018. The indirect costs include but are not limited to Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and State Procurement Cost.
- Operations and Maintenance Indirect Costs: Total indirect costs of 17.5% are applied for long-term O&M, also as agreed by the FA Work Group for FNMO's RCEs. The indirect costs include but are not limited to Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and State Procurement Cost.
- Reclamation Timeframe: This earthwork cost estimate assumes that reclamation occurs evenly (in terms of dollars spent) over a 15-year period (including 1 year of pre-construction work and 1 year of post-construction work). Revegetation monitoring, O&M are assumed to be completed at the end of 12 years in each area after the initial revegetation. Other earthwork reclamation and facility monitoring, operations, and maintenance are assumed to be fully completed at the end of 100 years (i.e., year 99).

Surface water and groundwater that accumulates within the Emma Pit sump during the closure/post-closure period will be conveyed to the Tyrone CCP water management and treatment system via the Emma pipeline and pump station over the 100-year following closure. The Tyrone CCP water management and treatment system has the capacity to handle the additional flows from the Emma Pit dewatering over the 100-year post-closure period. The O&M costs related to the Emma Pit dewatering system are detailed in **Appendix C** and summarized below.

8.3 Capital Cost Estimates

The cost estimate has been prepared in accordance with standard engineering practice and is supported with data from various references and is fully documented in the Earthwork Cost Estimate Summary report (**Appendix B**) and the Water Management and Treatment Cost Estimate Summary report (**Appendix C**) associated with this CCP. The capital costs for closure of the Emma Project area are summarized in the following table:

Capital Cost Summary			
Item	**Subtotal Direct Costs**	**Subtotal Indirect Costs[1]**	**Total (Current Cost)**
Earthwork			
EMW Waste Stockpile	$1,136,320	$340,896	$1,477,216
6HW Waste Stockpile	$2,395,888	$718,766	$3,114,654
Soil Stockpile	$8,113	$2,434	$10,547
Haul Roads	$64,216	$19,265	$83,481
Emma Pit	$462,079	$138,624	$600,702
Allowance for Other Disturbed Areas	$25,596	$7,679	$33,275
Earthwork Capital Subtotal	**$4,092,212**	**$1,227,663**	**$5,319,875**
Water Management and Treatment			
Sludge Disposal	$4,563	$1,369	$5,932

Capital Cost Summary			
Water Management and Treatment Capital Subtotal	**$4,563**	**$1,369**	**$5,932**
Total Capital Cost	**$4,096,775**	**$1,229,032**	**$5,325,807**

Notes:
[1] –It is assumed that indirect costs, for capital, is 30% of the estimated direct capital cost based on the 2018 FA Work Group meetings and agreement and the associated approval letter issued by the State of New Mexico in January 2019.

8.4 Operation and Maintenance Cost Estimates

The O&M cost estimate details and supporting documentation are provided in the Earthwork Cost Estimate Summary report (**Appendix B**) and the Water Management and Treatment Cost Estimate Summary report (**Appendix C**) associated with this CCP. O&M estimated costs relate to periodic erosion control, road maintenance, and vegetation maintenance are included in the following table along with O&M costs for water management and treatment for the 100-year post-closure period:

Earthwork O&M Cost Summary			
Item	**Subtotal Direct Costs**	**Subtotal Indirect Costs[1]**	**Total (Current Cost)**
Earthwork			
Road Maintenance	$422,985	$74,022	$497,008
Erosion Control	$99,273	$17,373	$116,646
Vegetation Maintenance	$50,624	$8,859	$59,483
Groundwater Monitoring	$1,569,636	$274,686	$1,844,322
Earthwork O&M Subtotal	**$2,142,519**	**$374,941**	**$2,517,459**
Water Management and Treatment			
Short-Term Evaporative Treatment System	$170,630	$29,860	$200,490
Long-Term Evaporative Treatment System	$21,869	$3,827	$25,696
Tyrone Water Treatment System (TTS)	$2,781,874	$486,828	$3,268,702
Dewatering System (Including Water Collection and Conveyance)	$654,639	$114,562	$769,201
Sludge Disposal	$164,906	$28,858	$193,764
Salt Disposal	$1,751	$306	$2,057
Water Treatment O&M Subtotal	**$3,795,669**	**$664,242**	**$4,459,911**
Total O&M Cost	**$5,938,188**	**$1,039,183**	**$6,977,370**

Note:
[1] –It is assumed that indirect O&M costs in total are 17.5% of the estimated direct O&M cost based on the 2018 FA Work Group meetings and agreement and the associated approval letter issued by the State of New Mexico in January 2019.

9.0 CLOSURE SCHEDULE

An update to the reclamation schedule is required pursuant to the MMD Permit and 19.1 0.5.506.B.1 NMAC. The proposed reclamation schedule is an integral component for the development of the FA cost estimate based on a total site-wide mine default scenario. The schedule assumes a default scenario and all Emma mining operations are terminated at the EOY 2026. The EOY 2026 was chosen for the development of the Emma CCP in that it represents the most conservative earthwork takeoff volumes and is the year with the most complex water management requirements within the Emma Pit and thus the highest reclamation cost estimate for the five-year period under evaluation.

Table 9-1 presents the anticipated schedule for implementation of earthwork closure activities based on best available information and mine planning forecasts. The proposed schedule summarizes Tyrone's understanding of the existing near-term mine operation and longer-term mine plan projections for Emma. More specifically, the schedule is based on the following considerations:

- Practical phasing of the reclamation projects to account for the anticipated labor, equipment and other resources that would be necessary to complete these projects based on current conditions;
- Sequential closure of facilities in a phased cost-efficient manner; and
- Total annual acreages that would be reclaimed over this period.

The anticipated durations for reclamation presented in **Table 9-1** include earthwork and reseeding, but do not include vegetation success/O&M/monitoring that will be conducted throughout the 100-year post-closure monitoring period as described in Section 6. Reclamation of the stockpiles, backfilled and covered portions of the Emma Pit, portions of the haul roads to be closed, and ancillary facilities and infrastructure would begin per the approved CCP schedule.

For clarity, the FA cost estimate and the proposed reclamation schedule are explicitly linked. Tyrone expects that the planned closure of the facilities represented by the proposed schedule will be conducted in a more cost-efficient manner than that reflected in the financial assurance cost estimate, which is predicated on the unlikely condition of forfeiture. As indicated earlier, implementation of the mine-for-closure concepts are expected to result in more efficient reclamation than might be considered in a forfeiture scenario.

10.0 USE OF THIS REPORT

Golder has compiled this plan to present the Emma CCP to the NMED and the MMD of the New Mexico Energy, Minerals and Natural Resources Department. In the compilation of this plan, Golder collaborated with various consultants involved in the CCP, including DBS&A, LCG, Telesto Solutions, Inc., and WestLand Resources, Inc. The Emma CCP has been developed to fulfill the requirements of the following permits:

- Supplemental Discharge Plan DP-1341, Phelps Dodge Tyrone, Inc., Tyrone Mine Facility, (DP-1341), issued by the NMED on April 8, 2003 (NMED 2003);
- Applicable conditions of the Copper Mine Rule, 20.6.7 NMAC adopted by the New Mexico Water Quality Control Commission on December 1, 2013 (NMWQCC 2013);
- Permit Revisions 01-1 and 09-1 to Permit GR010RE (MMD Permit), issued by the MMD of the New Mexico Energy, Minerals and Natural Resources Department on April 4, 2004 (MMD 2004) and March 29, 2021 (MMD 2021), respectively;

- DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021 (Tyrone 2021a); and
- Permit Revision GR010RE Application for the EMMA Expansion Project at the Tyrone Mine submitted to the MMD on October 22, 2021 (Tyrone 2021b).

11.0 REFERENCES

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper 56, Rome, Italy.

AMIRA. 2002. ARD Test Handbook. P387A Project. Prediction and Kinetic Control of Acid Mine Drainage, AMIRA International, Melbourne.

ASTM E2242-13. 2013. Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure, ASTM International, West Conshohocken, PA, www.astm.org

ASTM. 2018. D5744 – 18: Standard Test Method for Laboratory Weathering of Solid Materials Using a Humidity Cell.

Benson, S. 2002. Reclaiming Wildlife Habitat at the Buckskin Mine. Proceedings America Society of Mining and Reclamation, 241-259.

Dames & Moore,. 1994. Mining Operation Site Assessment for the Tyrone Mine. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico.

Daniel B. Stephens & Associates, Inc. (DBS&A), 1997a. Preliminary Materials Characterization. Tyrone Closure / Closeout. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. April 30.

DBS&A, 1997b. Supplemental Materials Characterization, Tyrone Closure/Closeout. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. October 31.

DBS&A, 1997c. Closure/ Closeout Plan. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. December 19.

DBS&A, 1999. Revised Closure/Closeout Plan. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. April 30.

DBS&A. 2014. Groundwater Flow and Geochemical Modeling, Little Rock Mine. Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. July 2, 2014.

DBS&A. 2017a. Field Investigation Work Plan for South Side and Upper East Side Areas Regional Groundwater Capture System, Tyrone Mine. Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. February 6.

DBS&A. 2017b. Application Requirements for Discharge Permits at a Copper Mine Facility (20.6.7 NMAC). Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. October 6, 2015 (Reissued with addendum June 9, 2017).

DBS&A. 2021a. Well installation report, December 2020–March 2021, Tyrone Mine. Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. July 29, 2021.

DBS&A. 2021b. Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project (See DP-396 Modification Application). Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. October 22.

Edwards, G.H. 1961. Geology of the Central Burro Mountains Grant County, New Mexico. University of Kansas. Unpublished master's thesis.

Freeport-McMoRan Tyrone, Inc. (Tyrone). 2010. Spill Prevention Control and Countermeasure Plan. September.

Tyrone. 2012. Multi-Sector General Storm Water Permit (MSGP)-2008 Stormwater Pollution Prevention Plan Tyrone Inc. September.

Tyrone. 2021a. Application for Discharge Permit 396 Renewal and Modification for the Emma Expansion Project. Tyrone, New Mexico. October 22, 2021.

Tyrone. 2021b. Permit GR010RE – Tyrone Mine Existing Mining Operation, Permit Revision Application for Emma Expansion Project at the Tyrone Mine. Tyrone, New Mexico. October 22, 2021.

Gillerman, E. 1964. Mineral deposits of western Grant County, New Mexico. State Bureau of Mines and Mineral Resources Bulletin 83. New Mexico Institute of Mining & Technology.

Golder Associates, Inc (Golder). 2005. Wildlife Monitoring Plan for Post Closure-Tyrone Mine. December 28.

Golder. 2006a. No.1 Stockpile Stability Analysis, Condition 78, DP1341, Phelps Dodge Tyrone, Inc. February.

Golder. 2006b. Technical Memorandum, RE: Tyrone Reclamation No. 1C Stockpile and 7A Waste Stability Analysis. May 4.

Golder. 2006c. Submittal of Slope Stability Analysis, Tyrone Mine Stockpiles 1A and 1B, DP-1341, Condition 78, and GR010RE, Condition 9L.2. July 28.

Golder. 2007a. Technical Memorandum, RE: Tyrone Reclamation, No. 2A/2B Stockpile Stability Analysis, DP-1341, Condition 78. April 6.

Golder. 2007b. Technical Memorandum, RE: Tyrone Reclamation 4C Stockpile Stability Analysis, DP-1341, Condition 78. May 11.

Golder. 2007c. Technical Memorandum, RE: Tyrone Reclamation Stability of Interior and In-Pit Stockpiles, DP-1341, condition 78. May 11.

Golder. 2019. 2013 Tyrone Mine Closure/Closeout Plan Update – Basis of Cost Estimate for Water Management and Treatment - Freeport-McMoRan Tyrone Operations, Tyrone, New Mexico. July 29.

Golder. 2020a. Tyrone Stockpile Stability Analysis for 2019 Closure Close-Out Plan Update Tyrone Rev 1., New Mexico. Freeport McMoRan Tyrone Inc. April 28.

Golder. 2020b. 2013 Tyrone Mine Closure/Closeout Plan Update – Basis of Cost Estimate for Water Management and Treatment - Freeport-McMoRan Tyrone Operations, Tyrone, New Mexico. April 28.

Golder. 2020c. Characterization and Volumetrics of Gila Conglomerate and Precambrian Granite Reclamation Cover Materials. Freeport McMoRan Tyrone Operations. April 29.

Golder. 2021a. Emma Expansion Project – Selection of Mine Configuration for Closure Planning (General Cost Analysis) Technical Memorandum to Mandy Lilla - Senior Engineer Freeport-McMoRan Tyrone, Inc. September 13.

Golder. 2021b. Characterization of Suitable Soils and Overburden and Soil Salvage Plan for the Emma Expansion Project, Freeport McMoRan Tyrone Inc. November 12.

Golder. 2021c. DP-396 Water Management Plan Freeport-McMoRan Tyrone, Inc. (submitted as Attachment IID-1 to the DP-396 Permit Renewal and Modification Application submitted to the NMED on October 22, 2021). October 22.

Golder. 2021d. Emma Expansion Stockpile Stability Evaluation. Submitted to Freeport-McMoRan Tyrone Inc. November 12, 2021.

Hedlund, D.C. (Hedlund).1978a.Geologic Map of the Burrow Peak Quadrangle, Grand Country, New Mexico. Miscellaneous Field Studies. U.S. Geological Survey Map MF-1040, Scale 1:24,000. Denver, Colorado.

Hedlund.1978b.Geologic Map of the Tyrone Quadrangle, Grand Country, New Mexico. Miscellaneous Field Studies. U.S. Geological Survey Map MF-1037, Scale 1:24,000. Denver, Colorado.

Hedlund. 1978c. Geologic Map of the White Signal Quadrangle, Grand Country, New Mexico. Miscellaneous Field Studies. U.S. Geological Survey Map MF-1041, Scale 1:24,000. Denver, Colorado.

Hedlund. 1978d. Geologic Map of the Wind Canyon Mountain Quadrangle, Grand Country, New Mexico. Miscellaneous Field Studies. U.S. Geological Survey Map MF-1031, Scale 1:24,000. Denver, Colorado.

Kolessar, J. 1982. The Tyrone copper deposit. In Spencer R. Titley (ed.), Advances in the Geology of the Porphyry Copper Deposits, Southwestern North America. University of Arizona Press, Tucson, Arizona.

Lapakko, K.A. and D.A. Antonson. 2002. Drainage pH, Acid Production, and Acid Neutralization for Archean Greenstone Rock. 2002 SME Annual Meeting.

Life Cycle Geo, LLC (LCG). 2020. Sampling and Analysis Plan for Emma. Reported prepared for Freeport-McMoRan Tyrone, Inc., Submitted to NMED in September 2020.

LCG. 2021a. Geochemical Characterization of Emma Waste Rock Materials. Report prepared for Freeport-McMoRan, Tyrone, Inc., Submitted to NMED in September 2021.

LCG. 2021b. Material Characterization and Handling Plan for Two Non-Discharging Facilities: Emma Project (See DP-396 Modification Application). October 22.

LCG. 2021c. Kinetic Testing Sampling and Analysis Plan for Emma. Report prepared for Freeport-McMoRan Tyrone, Inc., Submitted to NMED in January 2021.

LCG. 2021d. Water Quality Predictions for the Proposed Emma Pit. Report prepared for Freeport-McMoRan Tyrone, Inc., Submitted as Attachment IA-3 to the DP-396 Permit Renewal and Modification Application. October 22.

Mach, C.J. 2008. Tectonic controls, timing and geochemistry of supergene enrichment of the Tyrone Porphyry Copper Deposit, Grant County, New Mexico. University of Nevada, Reno. Unpublished doctorate thesis.

Metric Corporation. 1993. A Threatened and Endangered Floral and Wildlife Survey of 280 Acres and 2.5 Miles of Proposed Haul Road, Grant County, New Mexico. Prepared for Phelps Dodge Corporation, Tyrone, New Mexico.

Metric Corporation. 1996. A Threatened and Endangered Floral and Wildlife Survey of 300 Acres, Grant County, New Mexico. Prepared for Phelps Dodge Corporation, Tyrone, New Mexico.

Mining and Minerals Division (MMD). 1996. Closeout Plan Guidelines for Existing Mines. Mining Act Reclamation Bureau, Santa Fe, New Mexico. April 30.

MMD. 2004. Permit Revision 01-1 to Permit No. GR010RE Tyrone Mine Existing Mining Operation. Mining and Minerals Division Energy, Minerals and Natural Resources Department. April 12.

MMD. 2021. Reissued Permit No. GR010RE Permit Revision 09-1: Updated Site Wide Closure/Closeout Plan Tyrone Mine Existing Mining Operation. Mining and Minerals Division Energy, Minerals and Natural Resources Department. March 29.

Natural Resources Conservation Service (NRCS). 2004a. Part 630 Hydrology, National Engineering Handbook, Chapter 9: Hydrologic soil-cover complexes. July 2004. Available at <https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17758.wba>.

NRCS. 2004b. Part 630 Hydrology, National Engineering Handbook, Chapter 10: Estimation of direct runoff from storm rainfall. July 2004. Available at <https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17752.wba>.

New Mexico Environment Department (NMED). 1996. Characterization according to procedures recommended by the NMED.

NMED. 2003. Supplemental Discharge Permit for Closure, DP-1341, Phelps Dodge Tyrone, Inc., Tyrone Mine Facility. Issued April 8, 2003.

New Mexico Water Quality Control Commission (NMWQCC). 2013. Copper Rules as adopted by the NMWQCC was published in the New Mexico Register on October 31, 2013 as 20.6.7 NMAC, and became effective on December1, 2013.

Parnham, T.L., R. Paetzold, and C.E. Souders. 1983.Soil Survey of Grant County, New Mexico, Central and Southern Parts. USDA-Soil Conservation Service, U.S. Gov. Print. Office Washington DC.

SARB Consulting, Inc. (SARB). 1999. Geochemical Evaluation of Tailings and Stockpiles, Tyrone Mine. Prepared for Phelps Dodge Tyrone Inc. Tyrone, New Mexico. December 22.

Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and laboratory methods applicable to overburdens and mine soils. Report EPA-600/2-78-054, U.S. National Technical Information Report PB-280 495. 403 p.

Trauger, F. D. 1972, Water Resources and General Geology of Grant County, New Mexico: New Mexico Bureau of Mines and Mineral Resources: Hydrologic Report 2.

WestLand Resources, Inc. 2021. Emma Project Wildlife and Habitat Impact Assessment. Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. October 22.

Signature Page

Please contact the undersigned with any questions or comments on the information contained in this report.
Respectfully submitted,

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https://golderassociates.sharepoint.com/sites/149301/project files/6 deliverables/003-r-emma ccp/rev0/21476949-003-r-rev0-emma_ccp_12nov2021 .docx

Tables

Table 1-1: Copper Rule Section Reference to Emma Closure Closeout Plan

Copper Rule Section	Description	EMMA CCP Report Section
20.6.7.30	**CONTINGENCY REQUIREMENTS FOR COPPER MINE FACILITIES**	6.2
20.6.7.30.I	Leach Stockpiles, Tailings Impoundment or Waste Rock Stockpiles - Unstable Slopes	6.1, 6.6
20.6.7.30.J	Erosion of Cover Systems or Compromised Stormwater Conveyance Structure, Ponding of Stormwater, or Other Conditions	6.1
20.6.7.33	**CLOSURE REQUIREMENTS FOR COPPER MINE FACILITIES**	1.1
20.6.7.33.A	Design Storm Event	4.1, 5.1.2, Table 4-1
20.6.7.33.B	Slope Stability	4.1, Table 4-2
20.6.7.33.C	Surface Re-Grading	Table 4-1
20.6.7.33.D	Open Pits	NA
20.6.7.33.E	Surface Water Management	4.0
20.6.7.33.F	Cover Systems	2.3.7, Table 4-1
20.6.7.33.G	Process Solution Reduction Plans	NA
20.6.7.33.H	Closure Water Management and Treatment Plan	4.6, 5.6
20.6.7.33.I	Impoundments	NA
20.6.7.33.J	Pipelines, Tanks and Sumps	5.4.2
20.6.7.33.K	Crushing, Milling, Concentrating and Smelting	NA
20.6.7.33.L	Closure Monitoring and Maintenance	6.0
20.6.7.33.M	Exceptions to Design Criteria	NA
20.6.7.34	**IMPLEMENTATION OF CLOSURE**	NA
20.6.7.34.A	Notification of Intent to Close	6.8
20.6.7.34.B	Initiation of Closure	6.8
20.6.7.34.C	Notification of Change in Operational Status	NA
20.6.7.34.D	Department Notice Regarding Suspended Operations and Enforcement Action	NA
20.6.7.34.E	Deferral of Closure	NA
20.6.7.34.F	Final Design	6.8
20.6.7.34.G	CQA/CQC Report	6.8
20.6.7.35	**POST-CLOSURE REQUIREMENTS**	6.0
20.6.7.35.A	Seepage Interceptor System Inspections	6.2
20.6.7.35.B	Water Quality Monitoring and Reporting	6.0, 6.3.1, 6.3.2, 6.7
20.6.7.35.C	Reclamation Monitoring, Maintenance, and Inspections	6.1, 6.2, 6.4
20.6.7.35.D	Reporting	6.0
20.6.7.35.E	Contingency Requirements	NA

Notes:

NA – Not applicable

Table 2-1: Water Quality at Emma Project Groundwater Monitoring Locations[1]

Analyte	Concentration (mg/L [a])						
	Section 3103 Standard	MB-44		396-2021-01		396-2021-02	
		5/20/2021	8/18/2021	5/21/2021	8/25/2021	5/18/2021	8/18/2021
Alkalinity, total (as $CaCO_3$)	NS	218	227	120	126	234	249
Aluminum, dissolved	5.0	<0.080	<0.080	1.03	<0.080	<0.080	0.169
Arsenic, dissolved	0.01	<0.025	<0.025	**1.05**	<0.025	<0.025	<0.025
Bicarbonate (as $CaCO_3$)	NS	218	227	120	126	234	249
Cadmium, dissolved	0.005	<0.0020	<0.0020	**1.00**	<0.0020	<0.0020	<0.0020
Calcium, dissolved	NS	132	128	303	305	121	114
Carbonate (as $CaCO_3$)	NS	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloride	250	27.9	26.8	33.5	29.8	40.6	34.5
Chromium, dissolved	0.05	<0.0060	<0.0060	**0.994**	<0.0060	<0.0060	<0.0060
Cobalt, dissolved	0.05	<0.0060	<0.0060	**0.980**	<0.0060	<0.0060	<0.0060
Copper, dissolved	1.0	<0.0100	<0.0100	**1.06**	<0.0100	<0.0100	<0.0100
Electrical conductivity [b] (µmho/cm)	NS	845	822	1,827	2,043	887	857
Fluoride	1.6	0.342	0.387	**3.09**	**2.52**	0.398	0.371
Iron, dissolved	1.0	<0.100	<0.100	**10.1**	<0.100	<0.100	0.137
Lead, dissolved	0.015	<0.0075	<0.0075	**0.991**	<0.0075	<0.0075	<0.0075
Magnesium, dissolved	NS	14.5	14.6	85.5	66.8	18.1	18.2
Manganese, dissolved	0.2	<0.0080	0.0109	**3.84**	**2.8**	0.175	0.194
Nickel, dissolved	0.2	<0.0100	<0.0100	**0.979**	<0.0100	<0.0100	<0.0100

Table 2-1: Water Quality at Emma Project Groundwater Monitoring Locations[1]

Analyte	Concentration (mg/L [a])						
	Section 3103 Standard	MB-44		396-2021-01		396-2021-02	
		5/20/2021	8/18/2021	5/21/2021	8/25/2021	5/18/2021	8/18/2021
pH [b] (s.u.)	6–9	7.13	6.98	6.54	6.78	7.45	7.05
Potassium, dissolved	NS	2.12	2.03	29.2	7.58	3.65	3.48
Sodium, dissolved	NS	29.6	29.4	133	119	59.0	50
Sulfate	600	185	180	**1,120**	**1,120**	191	159
Temperature [b] (°C)	NS	24.1	23.9	19.8	23.4	20.7	21.9
Total dissolved solids	1,000	552	551	**1,850**	**1,870**	646	579
Zinc, dissolved	10	<0.0100	<0.0100	1.08	0.0373	<0.0100	0.0292

Notes:

[1] Source of data: DBS&A 2021b. Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project. Prepared for Freeport-McMoRan Tyrone Inc. October 22.

Bold indicates that value exceeds the Section 3103 standard (20.6.2.3103 NMAC).

[a] Unless otherwise noted.

[b] Measured in the field.

mg/L = Milligrams per liter
μmho/cm = Micromhos per centimeter
NS = No standard
s.u. = Standard units

Table 2-2: Summary of Emma Project Related Permits

Permit or Requirement	Agency	ID Number	Area Covered
Registration	U.S. Department of Labor, Mine Safety and Health Administration		Mine
Mining Act Permit[1]	New Mexico Mining Minerals Division	GR010RE and associated modifications and revisions	Mine
Groundwater Discharge Permits[2]	NMED Ground Water Quality Bureau	DP--396	Mine/Stockpile Unit
DP-1341 Settlement Agreement and Stipulated Final Order	NMED Ground Water Quality Bureau	DP-1341	Mine
NPDES Stormwater General Permit (2021 Multi-Sector General Permit)	U.S. EPA (Region 6)	NMR053073	Mine
Water Rights	New Mexico Office of State Engineer	GSF85, GSF85S, GSF02260, GSF3020, M02680, M04978, M04979, M04980	Surface Water & Groundwater
Air Quality	U.S. EPA (Region 6)	P147-R2 (as of December 2019)	Title V Mine-wide
SARA Title III			
Hazardous Waste Generator	U.S. EPA/New Mexico Department of Public Safety	NMD035806405	Mine
Hazardous Materials Transporter	U.S. Department of Transportation	062406-550-001OP	NA
Individual Liquid Waste Permit	NMED, Construction Industries Division	SC060183	Mine

Notes:
[1] – The Emma Expansion area will be incorporated into the Tyrone Mine Permit and Design Limit Boundary as part of the Permit GR010RE revision application (Tyrone 2021b).
[2] – The Emma Expansion area will be incorporated into DP-396 as part of the DP-396 renewal and modification application (Tyrone 2021a).
NA = Not applicable
NMED = New Mexico Environment Department
U.S. EPA = United States Environmental Protection Agency

Table 3-1: Predicted Water Quality for the Emma Pit Sump During Operations

Constituent	*Minimum*	*Median*	*Maximum*
pH	8.13	8.15	8.2
Arsenic	0.005	0.007	0.02
Boron	<0.00001	0.01	0.02
Cadmium	0.001	0.04	0.05
Cobalt	0.003	0.03	0.04
Copper	0.004	0.01	0.02
Nitrate	<0.00001	0.5	0.6
Lead	0.002	0.003	0.004
Selenium	<0.00001	0.006	0.008
Zinc	0.005	0.1	0.2
Sulfate	200	300	500
Total Dissolved Solids (TDS)	400	500	800

Note:
All concentrations are in mg/L, except pH which is in standard units
Only analytes with water quality standards that were detected in laboratory results are presented in table. The following analytes were not modeled because they were non-detect in testing: mercury, silver, vanadium, chromium
Reference: Data provided in the Life Cycle Geo, LLC Emma Pit Geochemical Modeling Report (2021d)

Table 3-2: Predicted Water Quality for the Emma Pit Sump Following Closure

Constituent	*Minimum*	*Median*	*Maximum*
pH	4.72	6.78	8.2
Arsenic	<0.00001	0.003	**0.2**
Boron	<0.00001	0.03	0.06
Cadmium	0.001	**0.8**	**2**
Cobalt	0.003	**9**	**20**
Copper	0.004	**30**	**800**
Nitrate	<0.00001	<0.00001	0.7
Lead	0.002	0.06	**3**
Selenium	<0.00001	**0.3**	**2**
Zinc	0.005	20	**50**
Sulfate	200	4000	8000
Total Dissolved Solids (TDS)	400	5000	10000

Note:
Exceedances of surface water and aquatic life standards solely for comparison purposes in bold
All concentrations are in mg/L, except pH which is in standard units
Only analytes with comparison water quality standards that were detected in laboratory results are presented in table. The following analytes were not modeled because they were non-detect in testing: mercury, silver, vanadium, chromium
Reference: Data provided in the Life Cycle Geo, LLC Emma Pit Geochemical Modeling Report (2021d)

Table 3-3: Interim Seed Mix for Stockpiled Soil Materials at Emma

Scientific Name	Common Name	PLS/ac[1]
Grasses		
Bouteloua curtipendula	Sideoats grama	1.00
Bouteloua gracilis	Blue grama	0.20
Pleuraphis jamesii	Galleta	0.75
Schizachyrium scoparium	Little bluestem	0.40
Eragrostis intermedia	Plains lovegrass	0.05
Shrubs		
Artemisia ludoviciana	White sagebrush	0.05
Atriplex canescens	Four-wing saltbush	0.30
Ericamerica nauseosus	Rubber rabbitbrush	0.10
Forbs		
Dalea candida	White prairie clover	0.10
Ratibida columnifera	Prairie coneflower	0.15
	Total	**3.10**

Notes:
[1] – Rate is in pounds of pure live seed (PLS) per acre; Substitutions may change seeding rates.

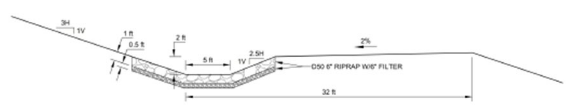
Table 4-1: Summary of Key Design Criteria for Facilities to be Closed

<table>
<tr><th colspan="2">Stockpiles – (Applicable to the EMW Waste Stockpile, 6HW Waste Stockpile area outside Conditional Waiver Area, and Soil Stockpile). Note, the Soil Stockpile will be fully consumed at closure for use as RCM.</th></tr>
<tr><th>CCP Design Criteria (in report)</th><th>Engineering Designs (design package)</th></tr>
<tr>
<td>

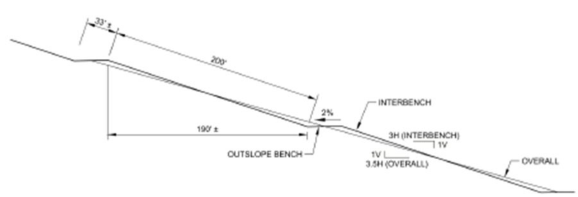
- Outslopes to be graded to a maximum inter-bench slope of 3H:1V.
- Maximum uninterrupted slope length of 200 feet for outslopes.
- Terrace benches will have maximum bench width of 32 feet.
- Bench longitudinal slopes at between 1 and 5 percent.
- Bench cross slopes and channels at a maximum of 5 percent.
- Top surfaces of non-discharging waste rock stockpiles - minor grading to ensure that stormwater water does not accumulate near or discharge over a crest.
- Construction of downdrains and energy dissipators as needed.
- Regrading to be done in such a manner that orients surface water conveyances to the exterior perimeter of the stockpiles.
- Slope channels will be located where possible in natural junctions or drainage chutes and may contain riprap and energy dissipation structures if engineering designs warrant them.
- Top surfaces and outslopes to be covered with 12 inches of suitable RCM from the Soil Stockpile.
- Top surfaces and outslopes of the covered stockpile surfaces and the disturbed area associated with the Soil Stockpile footprint to be ripped to a depth of 18 inches and vegetated in accordance with Appendix C of the MMD Permit and applicable modifications.

</td>
<td>

- Outslopes are regraded to an overall slope of 3.5H:1V.
- 3H:1V interbench slopes, ≤32 ft. bench widths.
- Inter-bench slope lengths of 200 ft.
- Bench and other channels are constructed with ≥5-foot base width and 3H:1V (inner) and 2.5H:1V (outer) side slopes.
- 12-inches of suitable RCM placed prior to construction of bench channels and filter material and riprap are placed for erosion control.
- 5.0% maximum cross-bench slope, and 2.0% longitudinal bench slope.
- Top surfaces and outslopes to be covered with 12 inches of suitable RCM from the Soil Stockpile.
- Top surfaces and outslopes of the covered stockpile surfaces and the disturbed area associated with the Soil Stockpile footprint to be ripped to a depth of 18 inches and vegetated in accordance with Appendix C of the MMD Permit and applicable modifications.
- Downdrains utilize ACBs for erosion protection.



NOT TO SCALE 1 011 TYPICAL BENCH CHANNEL DETAIL



NOT TO SCALE K 011 TYPICAL OUTSLOPE BENCH SECTION

</td>
</tr>
</table>

Table 4-1: Summary of Key Design Criteria for Facilities to be Closed

Emma Pit	
CCP Design Criteria (in report)	**Engineering Designs (design package)**
■ Upper North, Upper East, and Upper South areas of the Emma Pit will be backfilled with NPAG waste during operations and graded to drain toward the Emma Pit sump. ■ Slopes of backfilled areas to be graded to a maximum inter-bench slope of 3H:1V. ■ Maximum uninterrupted slope length of 200 feet for outslopes. ■ Terrace benches will have maximum bench width of 32 feet. ■ Bench longitudinal slopes at between 1 and 5 percent. ■ Bench cross slopes and channels at a maximum of 5 percent. ■ Backfilled areas to be covered with 12 inches of suitable RCM from the Soil Stockpile. ■ Covered surfaces to be scarified and vegetated in accordance with Appendix C of the MMD Permit and applicable modifications. ■ Pit haul roads - If residual non-acid generating material is present and no PAG highwalls are present above it, surface to be ripped to a depth of 18 inches and revegetated in accordance with Appendix C of the MMD Permit and applicable modifications. ■ Perimeter fence to be maintained with no trespass signage warning of hazards. ■ Removal of aboveground electrical systems and infrastructure, including pumps, lighting, and transmission lines not necessary for post-closure site operations and maintenance.	■ Upper North, Upper East, and Upper South areas of the Emma Pit will be backfilled with NPAG waste during operations and graded to drain toward the Emma Pit sump. ■ Slopes of backfilled areas to be graded to a maximum inter-bench slope of 3H:1V. ■ Maximum uninterrupted slope length of 200 feet for outslopes. ■ Terrace benches will have maximum bench width of 32 feet. ■ Bench longitudinal slopes at between 1 and 5 percent. ■ Bench cross slopes and channels at a maximum of 5 percent. ■ Backfilled areas to be covered with 12 inches of suitable RCM from the Soil Stockpile. ■ Covered surfaces to be scarified and vegetated in accordance with Appendix C of the MMD Permit and applicable modifications. ■ Pit haul roads - If residual non-acid generating material is present and no PAG highwalls are present above it, surface to be ripped to a depth of 18 inches and revegetated in accordance with Appendix C of the MMD Permit and applicable modifications. ■ Perimeter fence to be maintained with no trespass signage warning of hazards.

Table 4-1: Summary of Key Design Criteria for Facilities to be Closed

Northern Emma Haul Road and Southern Emma Haul Roads	
CCP Design Criteria	**Engineering Designs**
- Culverts and NPAG fill to be removed from the Oak Grove Wash crossing. - Other culverts to be removed where practicable, unless they serve a post closure purpose. - Reclaimed surfaces to be revegetated in accordance with Appendix C of the MMD Permit and applicable modifications. - A moderate maintenance program will be acceptable until cover vegetation establishes.	- Culverts and NPAG fill to be removed from the Oak Grove Wash crossing. - Haul roads to be reduced to 30-foot width for one lane used for maintenance activities. - Reclaimed surfaces to be revegetated in accordance with Appendix C of the MMD Permit and applicable modifications.

Table 4-1: Summary of Key Design Criteria for Facilities to be Closed

Other Ancillary Facilities and Structures (culverts and fill at the Oak Grove Wash crossing, electrical power transmission lines, power poles, and a substation; pipeline sections replaced during the post-closure period; operational and exploration roads; storm water structures for drainage, diversion, and sediment control; equipment storage areas; and fencing and security systems).	
CCP Design Criteria	**Engineering Designs**
■ Power transmission lines, power poles, booster pump stations, and substation to be removed once they are not needed for post-closure purposes. ■ Removal of any temporary, portable operations and maintenance facilities used to support mining and not needed for post-closure purposes. ■ Removal of culverts and NPAG fill associated with the Oak Grove Wash crossing. ■ Pipeline sections that may be replaced during the post-closure period - removal of residual sediments and fluids from pipelines and disposal of materials at an approved location. Removal or burial of sections of pipeline and dispose of pipe in an approved manner. ■ Ripping of non-impacted disturbed areas to a depth of 18 inches. ■ Seeding of ripped and covered areas to reestablish vegetation in accordance with MMD Permit GR010RE and applicable Permit revisions. ■ A moderate maintenance program will be acceptable until cover vegetation establishes.	■ Power transmission lines, power poles, booster pump stations, and substation will be removed once they are not needed for post-closure purposes. ■ Remove any temporary, portable operations and maintenance facilities used to support mining and not needed for post-closure purposes. ■ Removal culverts and NPAG fill associated with the Oak Grove Wash crossing. ■ Remove other culverts where practicable, unless they serve a post closure purpose. ■ Pipeline sections that may be replaced during the post-closure period - removal of residual sediments and fluids from pipelines and disposal of materials at an approved location. Removal or burial of sections of pipeline and dispose of pipe in an approved manner. ■ Rip non-impacted disturbed areas to a depth of 18 inches. ■ Seeding of ripped and covered areas to reestablish vegetation in accordance with MMD Permit GR010RE and applicable Permit revisions.

Notes:
MMD = Mining and Minerals Department
All proposed waste rock stockpiles and haul roads will be non-discharging units and therefore may not be subject to the Copper Mine Rule citations above.

Table 4-2: Stability Analysis Results for the Emma Project Stockpile Reclamation Plan[1]

Stockpile	Critical Failure Mode	Minimum Static FOS	Minimum Pseudo-Static FOS	Liquefied FOS
6HW Waste	Global failure, circular type	2.86	2.11	No liquefiable soils present
EMW Waste	Local toe, circular type	3.05	1.95	1.87

Notes:
[1] - Golder. 2021d. Emma Expansion Stockpile Stability Evaluation. Submitted to Freeport-McMoRan Tyrone Inc. November 12, 2021 and included in Appendix E of the Emma CCP.

FOS – Factor of safety

Table 7-1: Proposed Interim Seed Mix and Rates for the Emma Project Reclamation Sites

Species[a] Scientific Name	Common Name	Life-Form	Duration[b]	Seasonality	Rate[a,c]
Primary					
Bouteloua curtipendula	Sideoats grama	Grass	Per	Warm	1.50
Bouteloua eriopoda	Black grama	Grass	Per	Warm	0.10
Bouteloua gracilis	Blue grama	Grass	Per	Warm	0.50
Leptochloa dubia	Green sprangletop	Grass	Per	Warm	0.25
Eragrostis intermedia	Plains lovegrass	Grass	Per	Intermediate	0.05
Dalea candida	White prairie clover	Shrub	Per	NA	0.25
Linum lewisii	Blue flax	Forb	Per	NA	0.25
Sphaeralcea spp.	Globemallow spp.	Forb	Per	NA	0.10
Cercocarpus montanus	Mountain mahogany	Shrub	Per	NA	1.50
Fallugia paradoxa	Apache plume	Shrub	Per	NA	0.10
Krascheninnikovia lanata	Winterfat	Shrub	Per	NA	1.00
				Total	**5.60**
Alternate					
Andropogon gerardii	Big bluestem	Grass	Per	Warm	ND
Andropogon hallii	Sand bluestem	Grass	Per	Warm	ND
Andropogon saccharoides	Silver bluestem	Grass	Per	Warm	ND
Aristida purpurea	Purple three-awn	Grass	Per	Warm	ND
Bothriochloa barbinodis	Cane beardgrass	Grass	Per	Warm	ND
Bothriochloa ischaemum	Yellow bluestem	Grass	Per	Warm	ND
Buchloe dactyloides	Buffalograss	Grass	Per	Warm	ND
Digitaria californica	Arizona cottontop	Grass	Per	Warm	ND
Heterotheca contortus	Tanglehead	Grass	Per	Warm	ND
Hilaria belangeri	Curly mesquite	Grass	Per	Warm	ND
Pleuraphis mutica	Tobosa	Grass	Per	Warm	ND
Muhlenbergia montana	Mountain muhly	Grass	Per	Warm	ND
Muhlenbergia porteri	Bush muhly	Grass	Per	Warm	ND
Muhlenbergia rigens	Deergrass	Grass	Per	Warm	ND
Muhlenbergia torreyi	Ring muhly	Grass	Per	Warm	ND
Muhlenbergia wrightii	Spike muhly	Grass	Per	Warm	ND
Panicum obtusum	Vine mesquite	Grass	Per	Warm	ND
Panicum virgatum	Switchgrass	Grass	Per	Warm	ND
Pleuraphis jamesii	Galleta grass	Grass	Per	Warm	ND
Schizachyrium scoparium	Little bluestem	Grass	Per	Warm	ND
Setaria vulpiseta	Plains bristlegrass	Grass	Per	Warm	ND
Sorgastrum nutans	Indiangrass	Grass	Per	Warm	ND
Sporobolus airoides	Alkali sacaton	Grass	Per	Warm	ND
Sporobolus cryptandrus	Sand dropseed	Grass	Per	Intermediate	ND
Sporobolus giganteus	Giant dropseed	Grass	Per	Warm	ND
Sporobolus wrightii	Sacaton	Grass	Per	Warm	ND
Achillea millefolium	Western yarrow	Forb	Per	NA	ND
Baileya multiradiata	Desert marigold	Forb	Ann	NA	ND

Table 7-1: Proposed Interim Seed Mix and Rates for the Emma Project Reclamation Sites

Species[a]		Life-Form	Duration[b]	Seasonality	Rate[a,c]
Scientific Name	Common Name				
Berlandiera lyrata	Chocolate flower	Forb	Per	NA	ND
Calochortus 20mbiguous	Desert mariposa lily	Forb	Per	NA	ND
Calylophus hartwegii	Lavenderleaf primrose	Forb	Per	NA	ND
Castilleja integra	Indian paintbrush	Forb	Per	NA	ND
Castilleja sessiliflora	Downy paintbrush	Forb	Per	NA	ND
Coreopsis lanceolata	Lanceleaf tickseed	Forb	Per	NA	ND
Coreopsis tinctoria	Plains tickseed	Forb	Per	NA	ND
Dalea candida	White prairie clover	Forb	Per	NA	ND
Dalea jamesii	James' dalea	Forb	Per	NA	ND
Erigeron speciosus	Aspen fleabane	Forb	Per	NA	ND
Gaillardia aristata	Blanket flower	Forb	Per	NA	ND
Gaillardia pulchella	Firewheel	Forb	Per	NA	ND
Gilia tricolor	Bird's eyes	Forb	Per	NA	ND
Glandularia gooddingii	Desert verbena	Forb	Per	NA	ND
Heliomeris multiflora	Showy goldeneye	Forb	Per	NA	ND
Ipomopsis ambiguous	Scarlet gilia	Forb	Per	NA	ND
Lesquerella gordonii	Gordon bladderpod	Forb	Per	NA	ND
Lupinus arizonicus	Arizona lupine	Forb	Per	NA	ND
Lupinus perennis	Perennial lupine	Forb	Per	NA	ND
Machaeranthera bigelovii var.bigelovii	Bigelow's tansyaster	Forb	Per	NA	ND
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	Forb	Per	NA	ND
Mirabilis multiflora	Wild Four 'O Clock	Forb	Per	NA	ND
Monarda citriodora	Lemon beebalm	Forb	Per	NA	ND
Monarda fistulosa	Wild bergamot	Forb	Per	NA	ND
Oenothera elata	Hooker evening primrose	Forb	Per	NA	ND
Oenothera macrocarpa	Missouri evening primrose	Forb	Per	NA	ND
Penstemon ambiguous	Sand penstemon	Forb	Per	NA	ND
Penstemon barbatus	Scarlet bulger	Forb	Per	NA	ND
Penstemon eatonii	Firecracker penstemon	Forb	Per	NA	ND
Penstemon fendleri	Fendler's penstemon	Forb	Per	NA	ND
Penstemon palmeri	Palmer penstemon	Forb	Per	NA	ND
Penstemon pseudospectabilis	Desert penstemon	Forb	Per	NA	ND
Penstemon superbus	Superb penstemon	Forb	Per	NA	ND
Penstemon virgatus	Wandbloom penstemon	Forb	Per	NA	ND
Phacelia campanularia	Bluebells	Forb	Per	NA	ND
Phacelia crenulata	Desert bluebells	Forb	Per	NA	ND
Ratibida columnifera	Mexican hat	Forb	Per	NA	ND
Rudbeckia hirta	Blackeyed Susan	Forb	Per	NA	ND
Senecio longilobus	Silver groundsel	Forb	Per	NA	ND
Senna covesii	Desert senna	Forb	Per	NA	ND
Solidago canadensis	Canada goldenrod	Forb	Per	NA	ND

Table 7-1: Proposed Interim Seed Mix and Rates for the Emma Project Reclamation Sites

Species[a]		Life-Form	Duration[b]	Seasonality	Rate[a,c]
Scientific Name	Common Name				
Sphaeralcea ambigua	Desert globemallow	Forb	Per	NA	ND
Sphaeralcea coccinea	Scarlet globemallow	Forb	Per	NA	ND
Sphaeralcea grossulariifolia	Gooseberry globemallow	Forb	Per	NA	ND
Thelesperma filifolium	Greenthread	Forb	Per	NA	ND
Agave parryi	Parry's agave	Shrub	Per	NA	ND
Amorpha fruticosa	False indigo-bush	Shrub	Per	NA	ND
Artemisia ludoviciana	White sagebrush	Shrub	Per	NA	ND
Atriplex canescens	Fourwing saltbush	Shrub	Per	NA	ND
Brickellia californica	Canyon bricklebush	Shrub	Per	NA	ND
Calliandra eriphylla	Fairy duster	Shrub	Per	NA	ND
Chilopsis linearis	Desert willow	Shrub	Per	NA	ND
Dalea formosa	Feather dalea	Shrub	Per	NA	ND
Dasylirion wheeleri	Sotol	Shrub	Per	NA	ND
Erimaceria nauseosa	Rubber rabbitbrush	Shrub	Per	NA	ND
Encelia virginensis	Virgin river brittlebush	Shrub	Per	NA	ND
Lycium pallidum	Wolfberry	Shrub	Per	NA	ND
Mahonia repens	Creeping Oregon grape	Shrub	Per	NA	ND
Nolina microcarpa	Beargrass	Shrub	Per	NA	ND
Rhus trilobata	Skunkbush sumac	Shrub	Per	NA	ND
Ribes leptanthum	Canyon gooseberry	Shrub	Per	NA	ND
Robinia neomexicana	NM locust	Shrub	Per	NA	ND
Senegalia greggii	Catclaw acacia	Shrub	Per	NA	ND
Vachellia constricta	Whitethorn acacia	Shrub	Per	NA	ND
Yucca baccata	Broadleaf yucca	Shrub	Per	NA	ND
Yucca elata	Soap tree yucca	Shrub	Per	NA	ND
Yucca glauca	Spanish bayonet	Shrub	Per	NA	ND

Notes:

[a] The seed species list and associated mix will be included in the vegetation monitoring work plan and may be amended with MMD approval. Any proposed changes to the seed mix will be provided to the MMD no less than 60 days before any seeding occurs.

[b] Per - Perennial; Ann - Annual.

[c] Rate is in pounds of pure live seed (PLS) per acre; substitutions may change seeding rates.

Current alternate or substitute species list for the proposed seed mix is presented in Table 4 of Permit Modification 09-1 to Permit GR010RE.

Tyrone is assessing the opportunity to enhance the species in the reclaimed areas to support local priorities for habitat enhancements consistent with the surrounding life zone.

lbs/ac = pounds per acre

NA = Not applicable

ND = Not determined

PLS = Pure live seed

Table 7-2: Functions and Attributes of the Primary Plant Species Proposed for the Emma Project Reclamation Sites

Species	Character[a]	Attributes and Function
Blue grama (*Bouteloua gracilis*)	N,P,W,G	Sod and bunch grass providing ground cover and forage
Side-oats grama (*Bouteloua curtipendula*)	N,P,W,G	Bunch grass providing ground cover and forage
Black grama (*Bouteloua eriopoda*)	N,P,W,G	Bunch grass providing ground cover and forage
Green sprangletop (*Leptochloa dubia*)	N,P,W,G	Erect bunch grass; aggressive short-lived nurse plant with forage value
Plains lovegrass (*Eragrostis intermedia*)	N,P,I,G	Bunch grass providing ground cover and early spring forage
Apache plume (*Fallugia pardoxa*)	N,P,S	Mid-height shrub providing browse, cover, and erosion control
Mountain mahogany (*Cercocarpus montanus*)	N,P,S	Mid-height to tall shrub providing browse and cover
Winterfat (*Krascheninnikovia lanata*)	N,P,HS	Low shrub providing winter browse
White prairie clover (*Dalea candida*)	N,P,F	Early season legume providing ground cover and forage
Blue flax (*Linum lewisii*)	N,P,F	Persistent forb providing winter and spring forage for wildlife
Globemallow spp. (*Sphaeralcea spp.*)	N,P,F	Persistent mid-height forb providing browse

Notes:
The seed species list and associated mix will be included in the vegetation monitoring work plan and may be amended with MMD approval. Any proposed changes to the seed mix will be provided to the MMD no less than 60 days before any seeding occurs.
The forbs listed above and Apache plume are important to pollinators.
[a] N = Native
P = Perennial
W = Warm season
I = Intermediate season
G = Grass
S = Shrub
HS = Half shrub
F = Forb

Table 7-3: Proposed Plant Diversity Guidelines for the Emma Project

Class	Seasonality	Numbers	Minimum Occurrence (% cover)
Perennial Grasses	Warm	3	1
Perennial Shrubs	NA	2	1
Perennial Forbs	NA	2	0.1

Note:
NA = Not applicable

Table 9-1: Reclamation Schedule for the Emma Project

Unit	Anticipated or Actual Start Date for Reclamation to Begin[a]	Anticipated Duration (Years)[b] or Completion Date
6HW Waste stockpile	180 days following Cessation of Operation	2
EMW Waste stockpile	180 days following Cessation of Operation	3
Emma Pit[c]	180 days following Cessation of Operation	3
Haul Roads and Access Roads[d]	180 days following Cessation of Operation	3
Ancillary Facilities and Structures	180 days following Cessation of Operation	1

Notes:

[a] Anticipated start dates are subject to modification.

[b] Estimated duration for facility reclamation does not include regulatory design review and approval processes.

[c] NPAG waste rock mined from the Emma Pit will be placed within the upper bench areas of the pit (Upper North, Upper South and Upper East areas) and the South Main area during mine operations and graded to promote surface water runoff toward the pit sump. An additional one-foot thick layer of soil from the Soil Stockpile will be placed over the NPAG waste rock backfill and revegetated in accordance with Appendix C of the MMD Permit GR010RE and applicable modifications in the Upper East area during operations. The remaining areas receiving the NPAG waste rock backfill during operations (Upper North, Upper South, and South Main) will receive an additional one-foot of soil cover and be revegetated during closure.

[d] Only portions of haul roads not required for post-closure monitoring access will be reclaimed. A 30-foot wide corridor of the Emma haul roads will be maintained for access to the pit sump and reclaimed areas for O&M activities.

Figures

STATE OF NEW MEXICO

NOT TO SCALE

CLIENT

FREEPORT-MCMORAN

TYRONE INC.

PROJECT

Emma Project

CONSULTANT

GOLDER

MEMBER OF WSP

YYYY-MM-DD	09/17/21
PREPARED	SIB
DESIGN	TS
REVIEW	TS
APPROVED	TS

TITLE

MINE LOCATION MAP

PROJECT No.	PHASE	Rev.	FIGURE
21476949		0	1-1

Path: \\richmond\data\Plan Production Data Files\Albuquerque_CAD Support\CAD\2021 Projects\21476949 EMMA Closure Plan and Permitting 2021\PRODUCTION_B EMMA Dp-396\ | File Name: Figure IIA-1.dwg

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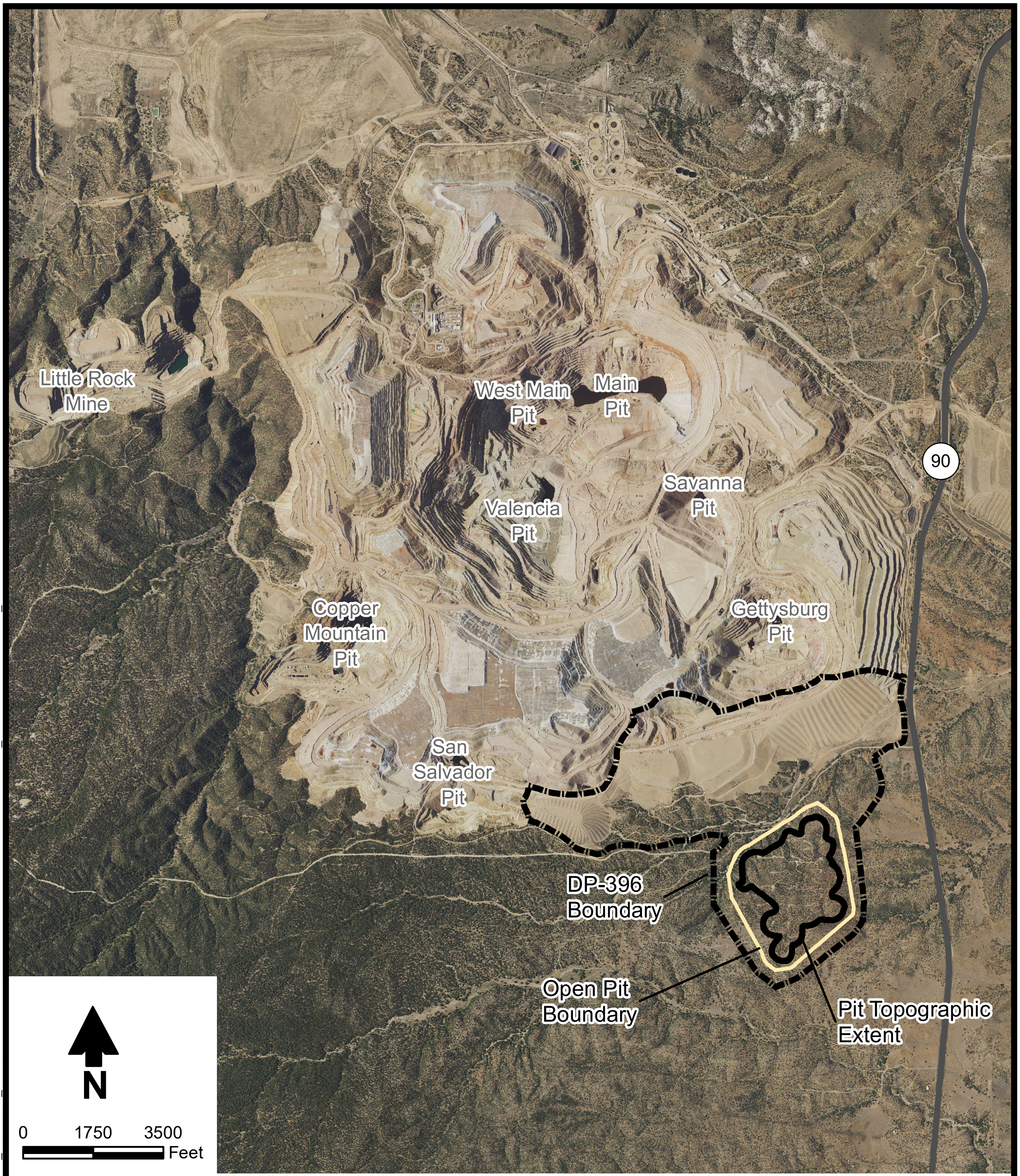


S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\DP-396\RENEWAL APPLICATION\FIGURE IIA-2_SCALED FACILITY MAP_OVERALL.MXD

Explanation

Proposed new DP-396 boundary

Proposed Emma pit topographic extent

Proposed Emma open pit boundary

Source: Aerial imagery (NAIP, 2020)

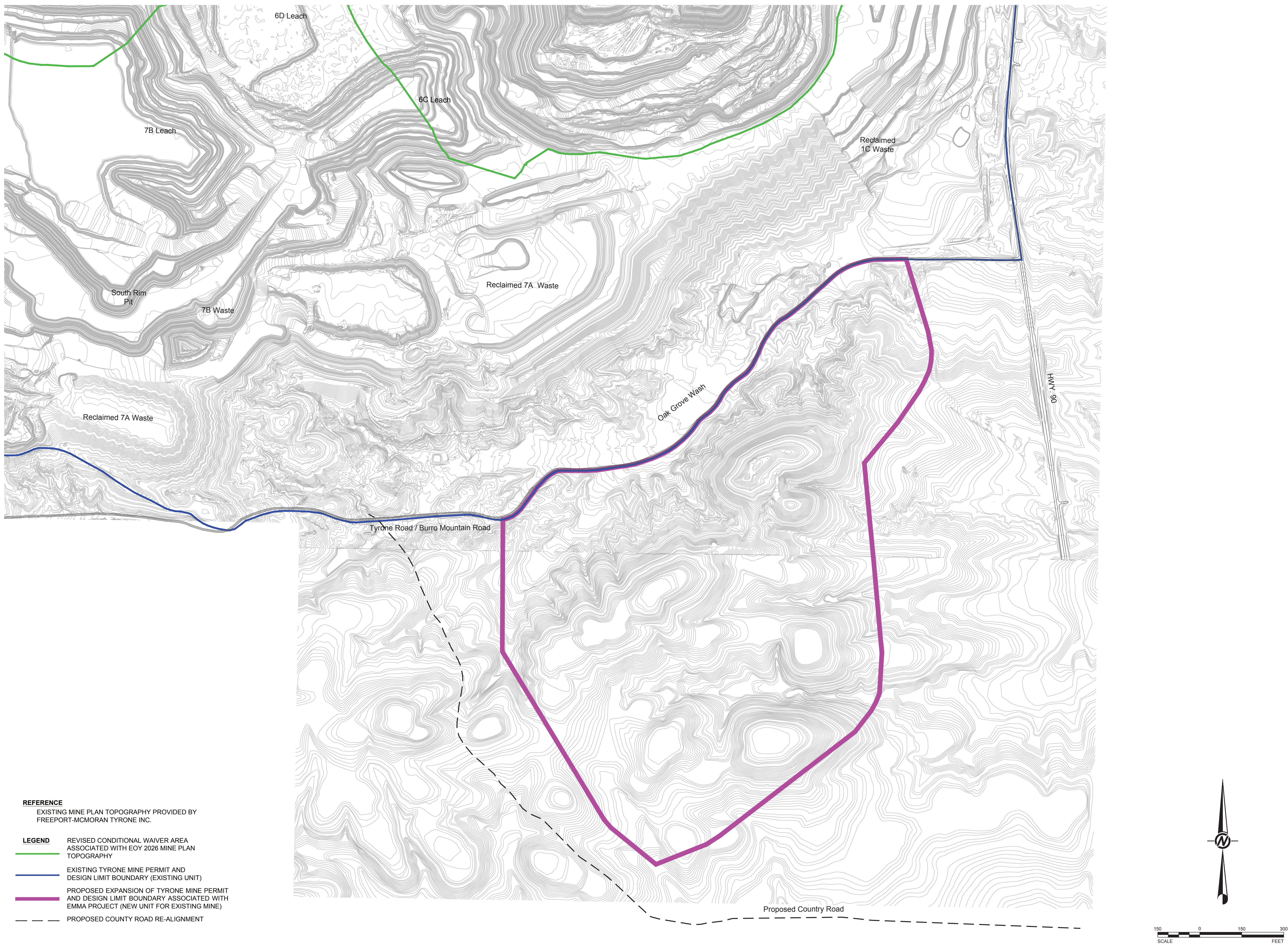
FREEPORT-MCMORAN

TYRONE MINE

Scaled Facility Map: Overall Tyrone Mine

DBS&A
Daniel B. Stephens & Associates, Inc.
10/21/2021 DB20.1392

Figure 1-2



REFERENCE

EXISTING MINE PLAN TOPOGRAPHY PROVIDED BY FREEPORT-MCMORAN TYRONE INC.

LEGEND

- REVISED CONDITIONAL WAIVER AREA ASSOCIATED WITH EOY 2026 MINE PLAN TOPOGRAPHY
- EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)
- PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
- PROPOSED COUNTY ROAD RE-ALIGNMENT

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
0	2021-09-10	-	SIB			

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

CONSULTANT
GOLDER
MEMBER OF WSP
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

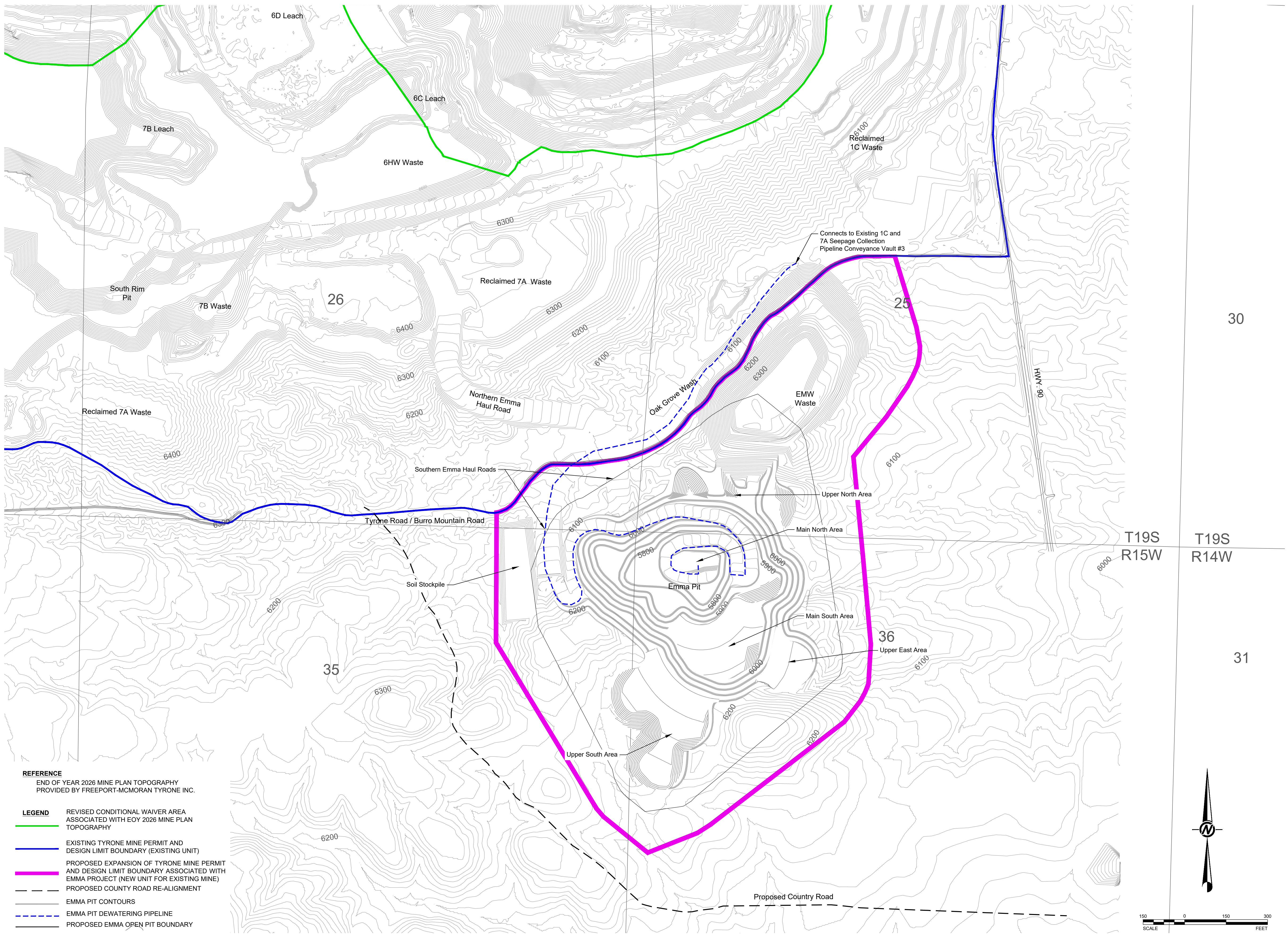
PROJECT
Emma Project

TITLE
PROPOSED EXPANSION OF EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH THE EMMA PROJECT

PROJECT NO.
21-476949

REV. 0 of FIGURE 1-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D



REV. 0 | 2021-10-04 | - | SIB
REV. MM/DD/YY DESCRIPTION DESIGN CADD CHECK REVIEW

SEAL

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www.golder.com

PROJECT
Emma Project

TITLE
LAYOUT OF EMMA FACILITY AT THE END OF YEAR 2026

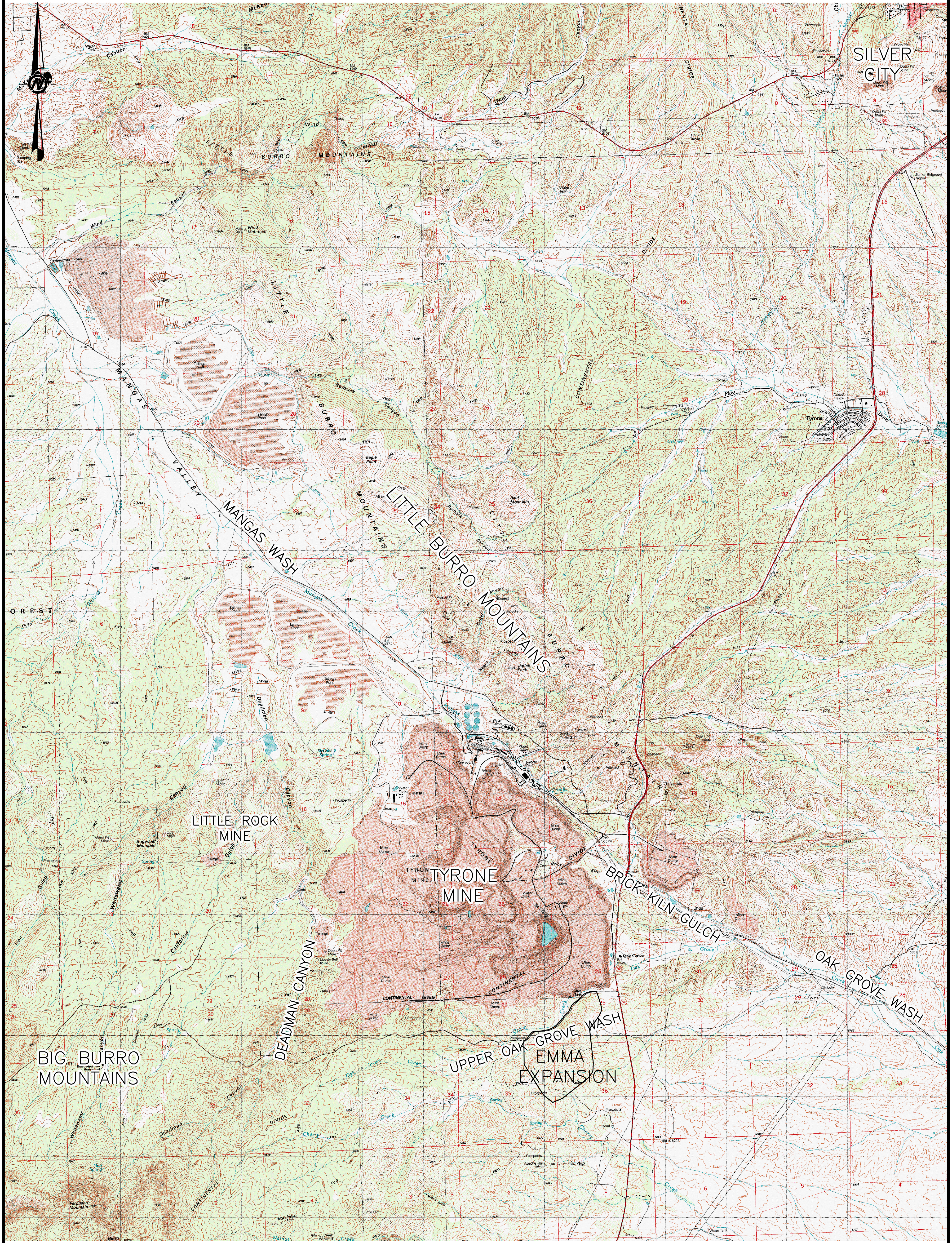
PROJECT NO.
21-476949

REV. 0 of FIGURE 2-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

Path: G:\Plan Production Data Files\Albuquerque_CAD Support\CAD\2021 Projects\21476949 EMMA Closure Plan and Permitting 2021\PRODUCTION_A EMMA DESIGN\Figure 2-1.dwg

Drawing file: Figure 2-2.dwg Sep 21, 2021 - 5:22pm



NOTE: TOPOGRAPHIC MAP DETAILS WERE DEVELOPED BETWEEN 1992 AND 1999. SPECIFIC MINE FEATURES MAY VARY FROM THOSE SHOWN ON THIS MAP. FOR SPECIFIC MINE TOPOGRAPHY AND PHYSICAL FEATURES, REFER TO PLATES 1 THROUGH 3 OF THIS CCP.

FREEPORT-McMoRAN
TYRONE INC.

1500 0 1500
SCALE METERS

SOURCE: ALL TOPO MAPS V7 PROFESSIONAL MAP REFERENCE SET, NEW MEXICO RELEASE 3. INCLUDES QUADS: CIRCLE MESA, SILVER CITY, TYRONE, WIND MOUNTAIN, WHITE SIGNAL AND BURRO PEAK.

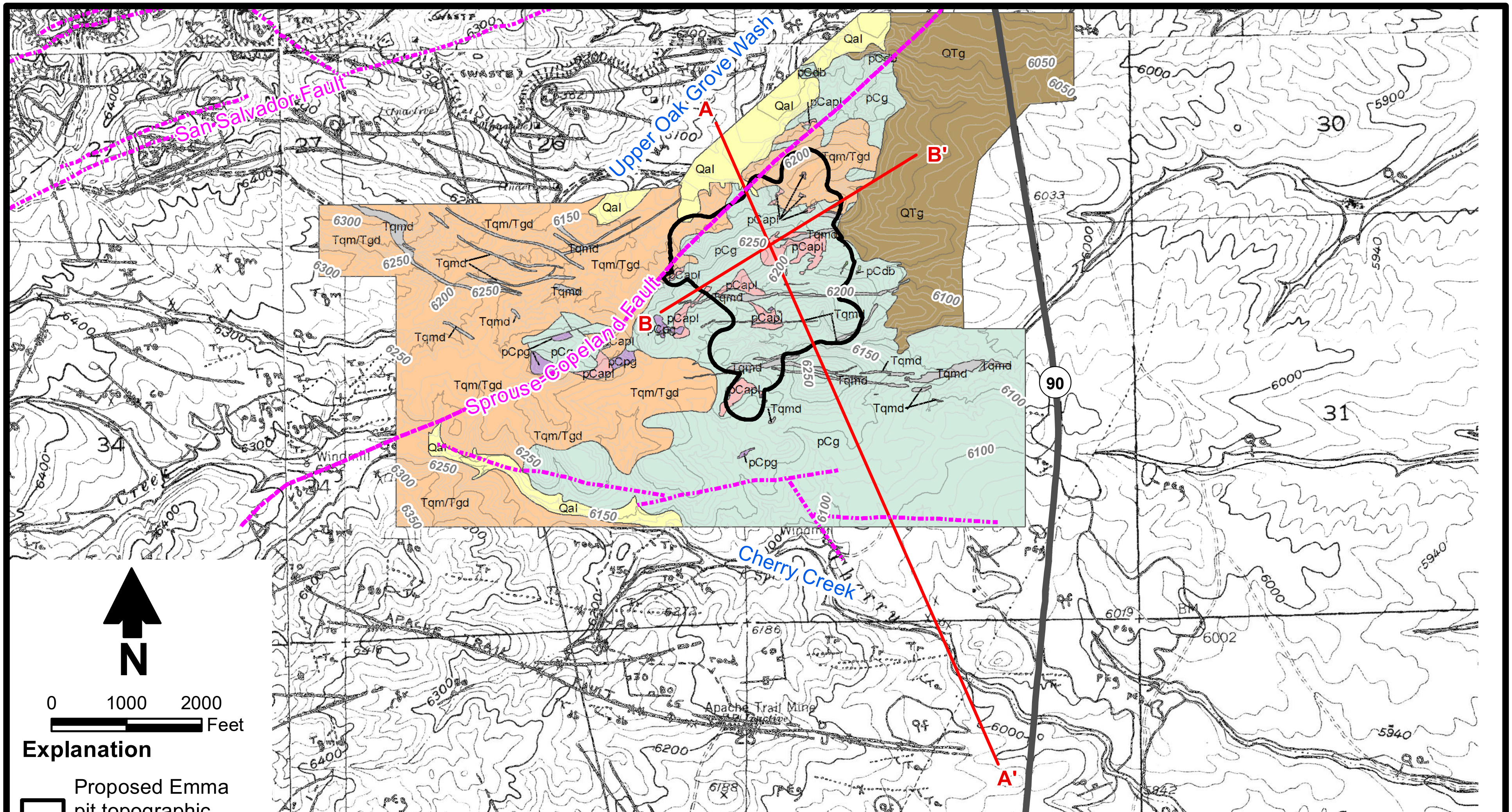
PROJECT
Emma Project
Grant County, New Mexico

TITLE
GENERALIZED REGIONAL TOPOGRAPHIC MAP

GOLDER
MEMBER OF WSP

PROJECT No.	21476949	FILE No.	Tyrone Area Topo Map
DESIGN	TS	09/20/21	SCALE AS SHOWN REV. 1
CADD	SIB	09/20/21	
CHECK			**FIGURE 2-2**
REVIEW			

S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\EMMA CCP SUPPORT\FIGURE 2-3_GENERALIZED SURFACE GEOLOGY MAP.MXD



Explanation

Proposed Emma pit topographic extent

Fault

Cross section line

Topography (10-ft contour interval, ft msl)

(50-ft contour interval, ft msl)

Qal	Quaternary alluvial deposits
QTg	Quaternary-Tertiary Gila Conglomerate
Tqm/Tgd	Tertiary quartz monzonite/Tertiary granodiorite
Tqmd	Tertiary quartz monzonite porphyry dike
pCapl	Precambrian aplite
pCpg	Precambrian pegmatite
pCg	Precambrian granite
pCdb	Precambrian diabase

Source: 1. Emma geology provided by Tyrone, dated 2021.
2. Regional geology from Hedlund (1978c).
3. Emma pit topographic extent represents the EOY 2026 pit configuration.

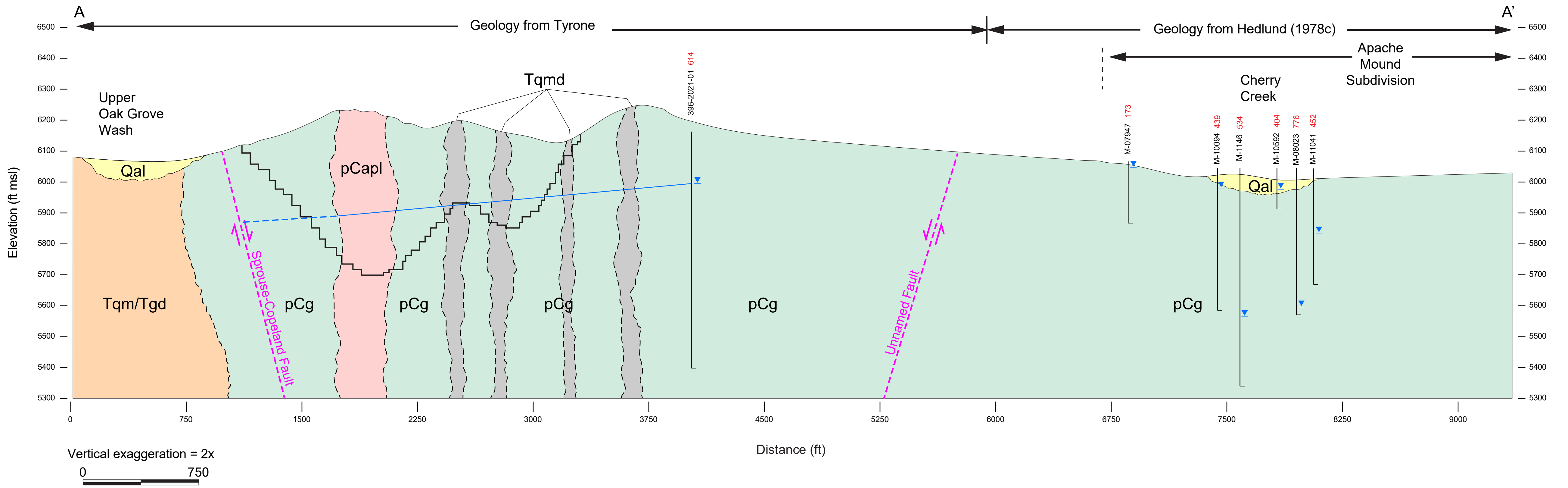
FREEPORT-McMoRAN

TYRONE MINE

Emma Project
Generalized Surface Geology Map

DBS&A
Daniel B. Stephens & Associates, Inc.
10/21/2021
DB20.1392

Figure 2-3



Explanation

Well

Projection Distance

Well ID

Water Level

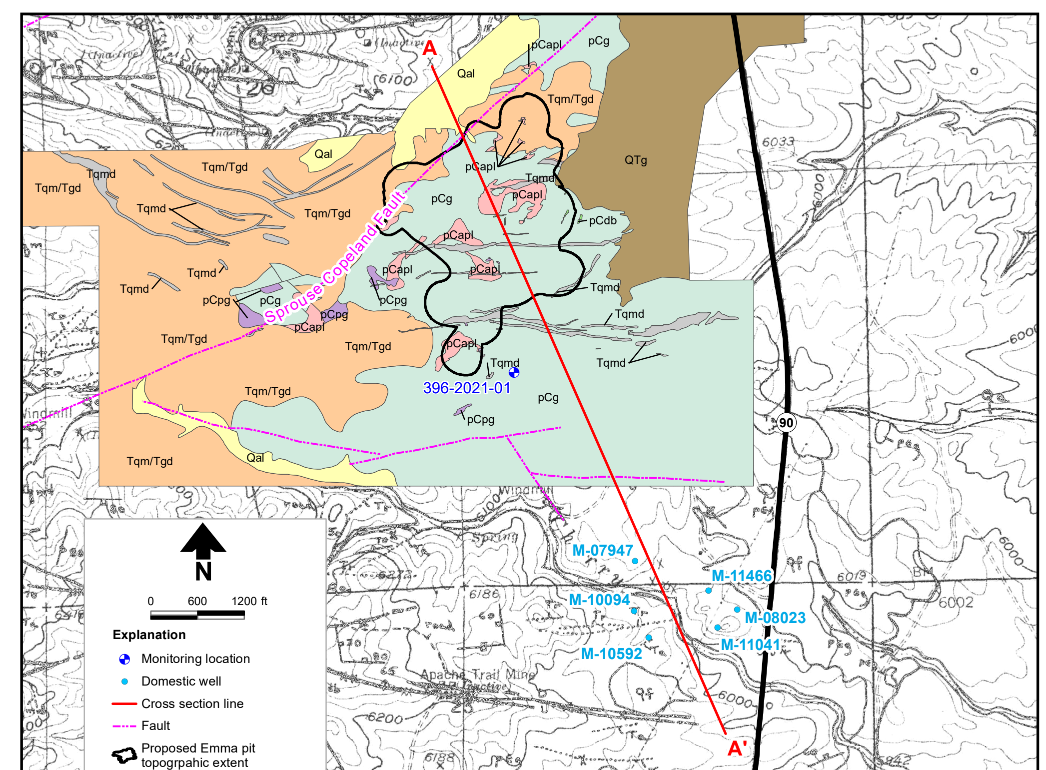
Groundwater elevation contour (dashed where inferred)

Geology

Qal	Quaternary alluvium
QTg	Quaternary-Tertiary Gila Conglomerate
Tqm/Tgd	Tertiary quartz monzonite/Tertiary granodiorite
Tqmd	Tertiary quartz monzonite porphyry dike
pCapl	Precambrian aplite
pCpg	Precambrian pegmatite
pCg	Precambrian granite
pCdb	Precambrian diabase

Source: 1. Emma geology provided by Tyrone, dated 2021.
2. Regional geology from Hedlund (1978c).
3. Domestic wells (New Mexico Office of State Engineer, 2021)

Notes: 1. Cross section does not include some of the thinner dikes intersected by the A to A' line.
2. Hedlund (1978c) geology used for very north end of cross section too (i.e., black and white region shown in plan view map).



Note: Emma pit topographic extent represents the EOY 2026 pit configuration.

FREEPORT-MCMORAN

TYRONE MINE

Emma Project

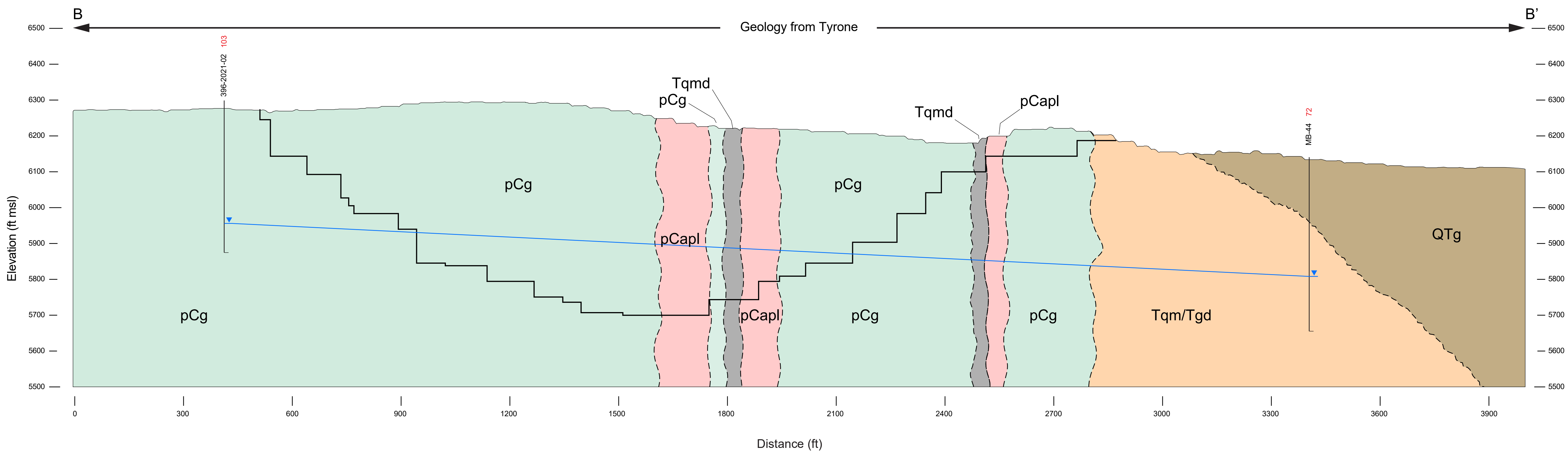
Generalized Hydrogeologic Cross Section A-A'

Figure 2-4

DBS&A Daniel B. Stephens & Associates, Inc.

10/20/2021 DB20.1392

S:\Projects\Mine_Tyrone\Projects\DP_Support_2021\VR_Drawings\AI\Emma_Apache_Mound\Cross_Section\A-A'-Emma_Apache_Mound\F06_Emma_Apache_Mound_Cross_Section A-A'.ai



No vertical exaggeration

0 300

Explanation

Well

Projection Distance 103

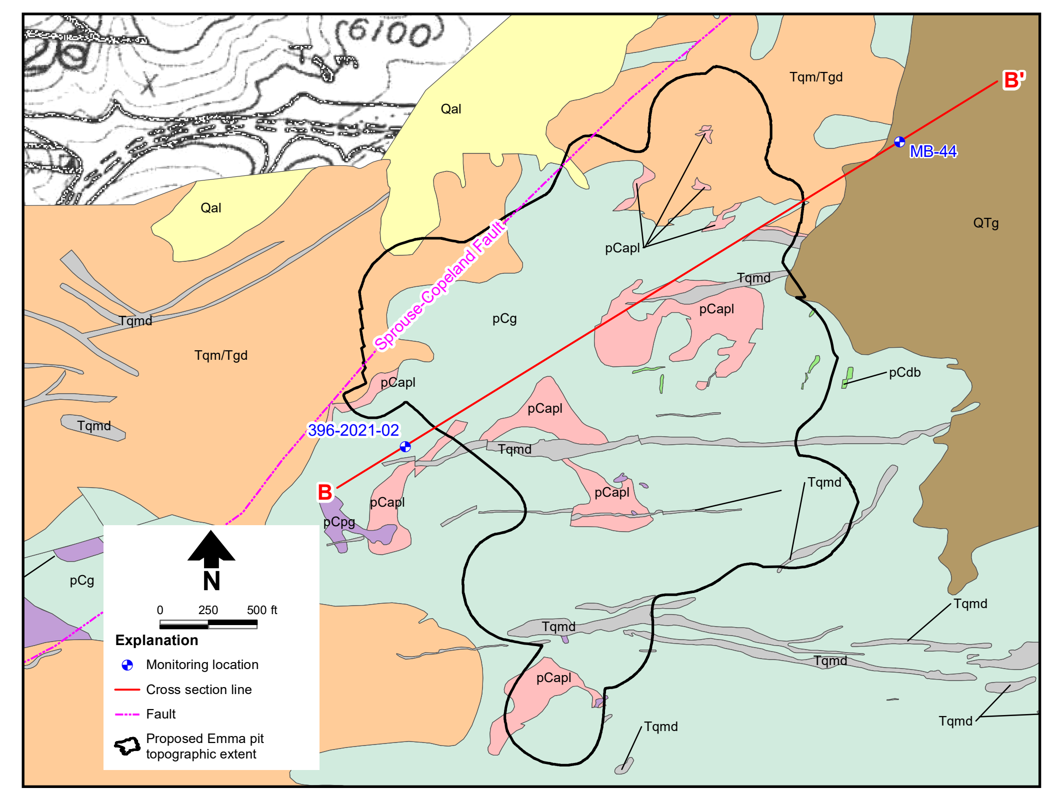
Well ID 396-2021-02

Water Level

Groundwater elevation contour (dashed where inferred)

Geology	
Qal	Quaternary alluvium
QTg	Quaternary-Tertiary Gila Conglomerate
Tqm/Tgd	Tertiary quartz monzonite/Tertiary granodiorite
Tqmd	Tertiary quartz monzonite porphyry dike
pCapl	Precambrian aplite
pCpg	Precambrian pegmatite
pCg	Precambrian granite
pCdb	Precambrian diabase

Source: 1. Emma geology provided by Tyrone, dated 2021.
2. Regional geology from Hedlund (1978c).



Note: Emma pit topographic extent represents the EOY 2026 pit configuration.

FREEPORT-MCMORAN

TYRONE MINE

Emma Project

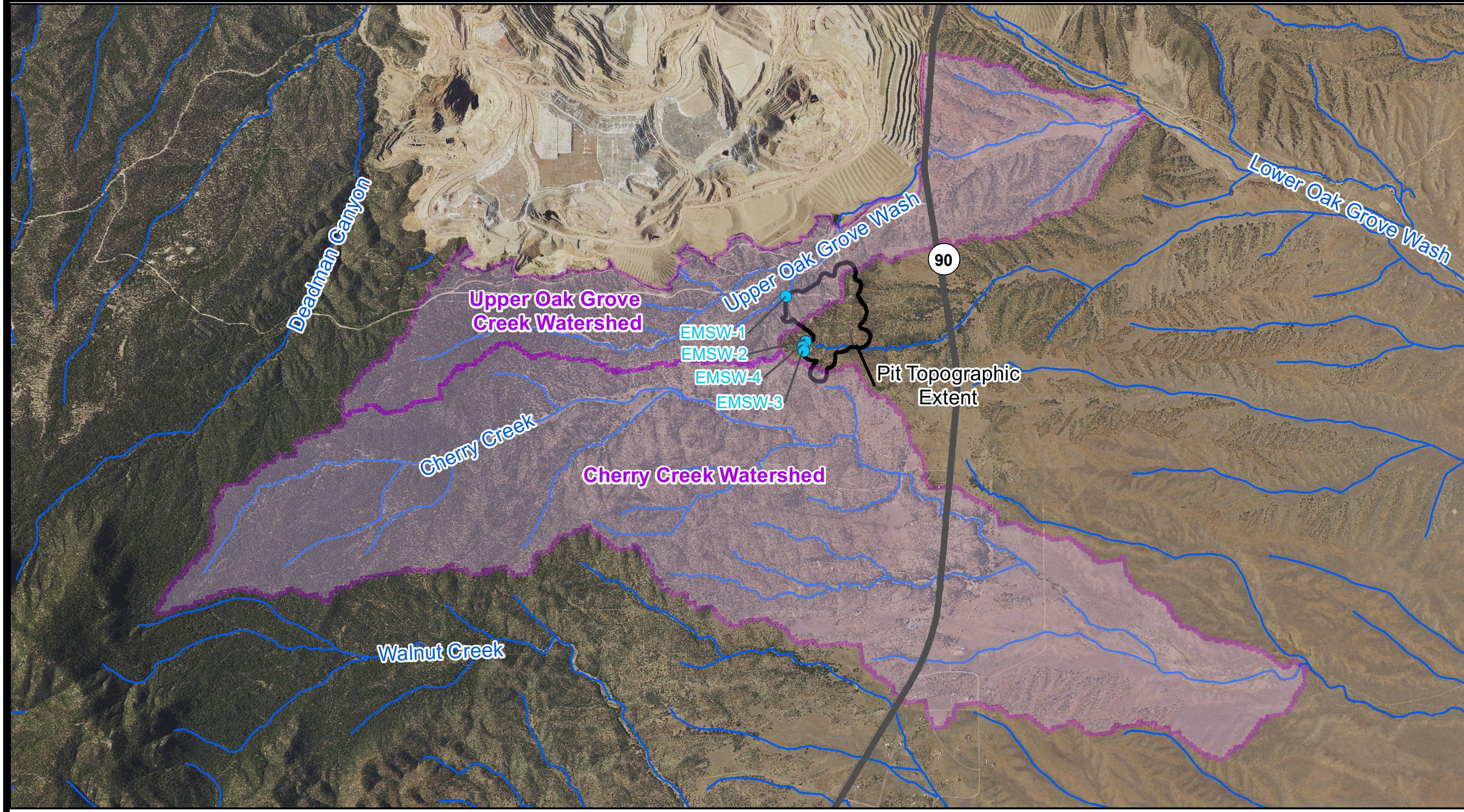
Generalized Hydrogeologic Cross Section B-B'

Figure 2-5

DBS&A
Daniel B. Stephens & Associates, Inc.
10/20/2021 DB20.1392

S:\Projects\Mine_Tyrone\Projects\DP_Support_2021\VR_Drawings\AI\Emma_Apache_Mound_Cross_Section\B-B'-Emma_Apache_Mound_Cross_Section_SW-NE\F07_Emma_Apache_Mound_Cross_Section_SW-NE_B-B'.ai

S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\EMMA CCP SUPPORT\FIGURE 2-6_EXISTING SURFACE WATER DRAINAGE.MXD



N

0 2250 4500 Feet

Explanation

- Proposed Emma pit topographic extent
- Watershed
- Ephemeral surface water drainage
- Stormwater sample location

Source: 1. Aerial image, NAIP (2020).
2. Watersheds developed from USGS StreamStats (2021).
3. Ephemeral surface water drainage file (U.S. Census Bureau, 2019)
4. Emma pit topographic extent represents the EOY 2026 pit configuration.

FREEPORT-McMoRAN

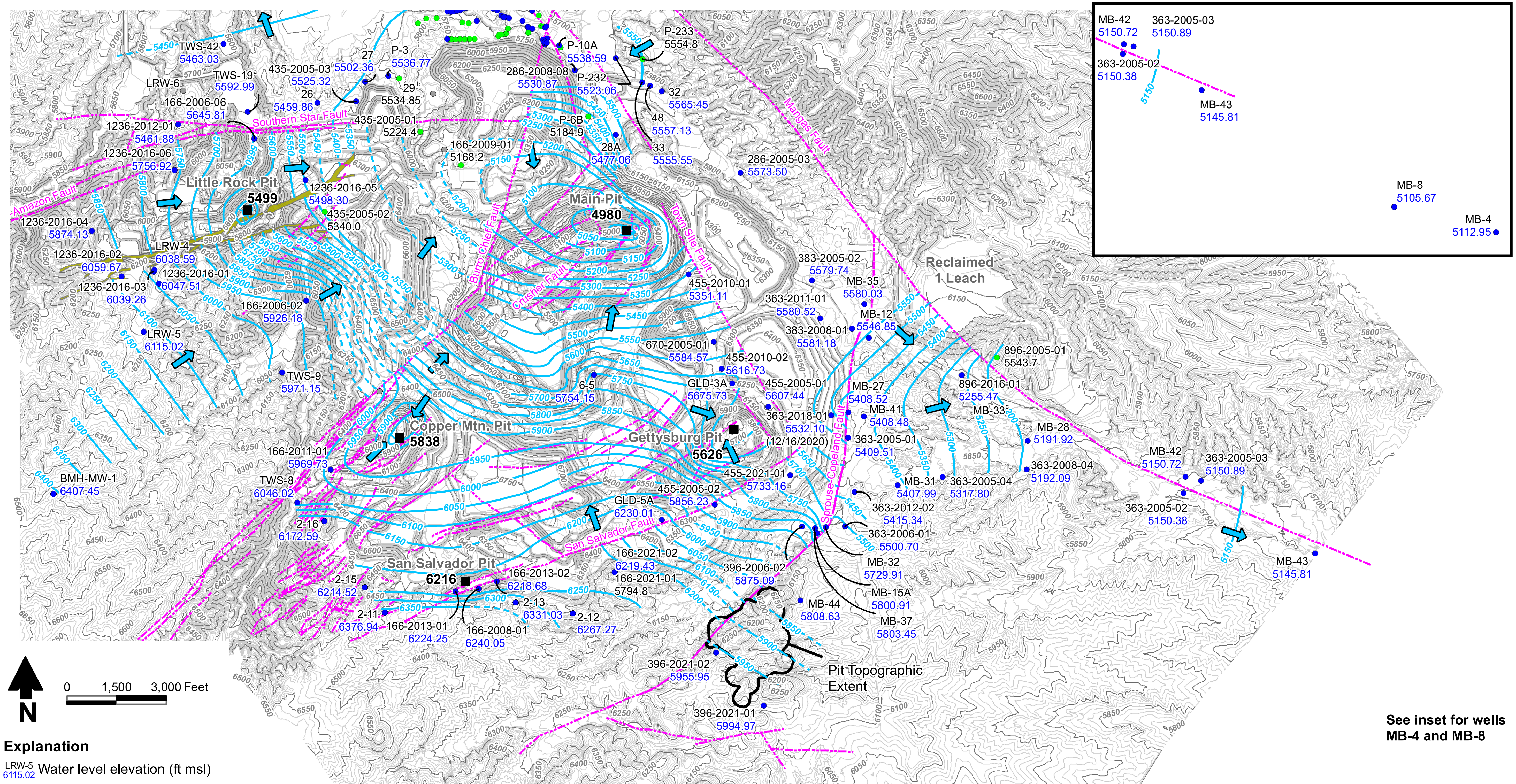
TYRONE MINE

Emma Project

Existing Surface Water Drainages

DBS&A
Daniel B. Stephens & Associates, Inc.
10/21/2021 DB20.1392

Figure 2-6



Explanation

LRW-5 6115.02 Water level elevation (ft msl)

- Regional monitor well with water level elevation (ft msl)
- Dry regional monitor well with bottom of screen elevation, total depth, or top of pump elevation (ft msl)
- Not measured
- Pit water elevation (ft msl)
- Groundwater flow direction
- Water level elevation contour (ft msl), dashed where inferred (contour interval 50-ft)
- Fault
- Dike
- Proposed Emma pit topographic extent

Topography
(10-ft contour interval, ft msl)
(50-ft contour interval, ft msl)

Notes:
1. Water level elevation data are for January 7 through June 24, 2021, unless noted otherwise.
2. [a] Well appears to be screened in a shallower water bearing zone, not used for contouring.
3. [b] Water level measurement determined to be in well sump. Well considered dry, and sump water level posted.

Source: Tyrone Mine topography, December 2020.

FREEPORT-MCMORAN

TYRONE MINE

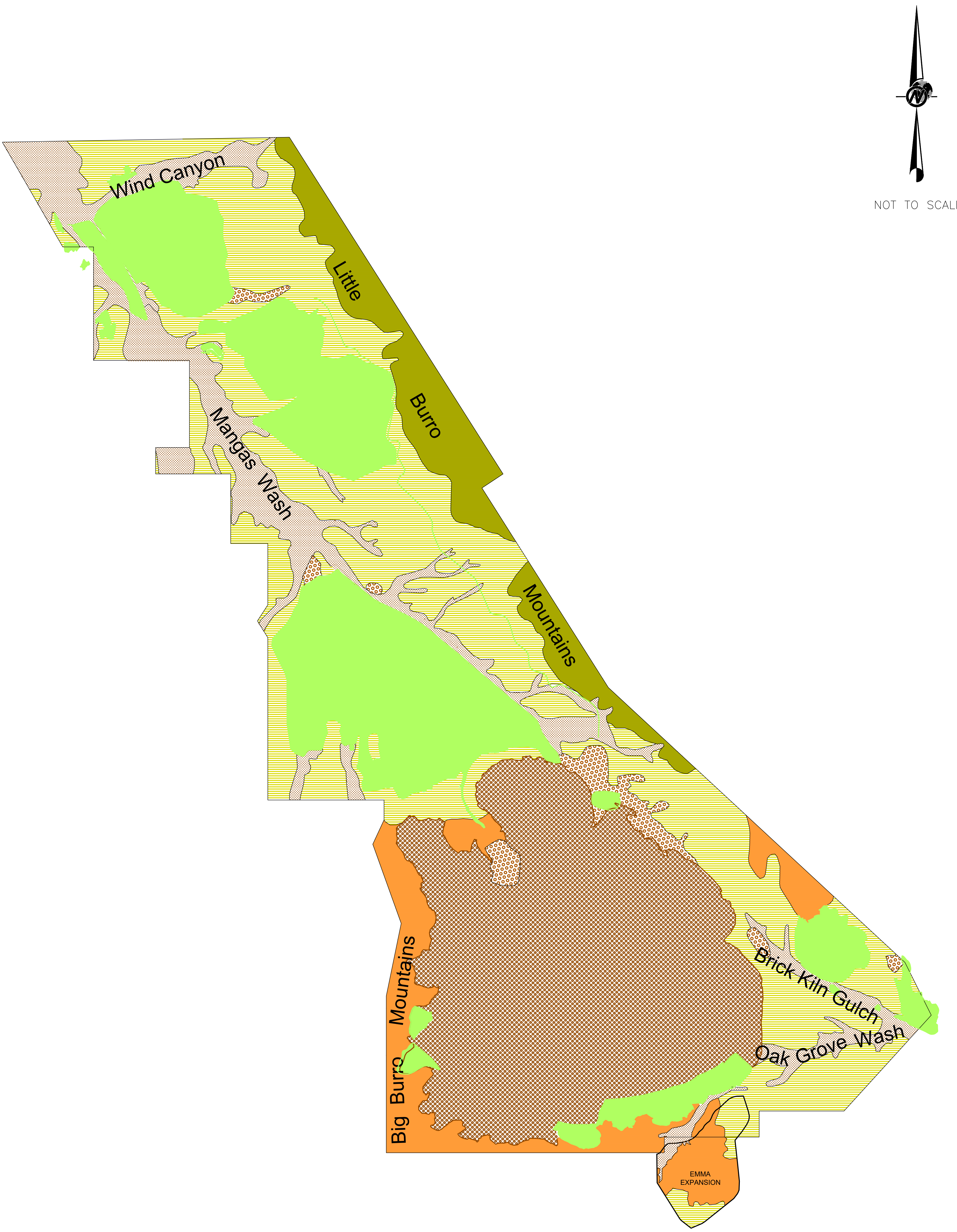
Regional Groundwater Level Elevations
First and Second Quarter 2021

DBS&A
Daniel B. Stephens & Associates, Inc.
10/21/2021 DB20.1392

S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\DP-396\RENEWAL APPLICATION\FIGURE IVE-1 - REGIONAL WLE.MXD

Figure 2-7

Drawing file: Figure 2-8.dwg Sep 21, 2021 - 4:20pm



ALLUVIAL GRASSLAND
PIEDMONT SCRUB SAVANNA
MOUNTAIN SLOPE SCRUB SAVANNA
MOUNTAIN SLOPE MIXED EVERGREEN WOODLAND
FACILITIES AND DISTURBED AREAS
MINE PITS AND STOCKPILES
RECLAIMED MINE FACILITY

FREEPORT-McMoRAN
TYRONE INC.

PROJECT
Emma Project

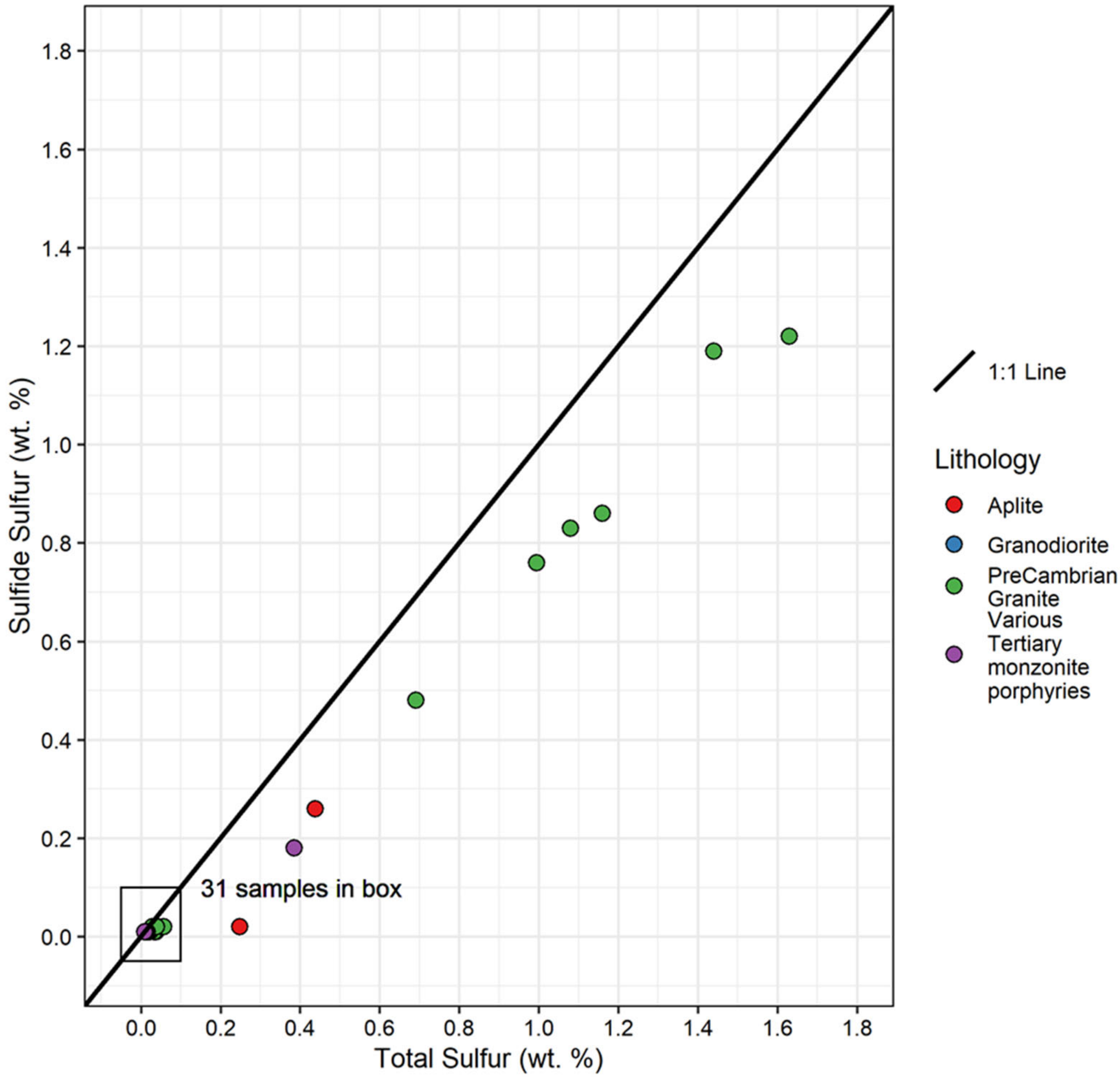
TITLE
SOIL-VEGETATION ASSOCIATIONS AND MISCELLANEOUS LAND AREAS

GOLDER
MEMBER OF WSP

PROJECT No.		21476949
DESIGN	TS	09/20/21
CADD	SIB	09/20/21
CHECK		
REVIEW		

FILE No.	Soil-Vegetoion
SCALE AS SHOWN	REV. 1

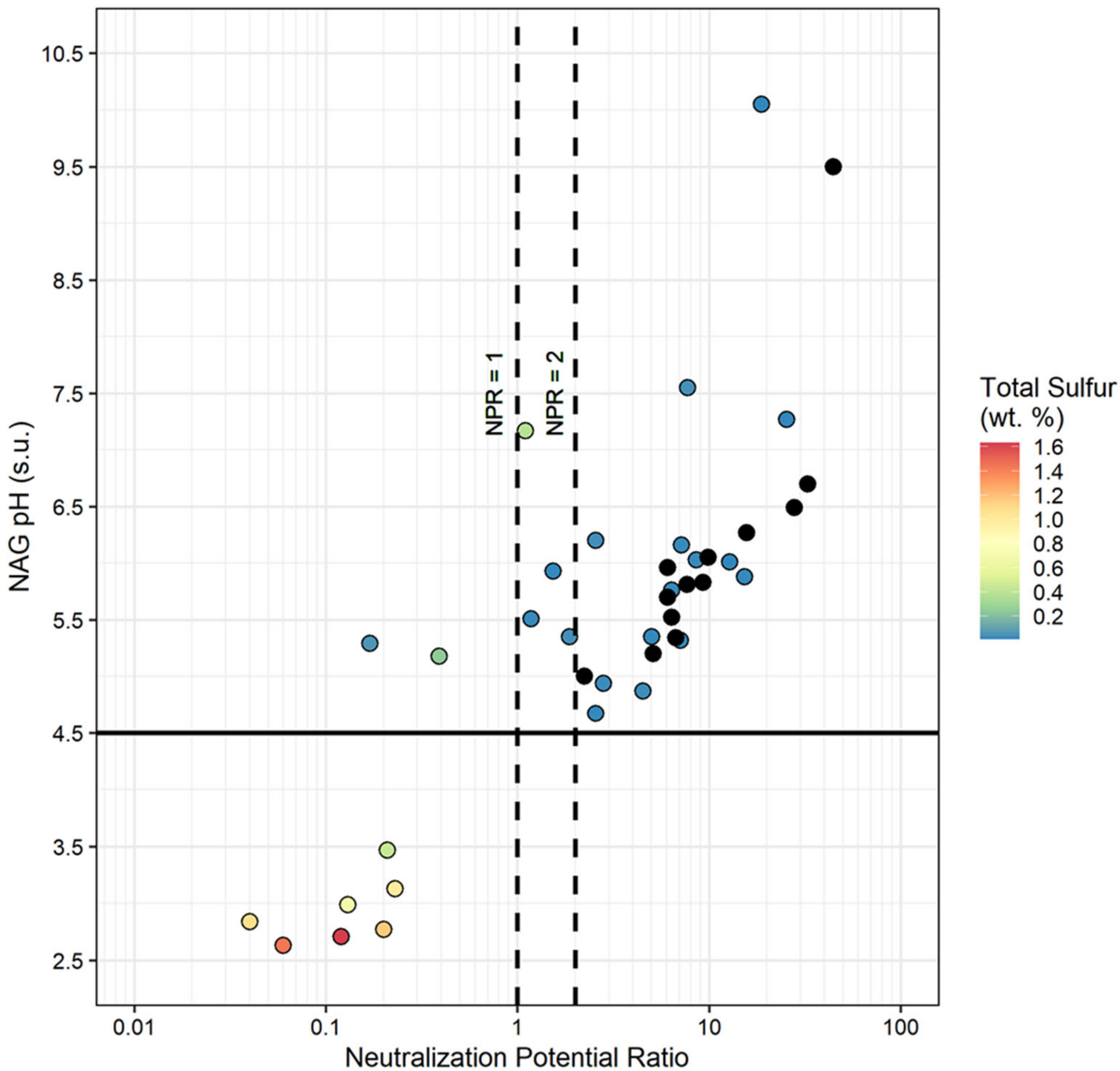
FIGURE 2-8



Reference: Figure provided by Life Cycle Geo, LLC on 09/20/2021

CLIENT FREEPORT-MCMORAN TYRONE INC.	GOLDER MEMBER OF WSP	TITLE **Sulfide Sulfur Versus Total Sulfur for Emma Waste Material**
PROJECT **Emma Project**		

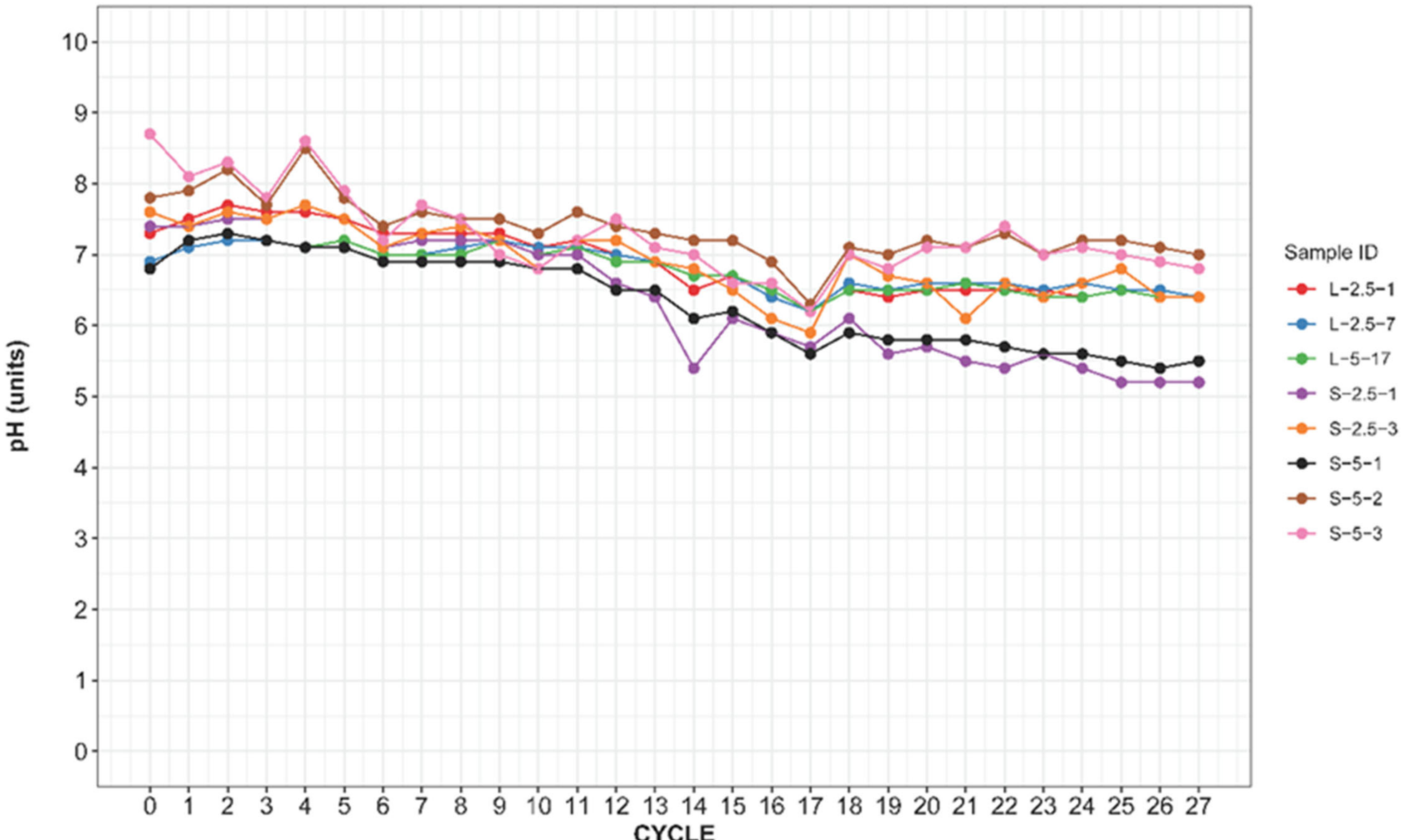
DRAWN	CHECKED	REVIEWED	DATE	REV NO.	JOB NO.	FIGURE
LCG	LCG	TS	09/20/2021	0	21476949	**2-9**



Reference: Figure provided by Life Cycle Geo, LLC on 09/20/2021

CLIENT		TITLE
FREEPORT-McMoRAN TYRONE INC.	GOLDER MEMBER OF WSP	**Neutralization Potential Ratio Versus Net Acid Generation pH for Emma Materials**
PROJECT **Emma Project**		

DRAWN	CHECKED	REVIEWED	DATE	REV NO..	JOB NO.	FIGURE
LCG	LCG	TS	09/20/2021	0	21476949	**2-10**

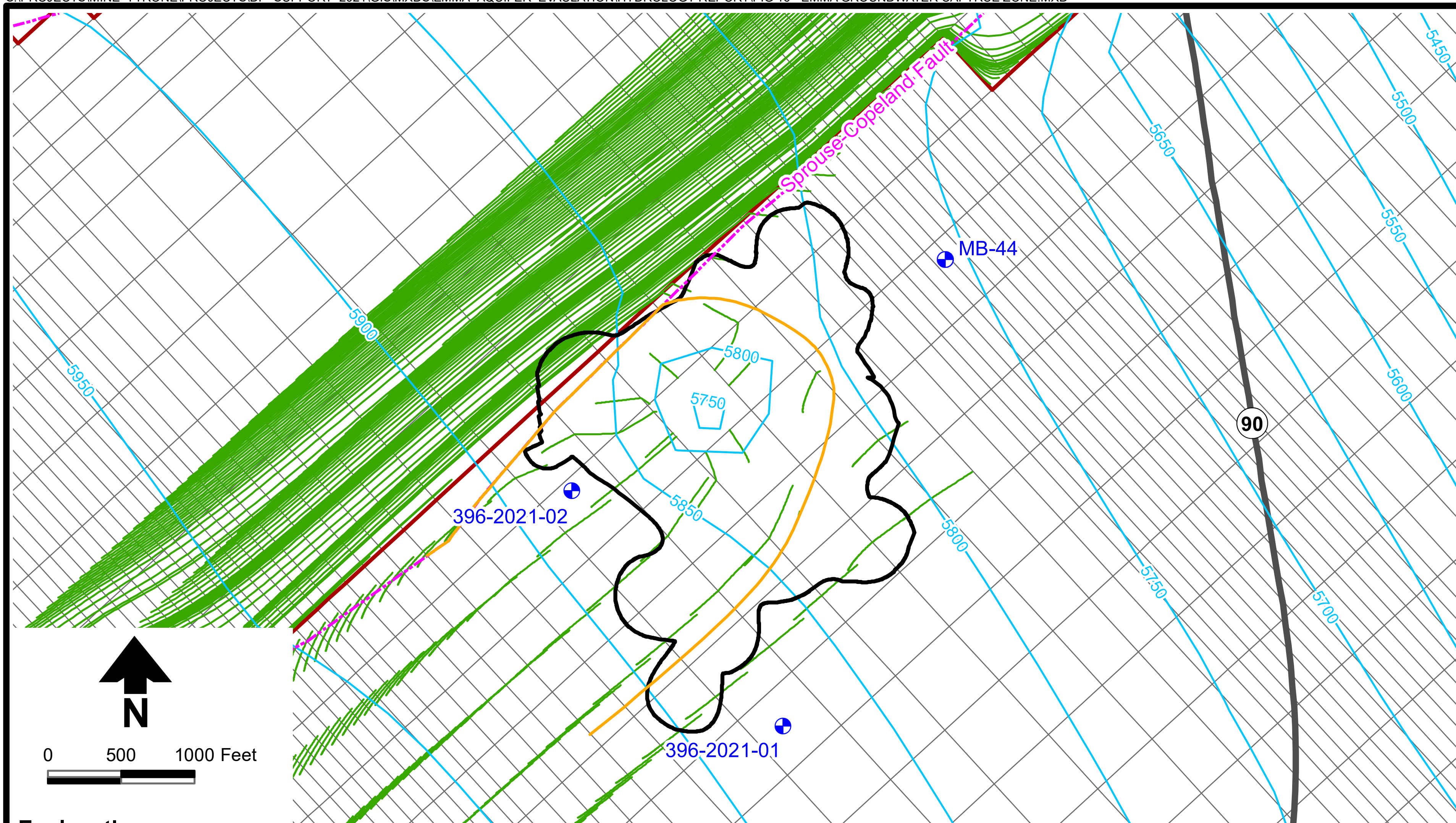


Reference: Figure provided by Life Cycle Geo, LLC on 09/20/2021

GOLDER MEMBER OF WSP	CLIENT FREEPORT-MCMORAN TYRONE INC.	PROJECT **Emma Project**	TITLE **Humidity Cell Test Results for Emma Materials**

DRAWN	CHECKED	REVIEWED	DATE	SCALE	JOB NO.	DWG NO.	SUBTITLE	REV. NO.	FIGURE
LCG	LCG	TS	09/20/2021	NA	21476949	NA	NA	0	**2-11**

S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\EMMA_AQUIFER_EVAULATION\HYDROLOGY REPORT\FIG 16 - EMMA GROUNDWATER CAPTRUE ZONE.MXD



Explanation

- Monitoring location
- Fault
- Proposed Emma pit topographic extent
- MODFLOW model grid
- Simulated horizontal flow barrier
- Simulated groundwater elevation contour (100-years post closure, 50-ft contour interval, ft msl)
- Simulated particle trace
- Predicted groundwater capture zone

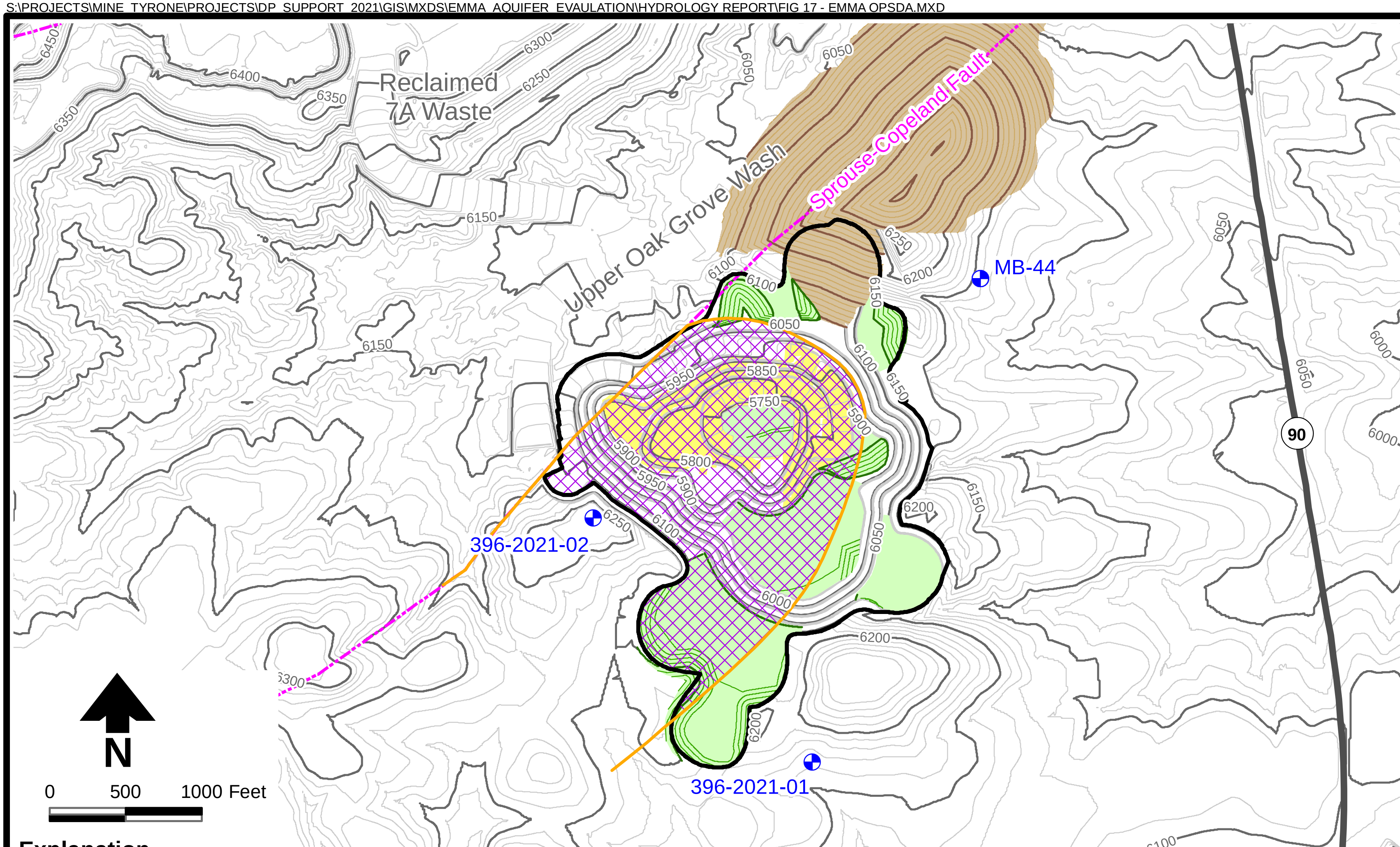
Source: Emma pit topographic extent represents the EOY 2026 pit configuration.

FREEPORT-MCMORAN
TYRONE MINE
Emma Pit Predicted Groundwater Capture Zone

DBS&A
Daniel B. Stephens & Associates, Inc.
10/20/2021 DB20.1392

Figure 3-1

S:\PROJECTS\MINE_TYRONE\PROJECTS\DP_SUPPORT_2021\GIS\MXDS\EMMA_AQUIFER_EVAULATION\HYDROLOGY REPORT\FIG 17 - EMMA OPSDA.MXD



Source: Topography represents the EOY 2026 pit configuration.

Explanation

- Monitoring location
- Fault
- Proposed Emma pit topographic extent
- Proposed backfill area
- EMW stockpile
- Predicted groundwater capture zone
- Predicted open pit surface drainage area
- Potentially acid-generating rocks
- Topography
  (10-ft contour interval, ft msl)
  6450 (50-ft contour interval, ft msl)

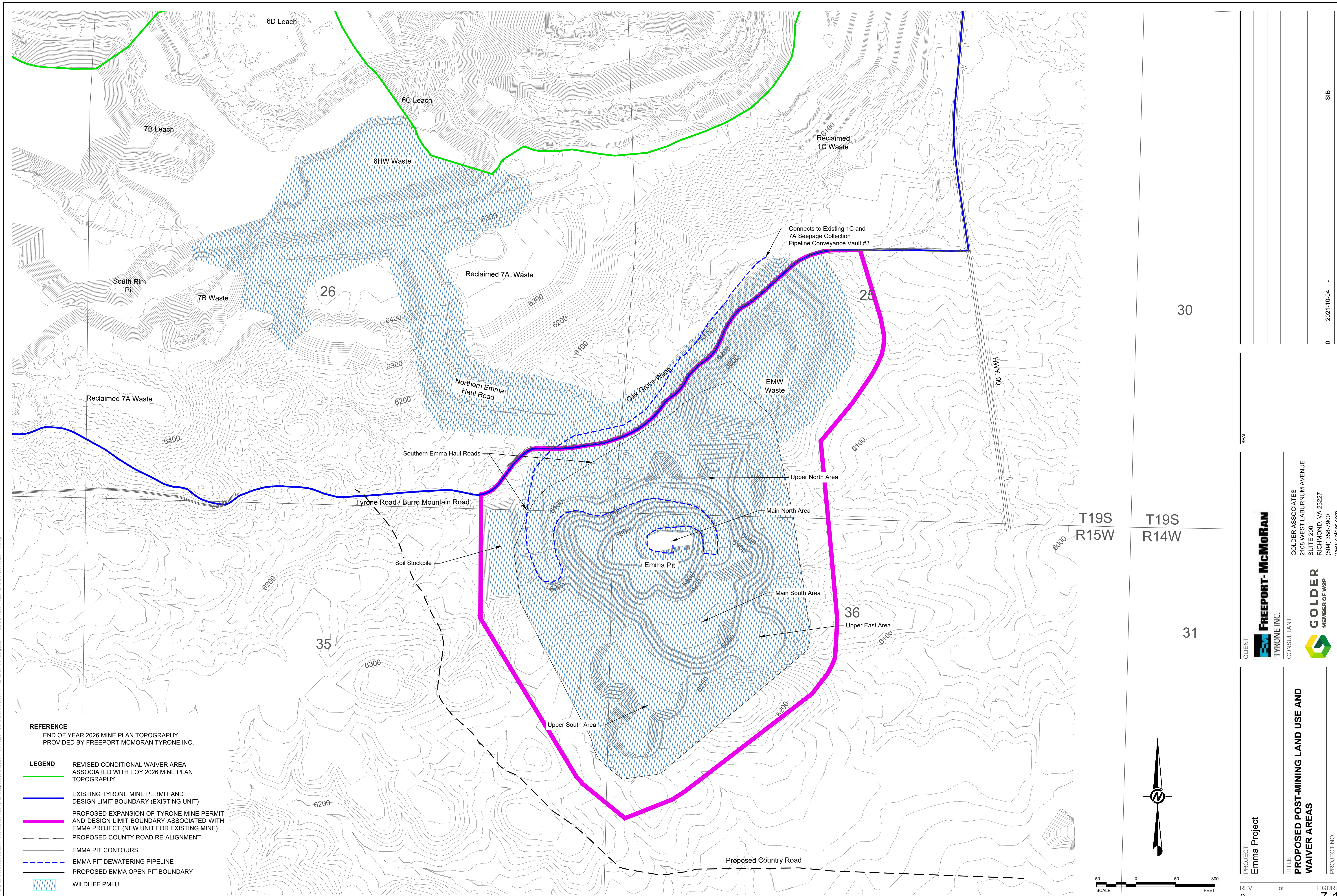
FREEPORT-McMoRAN

TYRONE MINE

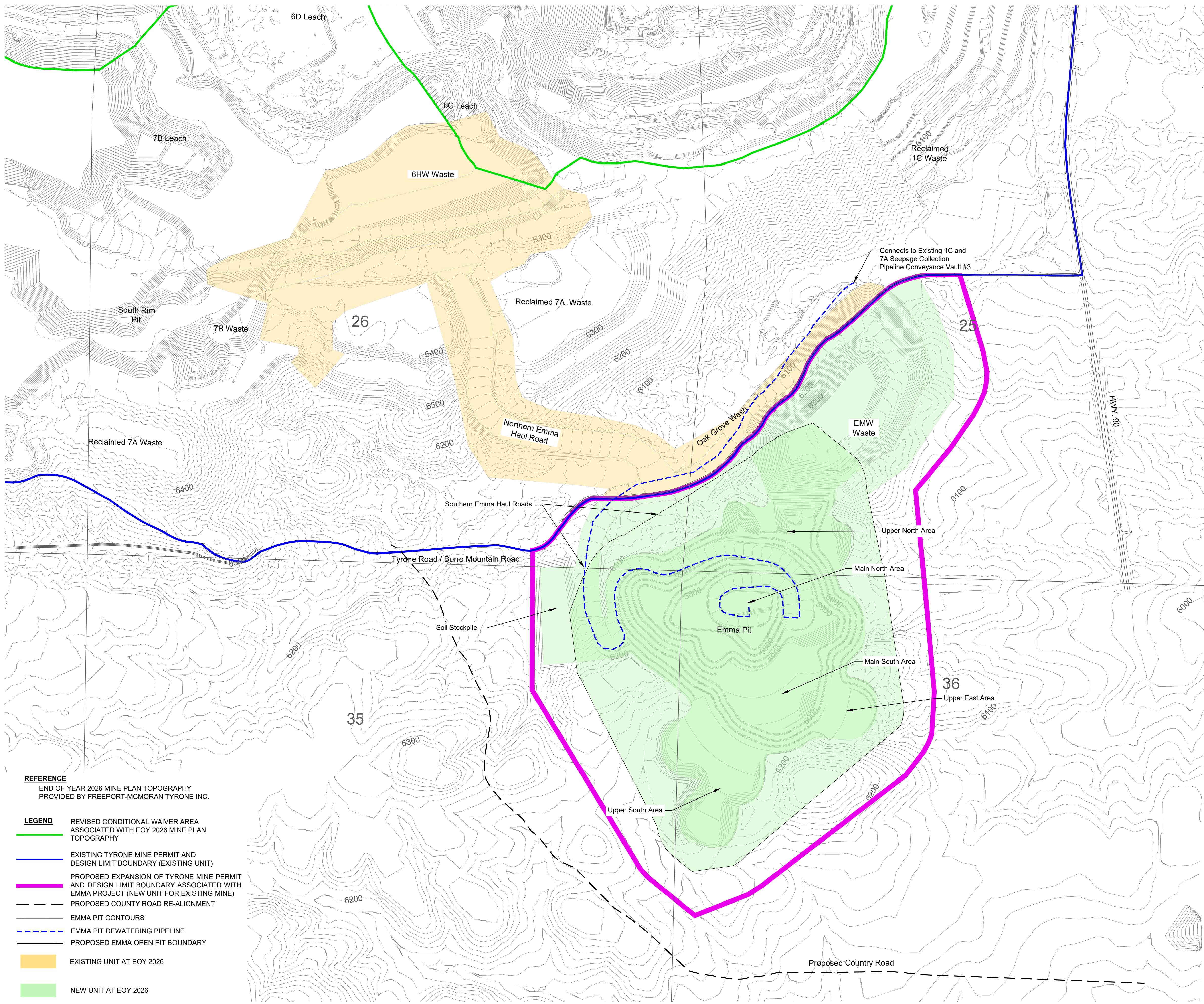
Emma Predicted Open Pit Surface Drainage Area

DBS&A
Daniel B. Stephens & Associates, Inc.
10/20/2021 DB20.1392

Figure 3-2



6D Leach
6C Leach
7B Leach
6HW Waste
Reclaimed 1C Waste
Connects to Existing 1C and 7A Seepage Collection Pipeline Conveyance Vault #3
South Rim Pit
7B Waste
26
Reclaimed 7A Waste
25
30
HWY. 90
Northern Emma Haul Road
Oak Grove Wash
EMW Waste
Reclaimed 7A Waste
Southern Emma Haul Roads
Upper North Area
Tyrone Road / Burro Mountain Road
Main North Area
T19S R15W
T19S R14W
Soil Stockpile
Emma Pit
Main South Area
36
Upper East Area
31
35
Upper South Area
Proposed Country Road
REFERENCE
END OF YEAR 2026 MINE PLAN TOPOGRAPHY PROVIDED BY FREEPORT-MCMORAN TYRONE INC.
LEGEND
REVISED CONDITIONAL WAIVER AREA ASSOCIATED WITH EOY 2026 MINE PLAN TOPOGRAPHY
EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)
PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
PROPOSED COUNTY ROAD RE-ALIGNMENT
EMMA PIT CONTOURS
EMMA PIT DEWATERING PIPELINE
PROPOSED EMMA OPEN PIT BOUNDARY
WILDLIFE PMLU
150 0 150 300
SCALE FEET
0 2021-10-04 - SIB
REV. MM/DD/YY DESCRIPTION DESIGN CADD CHECK REVIEW
SEAL
CLIENT
FREEPORT-McMoRan
TYRONE INC.
CONSULTANT
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com
GOLDER MEMBER OF WSP
PROJECT
Emma Project
TITLE
PROPOSED POST-MINING LAND USE AND WAIVER AREAS
PROJECT NO.
21-476949
REV.
0
FIGURE
7-1



REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
0	2021-10-04	-	SIB			

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
Emma Project

TITLE
DISTURBANCE AREAS AT THE EOY 2026

PROJECT NO. 21-476949
REV. 0
FIGURE 7-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

Path: G:\Plan Production Data Files\Albuquerque_CAD Support\CAD\2021 Projects\21476949 EMMA Closure Plan and Permitting 2021\PRODUCTION_A EMMA DESIGN\Figure 7-2.dwg

APPENDIX A

Reclamation Design Drawings

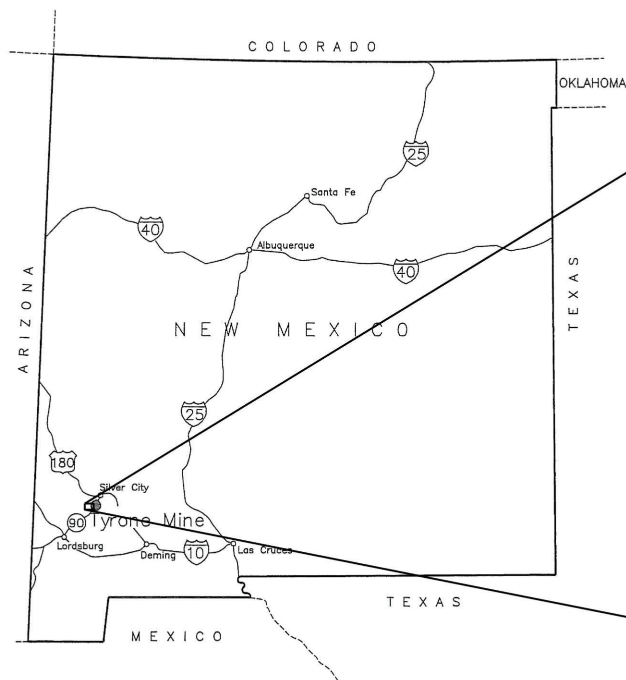
APPENDIX A-1

Emma Project Conceptual Closure Plan

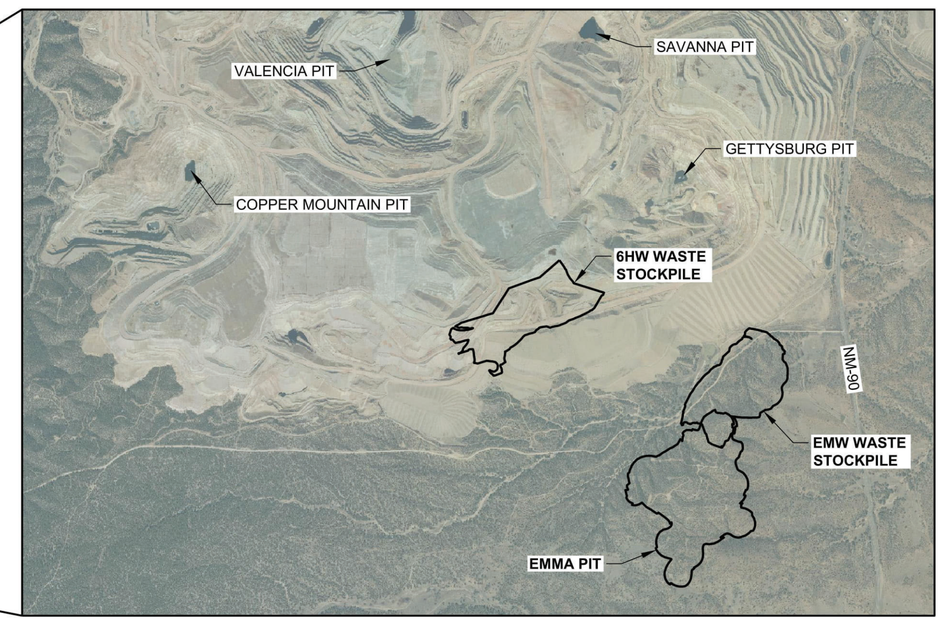
FREEPORT-McMoRAN

TYRONE INC.

EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
2021-11-11



STATE OF ARIZONA
NOT TO SCALE



PROJECT LOCATION MAP
NOT TO SCALE

LIST OF DRAWINGS

REFERENCES(S)

1. THE EXISTING GROUND, DESIGN FOR EMMA PIT, EMW STOCKPILE AND 6HW STOCKPILE WERE PROVIDED BY FREEPORT-McMoRAN TYRONE INC.
2. THE COORDINATE SYSTEM SHOWN IS THE TYRONE LOCAL MINE COORDINATE SYSTEM.
3. IMAGE: © 2021 MICROSOFT CORPORATION © 2021 MAXAR © CNES (2021) DISTRIBUTION AIRBUS DS bing.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

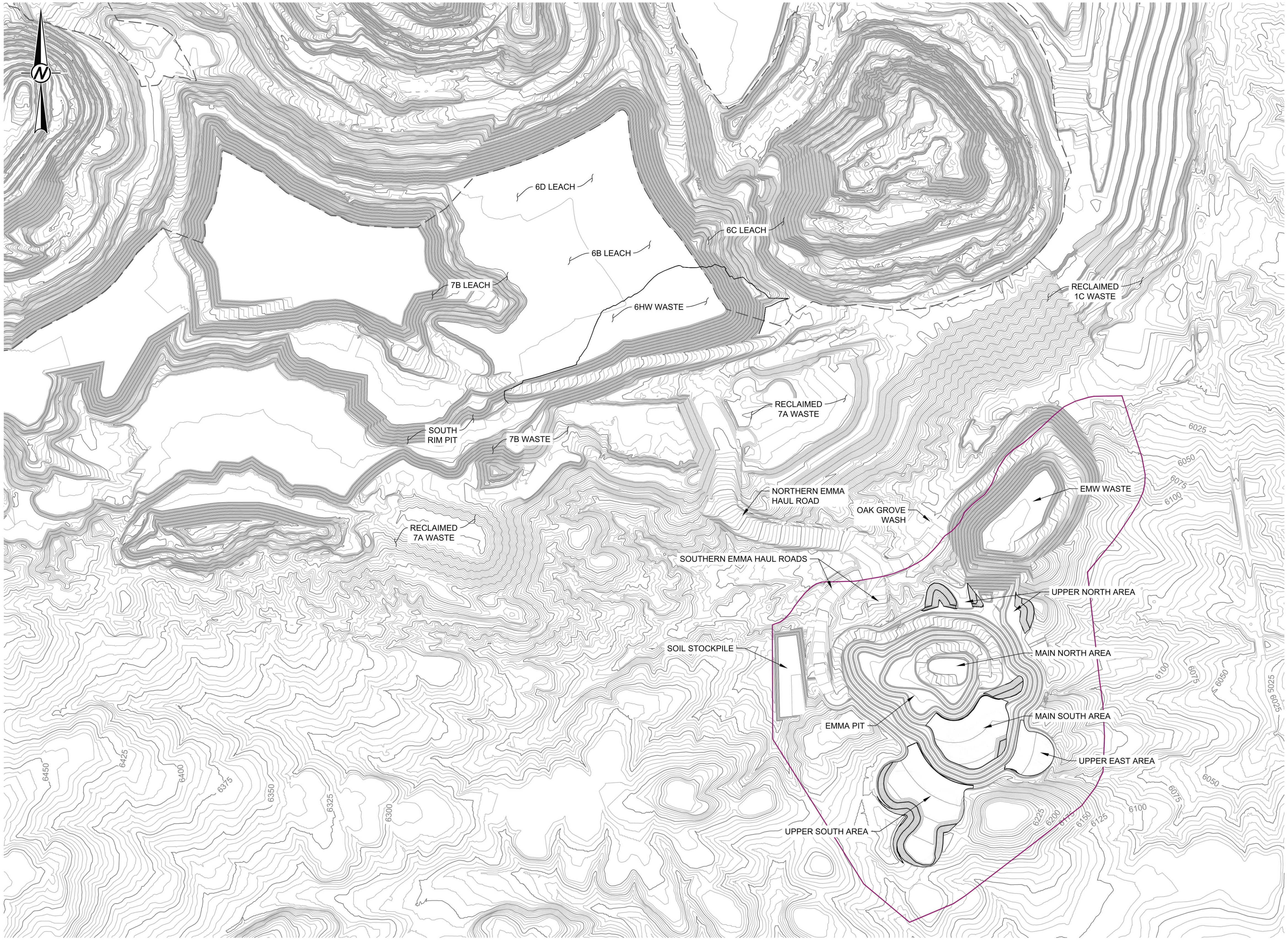
CONSULTANT
GOLDER
MEMBER OF WSP

TUCSON OFFICE
7458 N. LA CHOLLA BLVD.
TUCSON, ARIZONA
UNITED STATES OF AMERICA
[+1] (520) 888 8818
www.golder.com

PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
TITLE SHEET

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	1 of 11	001



GENERAL LEGEND

3600	EXISTING GROUND CONTOUR
	DESIGN CONTOURS
	PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
	REVISED CONDITIONAL WAIVER AREA (BASED ON 2026 MINE CONFIGURATION

REFERENCE(S)

1. THE EXISTING GROUND SURFACE WAS DEVELOPED BY GOLDER ASSOCIATES FROM 3D FACES PROVIDED BY THE MINE IN THE FILE: "Emma_Topo.dxf" (July 2021).

0 600 1200
1" = 600' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

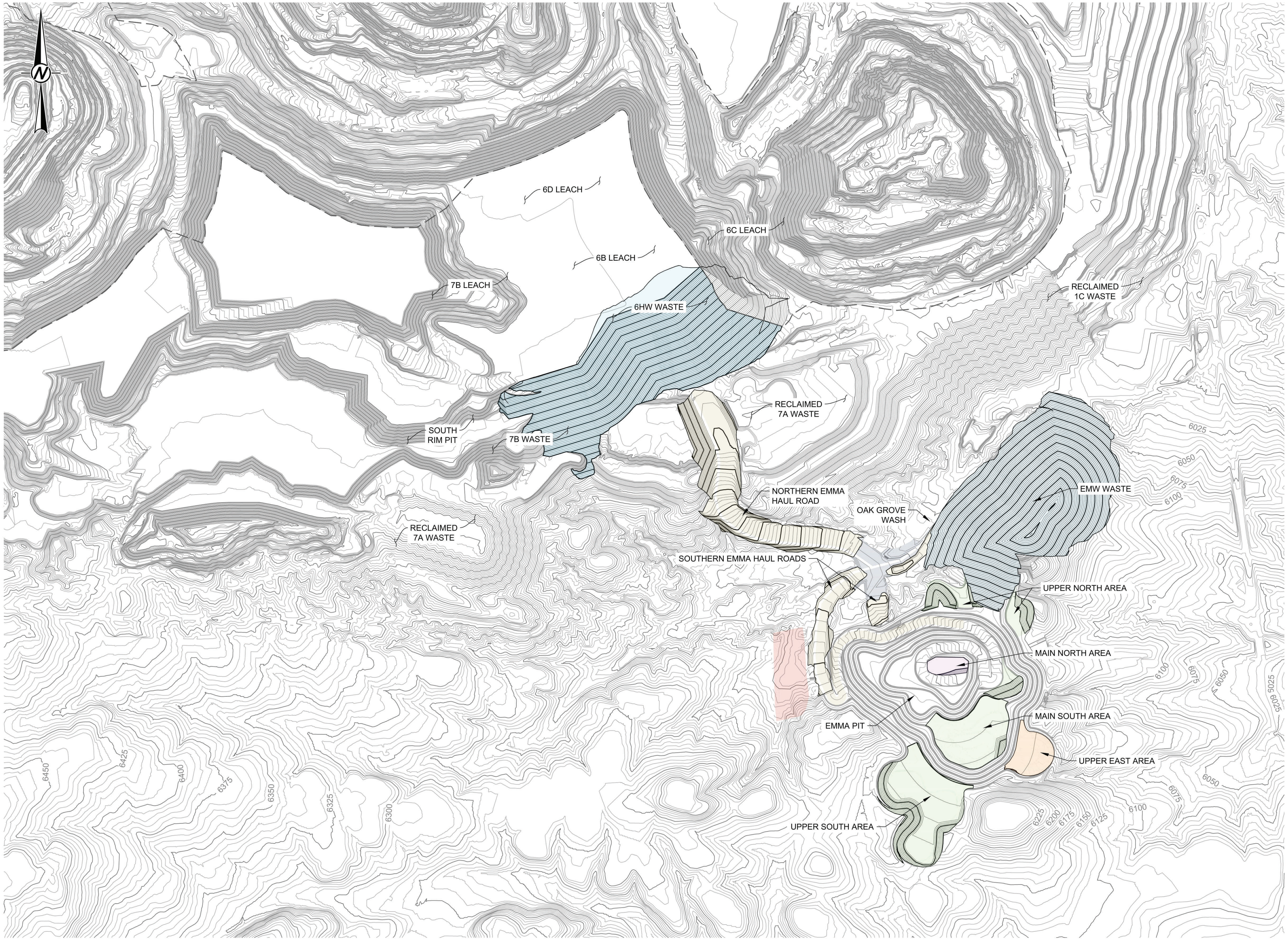
CONSULTANT
GOLDER
MEMBER OF WSP

TUCSON OFFICE
7458 N. LA CHOLLA BLVD.
TUCSON, ARIZONA
UNITED STATES OF AMERICA
[+1] (520) 888 8818
www.golder.com

PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
GENERAL ARRANGEMENT AT THE END OF YEAR 2026

PROJECT NO.	CONTROL	REV.	2 of 11	DRAWING
21476949	0400	D		002



GENERAL LEGEND

3600 EXISTING GROUND CONTOUR

DESIGN CONTOURS

PIT WAIVER BOUNDARY

AREA OF PIT TO BE BACKFILLED AND RECEIVE 1 FT OF SALVAGED SOIL DURING OPERATIONS

AREA OF PIT TO BE BACKFILLED DURING OPERATIONS AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE

AREA OF PIT TO BE BACKFILLED DURING CLOSURE

AREA OF STOCKPILES TO BE REGRADED AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE

AREA TO BE REVEGETATED

AREA OF HAUL ROAD TO BE RIPPED AND REVEGETATED DURING CLOSURE

AREA TO BE REVEGETATED DURING CLOSURE

REFERENCE(S)

1. THE EXISTING GROUND SURFACE WAS DEVELOPED BY GOLDER ASSOCIATES FROM 3D FACES PROVIDED BY THE MINE IN THE FILE: "Emma_Topo.dxf" (July 2021).

0 600 1200
1" = 600' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

CONSULTANT
GOLDER MEMBER OF WSP

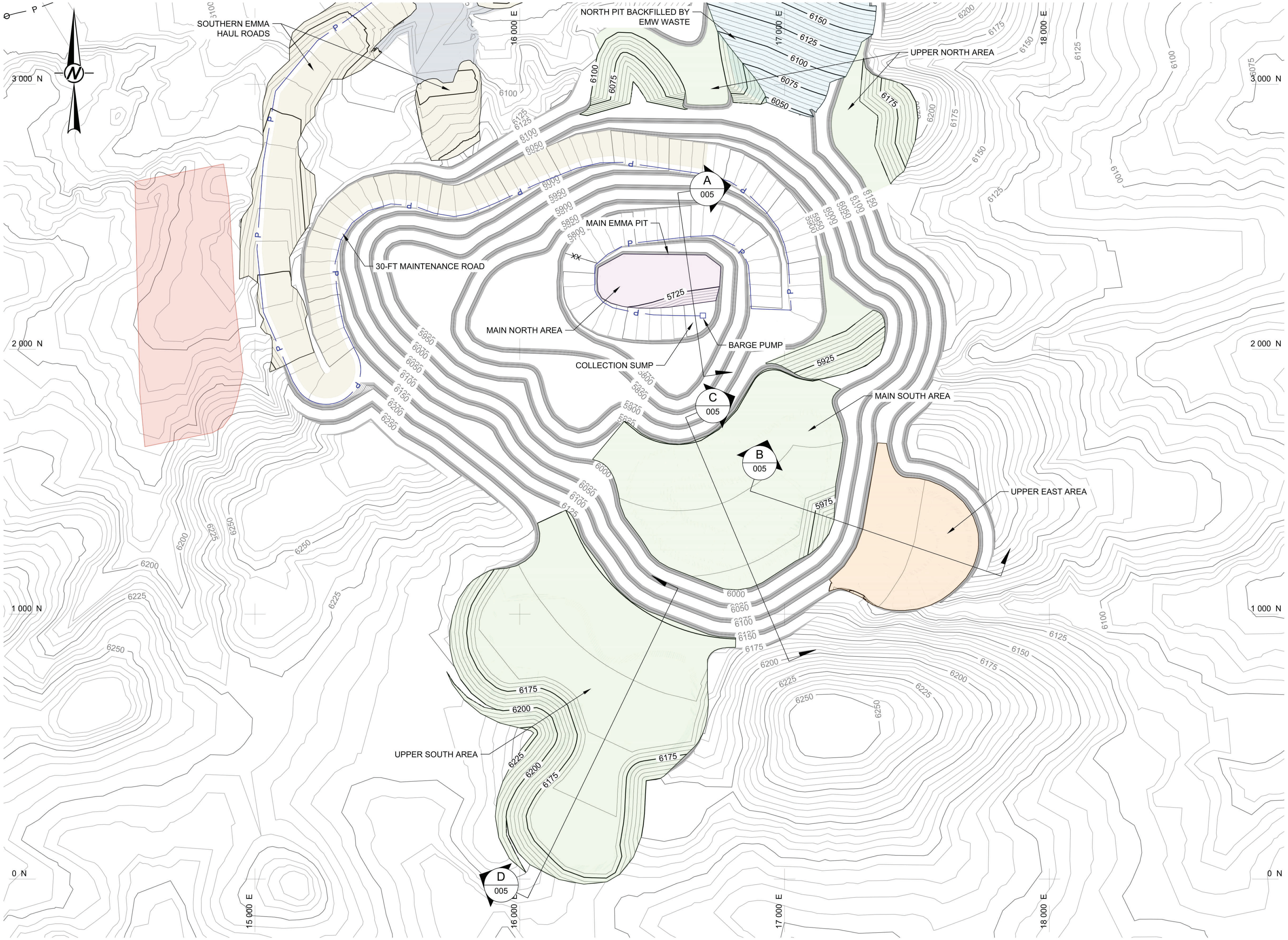
TUCSON OFFICE
7458 N. LA CHOLLA BLVD.
TUCSON, ARIZONA
UNITED STATES OF AMERICA
[+1] (520) 888 8818
www.golder.com

PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
GENERAL ARRANGEMENT POST-CLOSURE

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	3 of 11	003

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



GENERAL LEGEND

- 3600 — EMMA PIT DESIGN CONTOURS
- 3600 — DESIGN CONTOURS
- P — COLLECTION PIPE TO COLLECTION VAULT #3
- XX — FENCE
- AREA OF PIT TO BE BACKFILLED AND RECEIVE 1 FT OF SALVAGED SOIL DURING OPERATIONS
- AREA OF PIT TO BE BACKFILLED DURING OPERATIONS AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
- AREA OF PIT TO BE BACKFILLED DURING CLOSURE
- AREA OF STOCKPILES TO BE REGRADED AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
- AREA TO BE REVEGETATED
- AREA OF HAUL ROAD TO BE RIPPED AND REVEGETATED DURING CLOSURE
- AREA TO BE REVEGETATED DURING CLOSURE

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

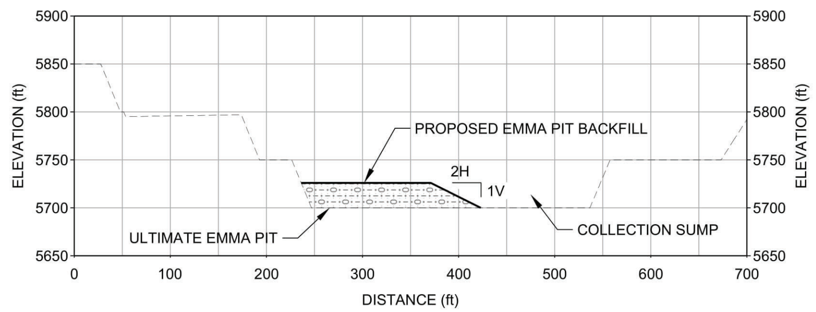
CONSULTANT
GOLDER
MEMBER OF WSP

TUCSON OFFICE
7458 N. LA CHOLLA BLVD.
TUCSON, ARIZONA
UNITED STATES OF AMERICA
[+1] (520) 888 8818
www.golder.com

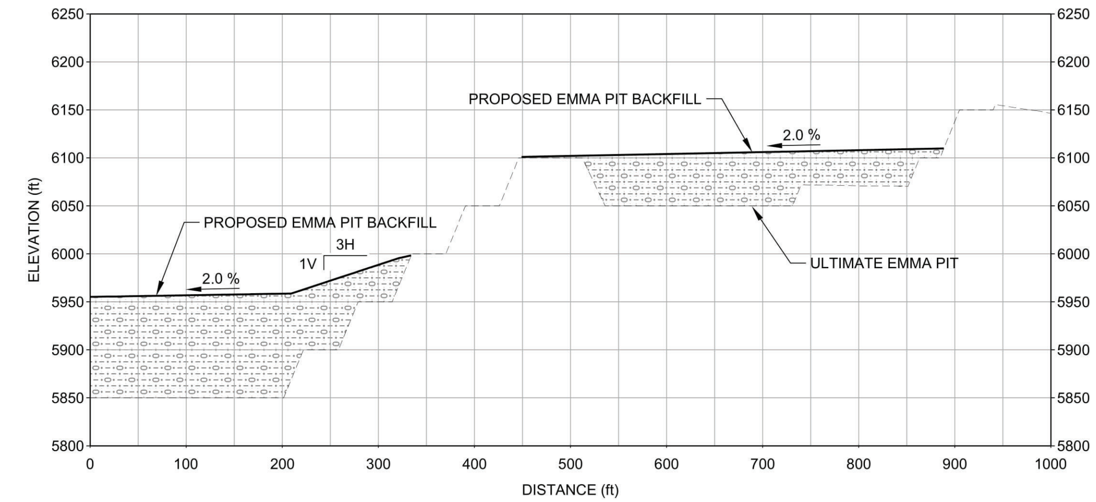
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
EMMA PIT BACKFILL CLOSURE PLAN

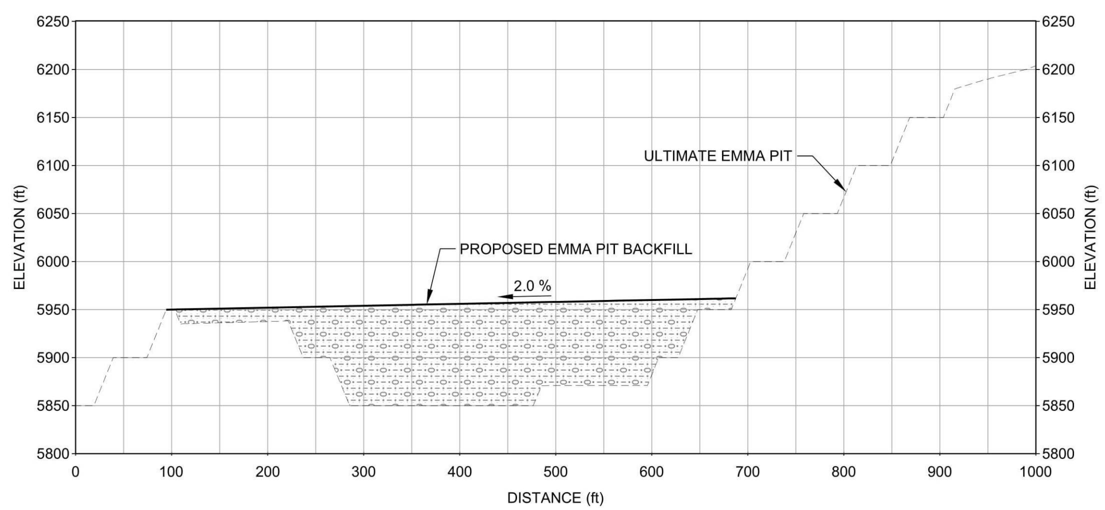
PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	4 of 11	004



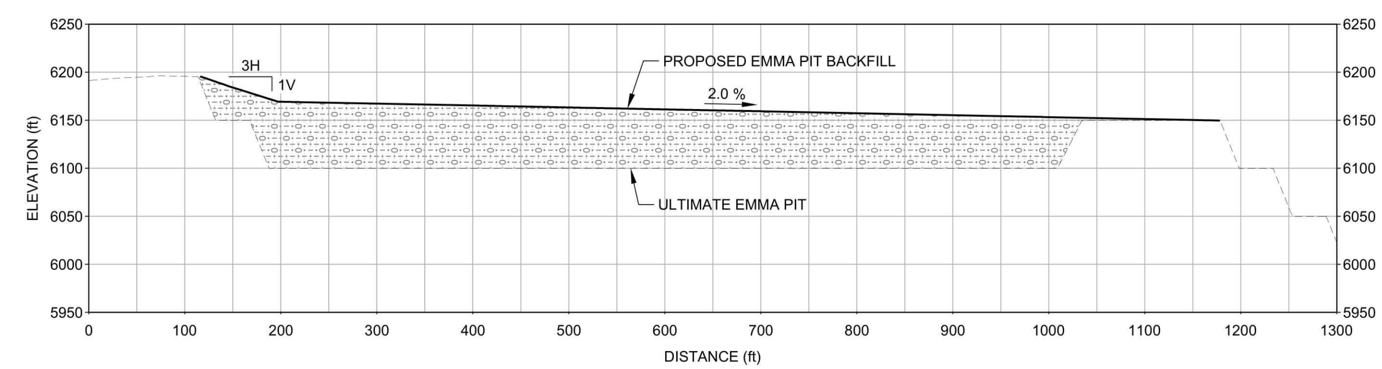
SCALE 1" = 100' A 005 CROSS-SECTION A



SCALE 1" = 100' B 005 CROSS-SECTION B



SCALE 1:100 C 005 CROSS-SECTION C



SCALE 1" = 100' D 005 CROSS-SECTION D

0 100 200
1" = 100' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
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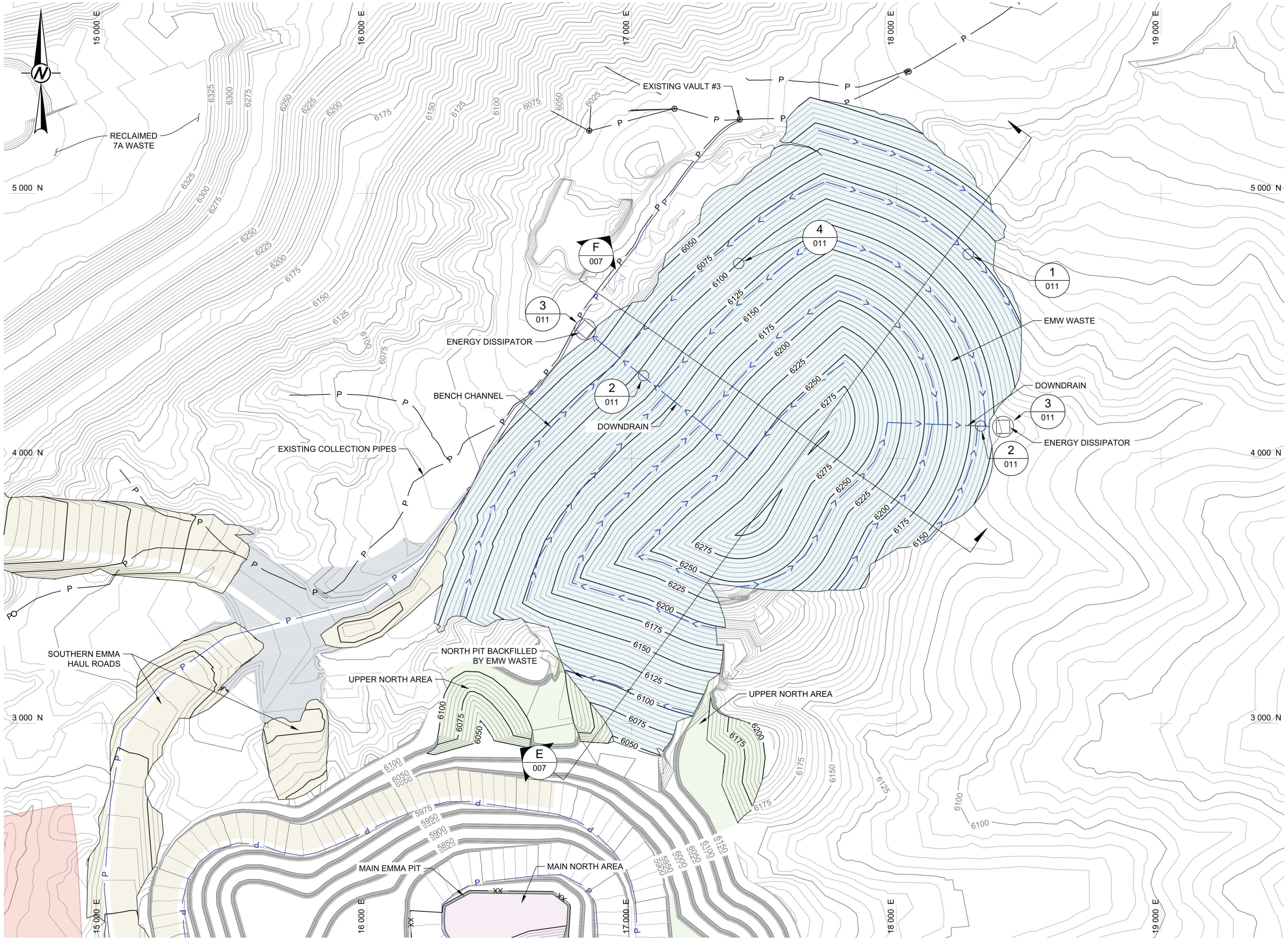
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
EMMA PIT BACKFILL CLOSURE PLAN CROSS-SECTIONS

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	5 of 11	005

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\tucson\cadd\FMI\Tyrone\99_projects\21476949 emma pit project\0400_ClosureAlt\02_PRODUCTION\DWG\ | File Name: 21476949_0400_DWG_005.dwg | Last Edited By: jlsanchez Date: 2021-11-09 Time:3:52:51 PM | Printed By: JLSanchez Date: 2021-11-12 Time:1:07:14 PM



GENERAL LEGEND

3600	EMMA PIT DESIGN CONTOURS
3600	DESIGN CONTOURS
>	STORM WATER CHANNEL
P	EXISTING COLLECTION PIPES
P	COLLECTION PIPE TO COLLECTION VAULT #3
XX	FENCE
	AREA OF PIT TO BE BACKFILLED DURING OPERATIONS AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
	AREA OF PIT TO BE BACKFILLED DURING CLOSURE
	AREA OF STOCKPILES TO BE REGRADED AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
	AREA TO BE REVEGETATED
	AREA OF HAUL ROAD TO BE RIPPED AND REVEGETATED DURING CLOSURE
	AREA TO BE REVEGETATED DURING CLOSURE

0 200 400
1" = 200' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

SEAL

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

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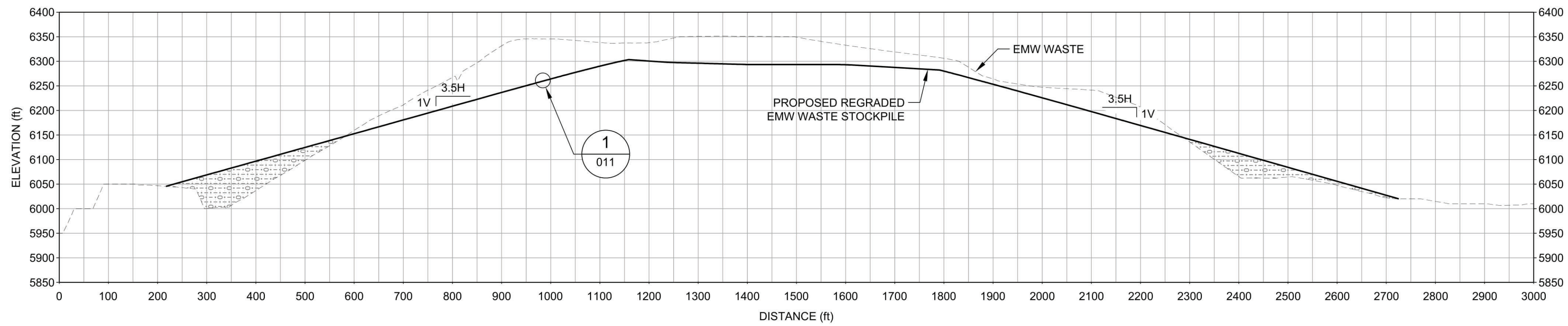
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

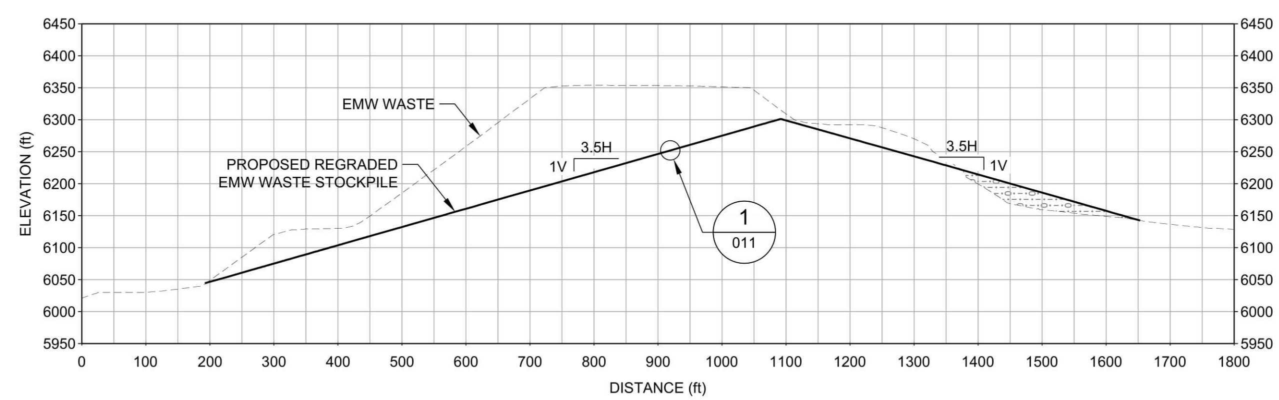
TITLE
EMW WASTE STOCKPILE CLOSURE PLAN

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	6 of 11	006

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE 1" = 150' E 007 CROSS-SECTION E



SCALE 1" = 150' F 007 CROSS-SECTION F

0 150 300
1" = 150' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

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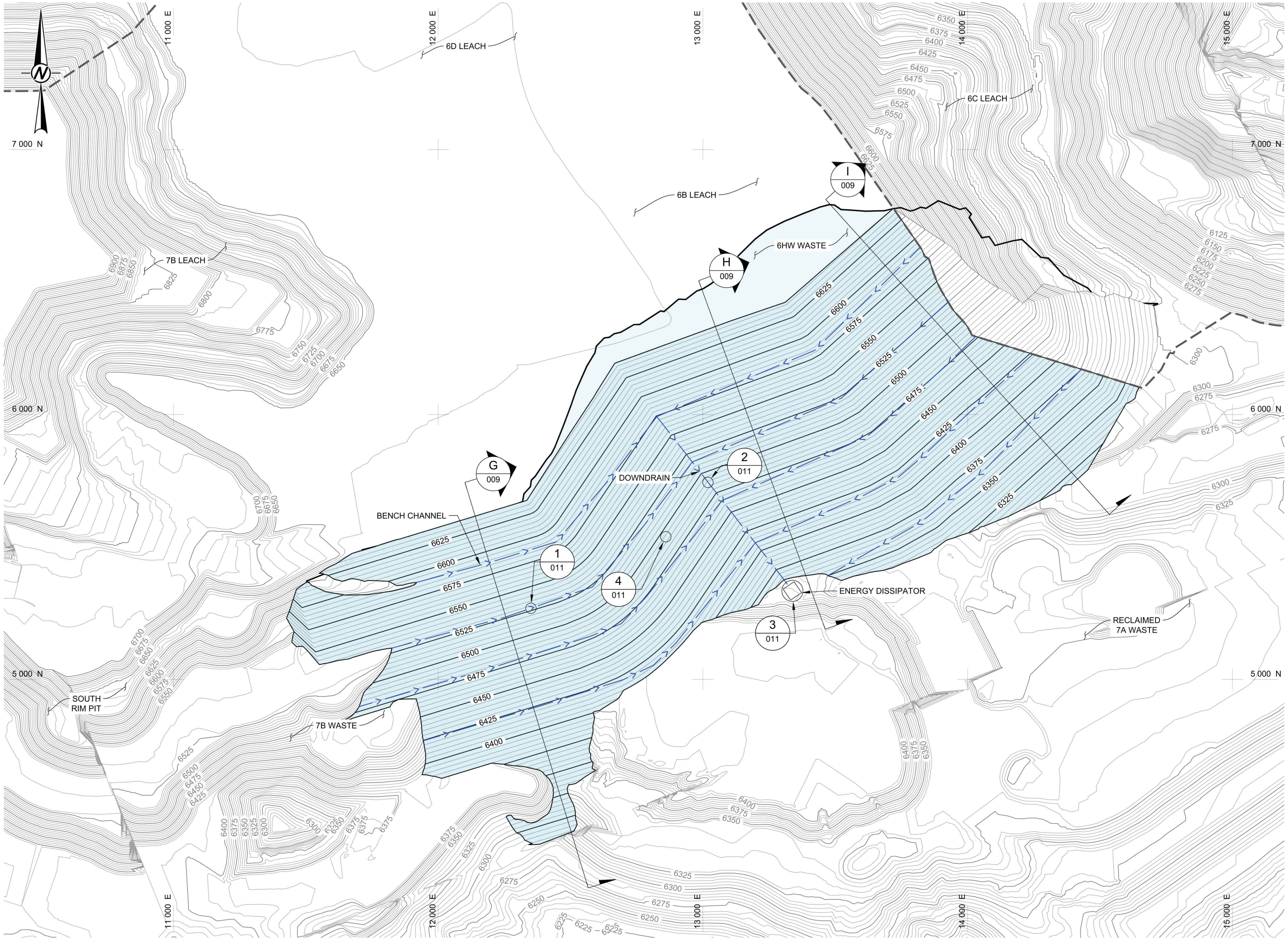
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
EMW WASTE STOCKPILE CLOSURE PLAN CROSS-SECTIONS

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	7 of 11	007



GENERAL LEGEND

- 3600 — EMMA PIT DESIGN CONTOURS
- 3600 — DESIGN CONTOURS
- PIT WAIVER BOUNDARY
- STORM WATER CHANNEL
- AREA OF STOCKPILES TO BE REGRADED AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

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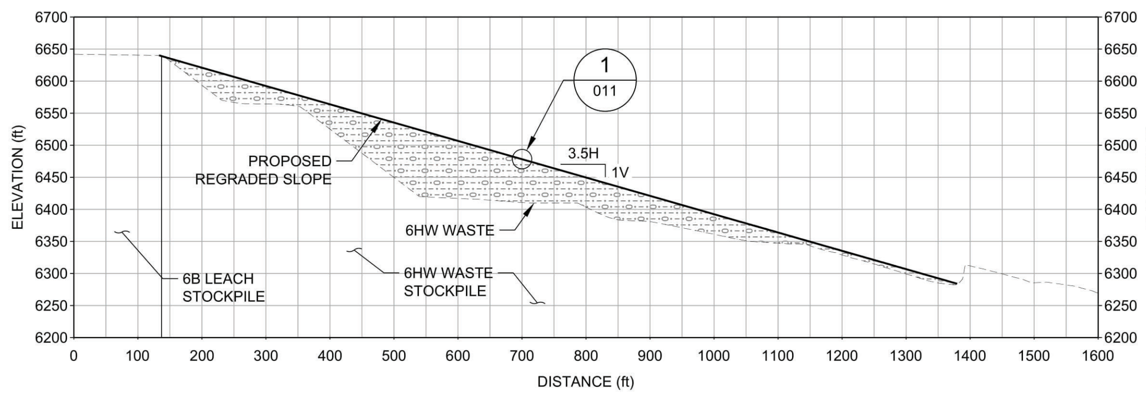
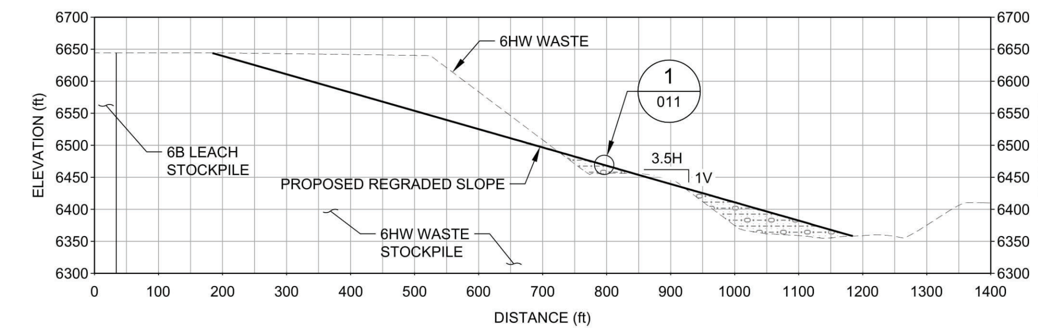
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
6HW WASTE STOCKPILE CLOSURE PLAN

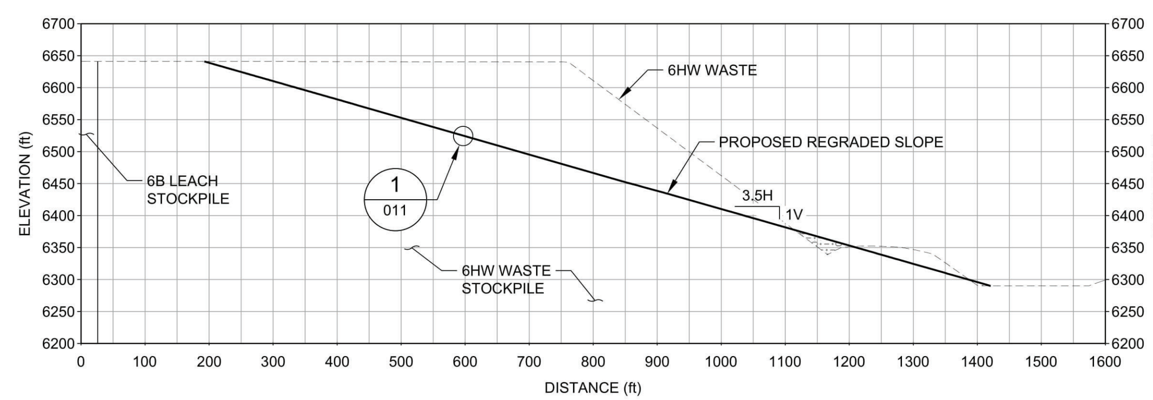
PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	8 of 11	008



SCALE 1" = 150' G 009 CROSS-SECTION G



SCALE 1" = 150' H 009 CROSS-SECTION H



SCALE 1" = 150' I 009 CROSS-SECTION I

0 150 300
1" = 150' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

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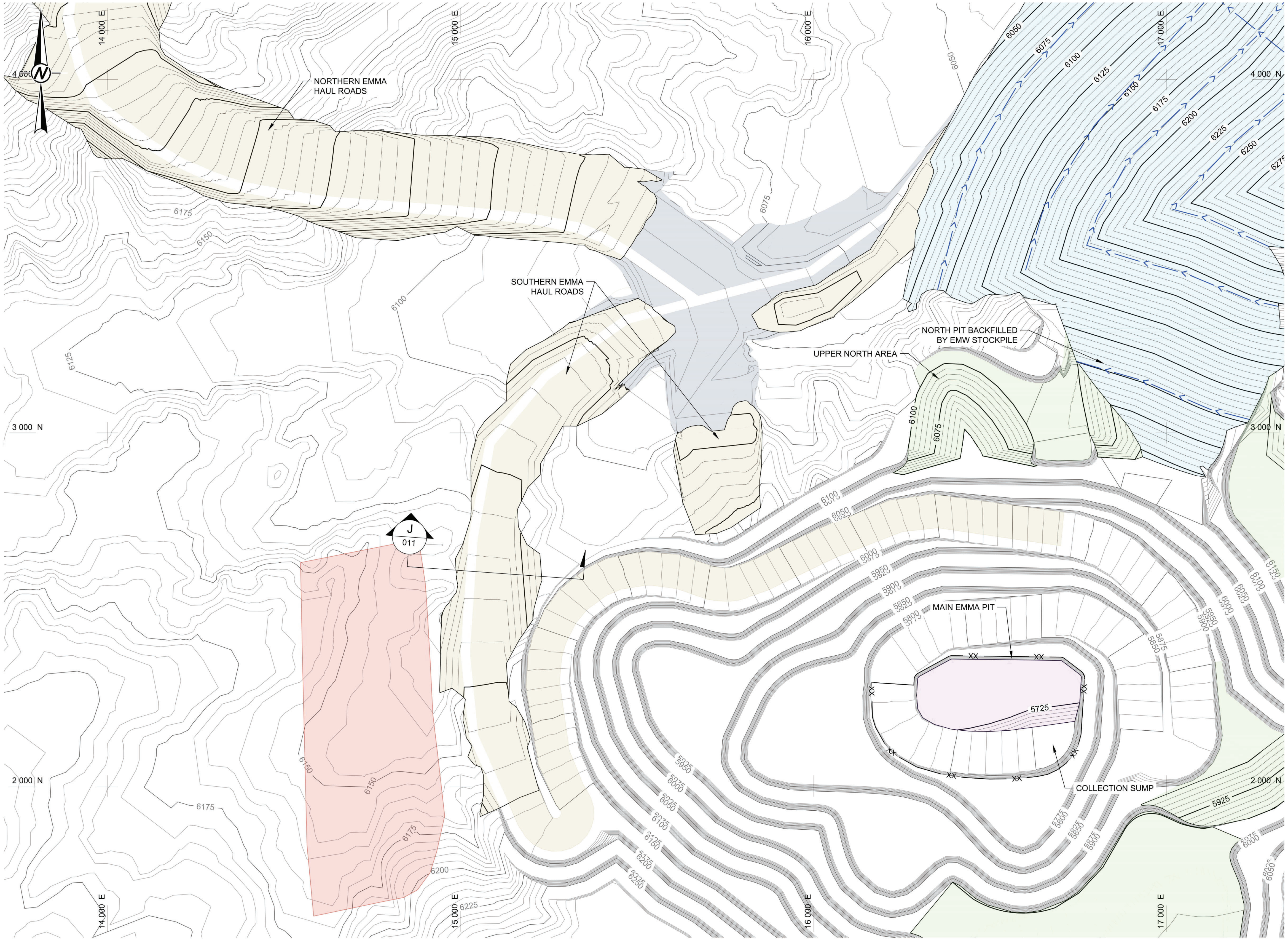
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

TITLE
6HW WASTE STOCKPILE CLOSURE PLAN CROSS-SECTIONS

PROJECT NO.	CONTROL	REV.		DRAWING
21476949	0400	D	9 of 11	009



GENERAL LEGEND

3600	EMMA PIT DESIGN CONTOURS
3600	DESIGN CONTOURS
	STORM WATER CHANNEL
XX	FENCE
	AREA OF PIT TO BE BACKFILLED DURING OPERATIONS AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
	AREA OF PIT TO BE BACKFILLED DURING CLOSURE
	AREA OF STOCKPILES TO BE REGRADED AND RECEIVE 1 FT OF SALVAGED SOIL DURING CLOSURE
	AREA TO BE REVEGETATED
	AREA OF HAUL ROAD TO BE RIPPED AND REVEGETATED DURING CLOSURE
	AREA TO BE REVEGETATED DURING CLOSURE

0 150 300
1" = 150' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

SEAL

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

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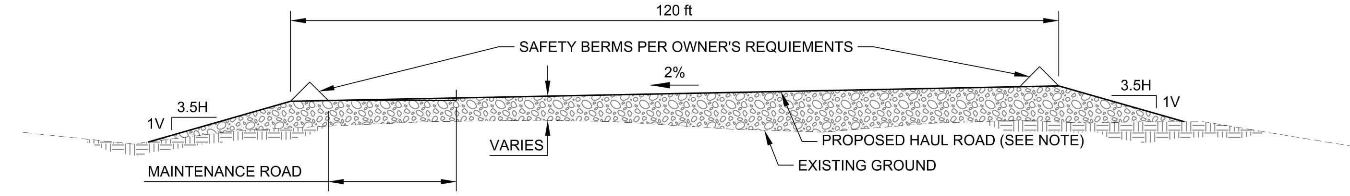
PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

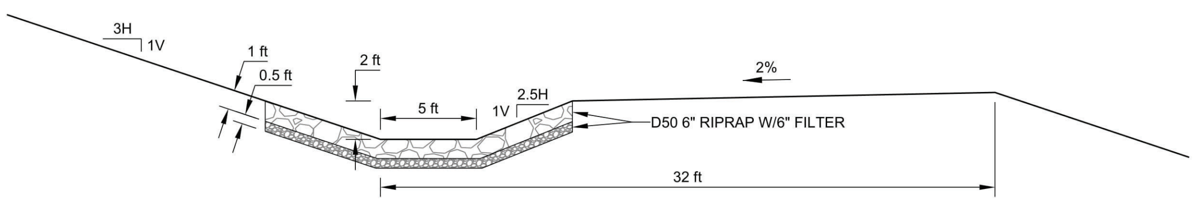
TITLE
HAUL ROAD CLOSURE PLAN

PROJECT NO.	CONTROL	REV.	10 of 11	DRAWING
21476949	0400	D		010

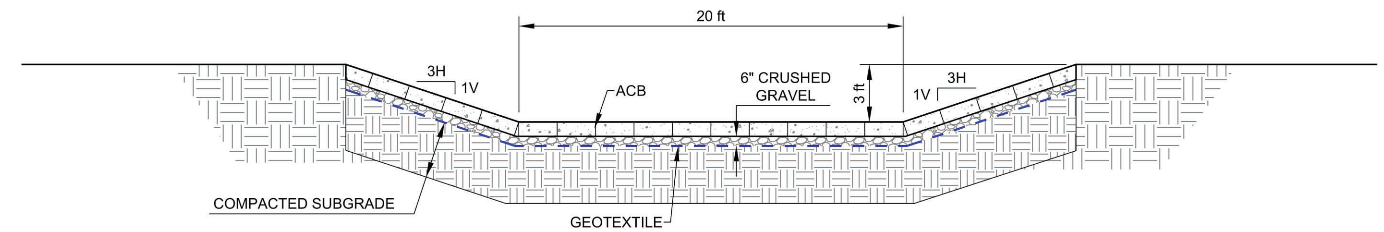
NOTE:
TOP SURFACE TO BE DOZER RIPPED AND REVEGETATED,
EXCEPT FOR ACCESS ROAD.



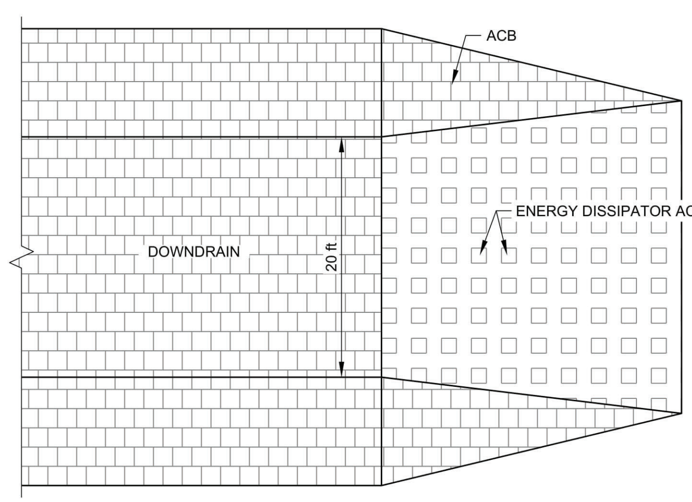
NOT TO SCALE J 011 TYPICAL HAUL ROAD SECTION



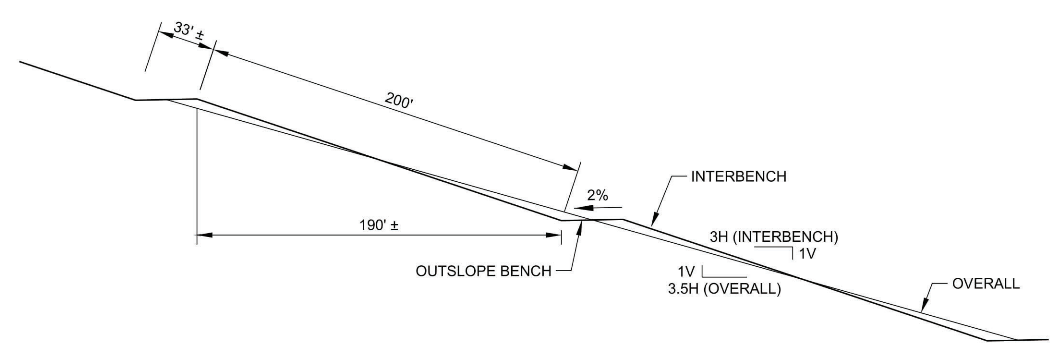
NOT TO SCALE 1 011 TYPICAL BENCH CHANNEL DETAIL



NOT TO SCALE 2 011 TYPICAL DOWNDRAIN DETAIL



NOT TO SCALE 3 011 TYPICAL ENERGEY DISSIPATOR DETAIL



NOT TO SCALE 4 011 TYPICAL OUTSLOPE BENCH SECTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
D	2021-11-11	ISSUED FOR CCP	GD	GD	MJG	TS
C	2021-11-09	REVISED ISSUED FOR CLIENT REVIEW	GD	JLS	MJG	TS
B	2021-10-25	ISSUED FOR CLIENT REVIEW	GD	GD	MJG	TS
A	2021-10-04	ISSUED FOR INTERNAL REVIEW	GD	GD	MJG	TS

CLIENT
FREEPORT-McMoRAN
TYRONE INC.

CONSULTANT
GOLDER
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PROJECT
EMMA PERMIT SUPPORT
CONCEPTUAL CLOSURE PLAN
TYRONE MINE, NEW MEXICO

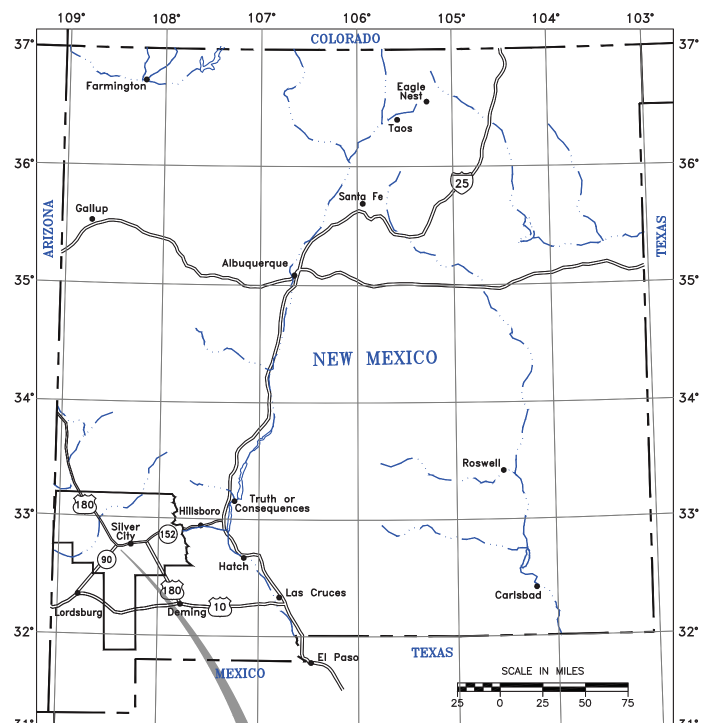
TITLE
TYPICAL SECTIONS AND DETAILS

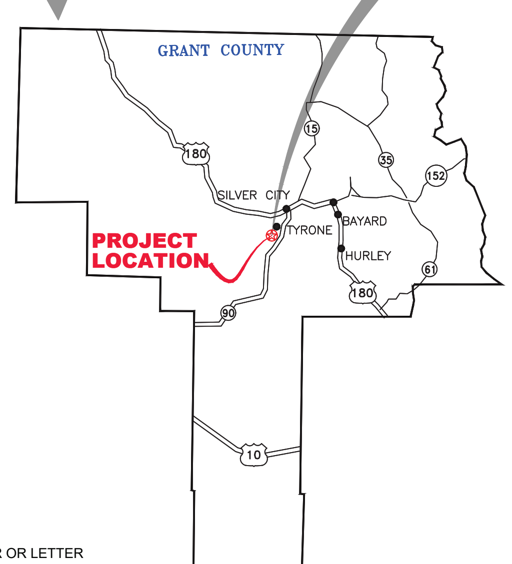
PROJECT NO.	CONTROL	REV.	11 of 11	DRAWING
21476949	0400	D		011

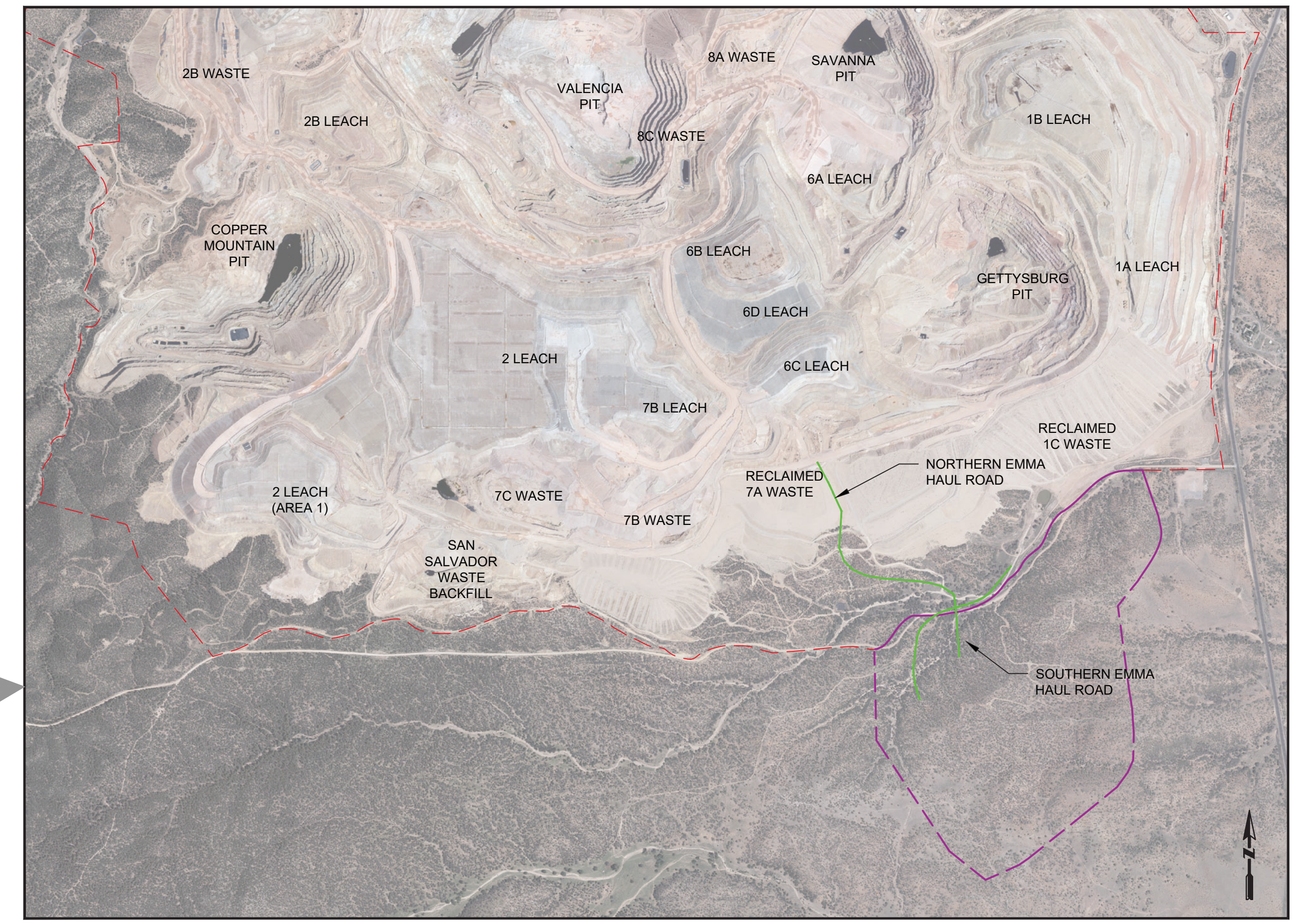
APPENDIX A-2

Conceptual Closure Plan for Northern and Southern Emma Haul Roads

NORTHERN AND SOUTHERN EMMA HAUL ROADS
TYRONE MINE 2021
ISSUED FOR PERMITTING PURPOSES







TYRONE MINE SOUTH - 2020

SHEET LIST TABLE	
SHEET NUMBER	SHEET TITLE
1	COVER SHEET
2	OPERATIONAL LAYOUT
3	OPERATIONAL/ RECLAMATION SECTION VIEWS
4	CLOSURE PLAN

CROSS SECTION REFERENCE

A / 1 — SECTION IDENTIFICATION NUMBER OR LETTER
NUMBER OF SHEET ON WHICH SECTION IS SHOWN

LEGEND / NOTES

- TYRONE PERMIT BOUNDARY
- HAUL ROAD ALIGNMENT
- PROPOSED EXPANSION OF TYRONE MINE PERMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT

COORDINATE SYSTEM
TYRONE LOCAL

FOR DISCUSSION PURPOSES ONLY

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR CLIENT REVIEW	9/27/21	JJM	TMT
1	FOR PERMITTING	10/14/21	JJM	WLN
2	ADD CLOSURE PLAN	11/2/21	TMT	WLN

DATE	11/2/2021
PROJECT	200552-001
TASK NUMBER	02/03
DRAWN BY	JJM/TMT
PROJECT ENGINEER	WLN
CHECKED BY	WLN

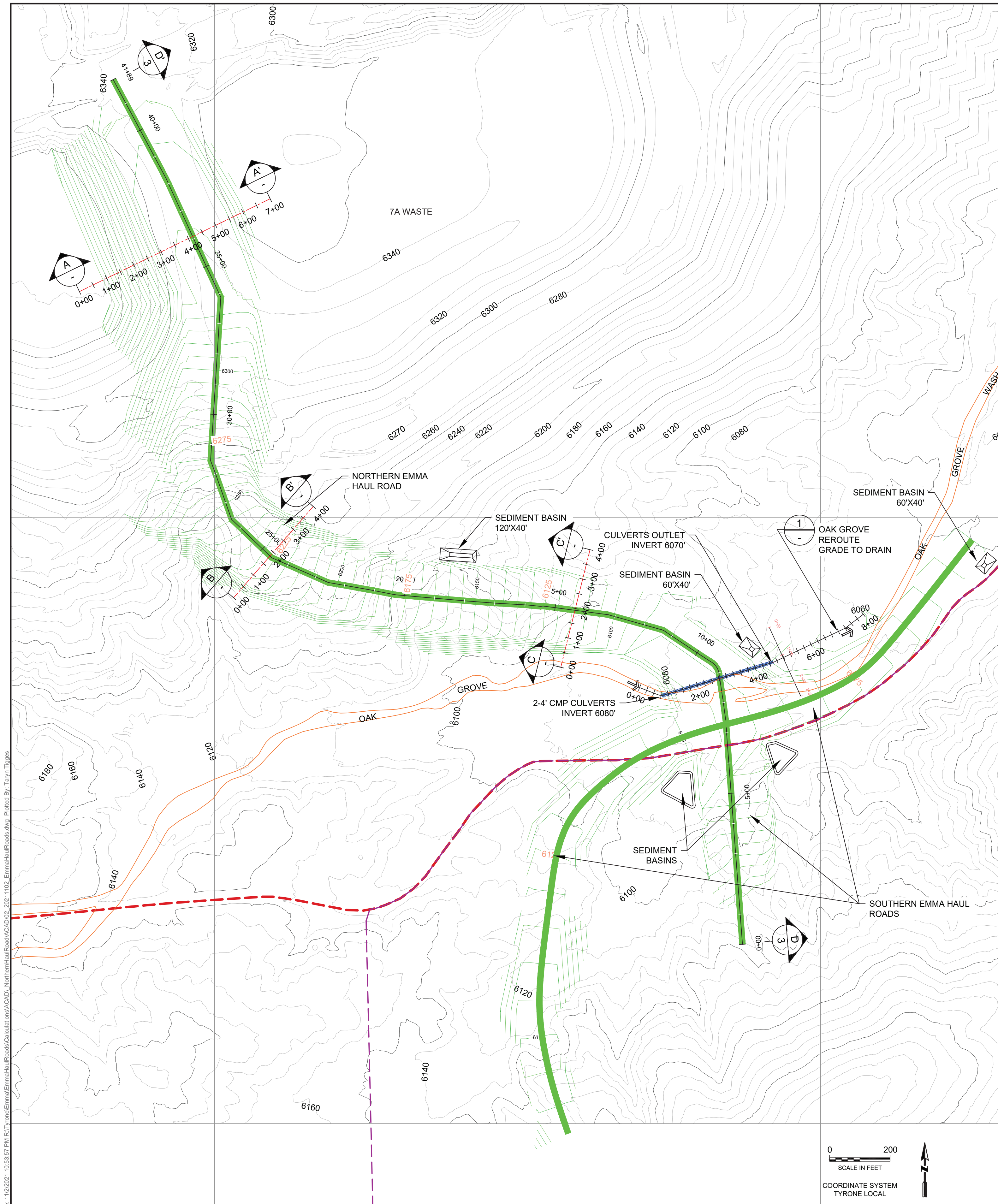
NORTHERN EMMA HAUL ROAD

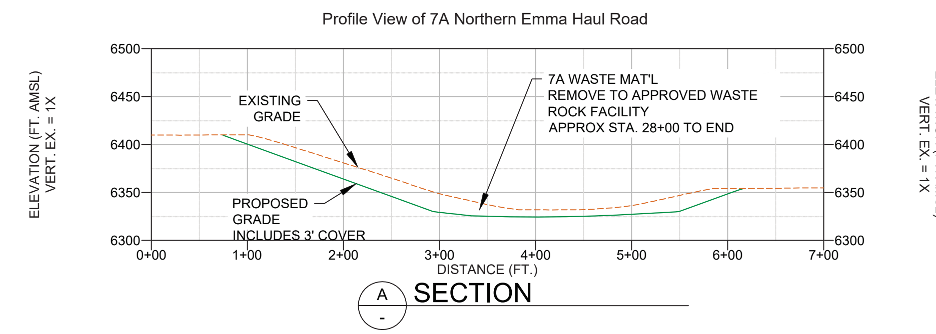
COVER SHEET

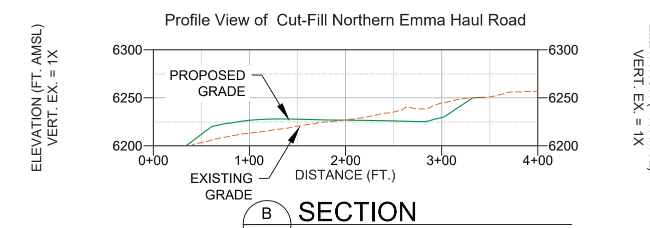
SHEET NUMBER: 1
REVISION NUMBER: 2

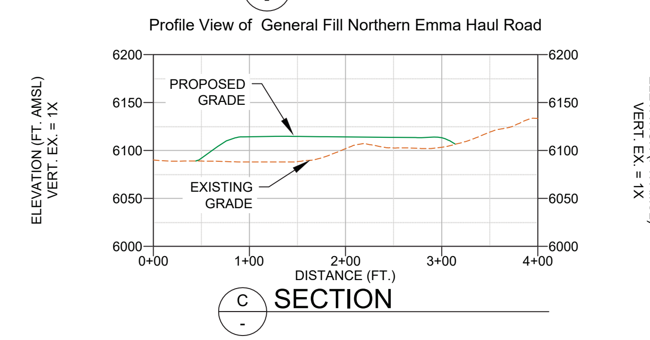
PREPARED BY: TELESTO SOLUTIONS INCORPORATED

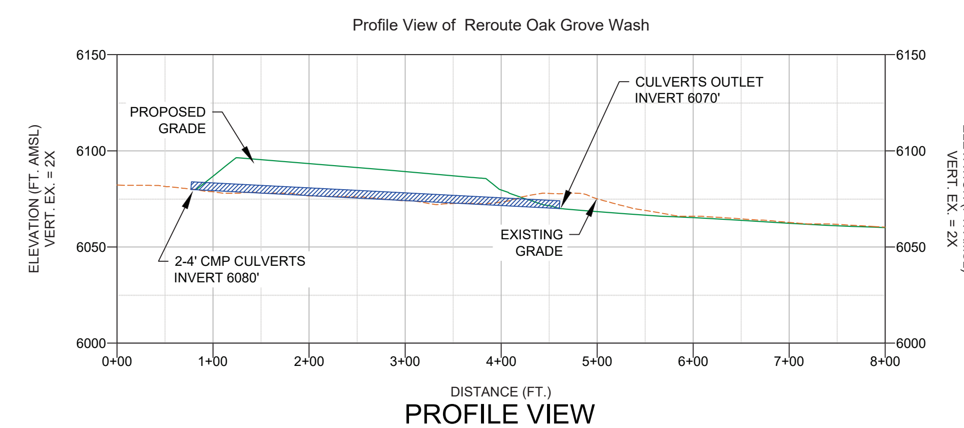
PREPARED FOR: FREEPORT-MCMORAN

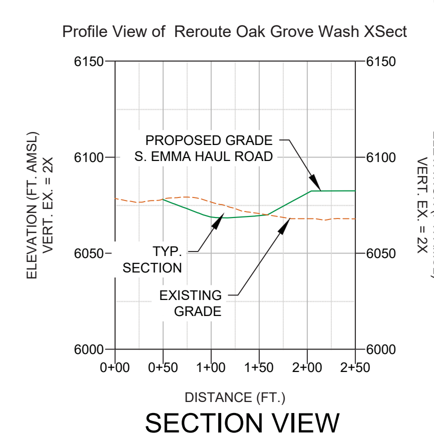












1 DETAIL
OAK GROVE WASH REROUTE AND CULVERT

LEGEND / NOTES

- TYRONE PERMIT BOUNDARY
- MAJOR CONTOUR (50 FT.)
- MINOR CONTOUR (10 FT.)
- PROPOSED MAJOR CONTOUR (10 FT.)
- PROPOSED MINOR CONTOUR (5 FT.)
- FLOW DIRECTION
- HAUL ROAD ALIGNMENT
- PROPOSED EXPANSION OF TYRONE MINE PERMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT

NOTES:

1. PRE-CONSTRUCTION TOPOGRAPHY FREEPORT-MCMORAN TYRONE INC. 2012
2. SEE SHEET 3 FOR DISPOSITION OF MATERIAL TYPES
3. SEE SHEET 3 FOR TYPICAL SEDIMENT BASIN PLAN AND PROFILE

FOR DISCUSSION PURPOSES ONLY

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR CLIENT REVIEW	9/27/21	JJM	TMT
1	FOR PERMITTING	10/14/21	JJM	WLN
2	ADD CLOSURE PLAN	11/2/21	TMT	WLN

DATE	11/2/2021
PROJECT	200552-001
TASK NUMBER	02/03
DRAWN BY	JJM/TMT
PROJECT ENGINEER	WLN
CHECKED BY	WLN

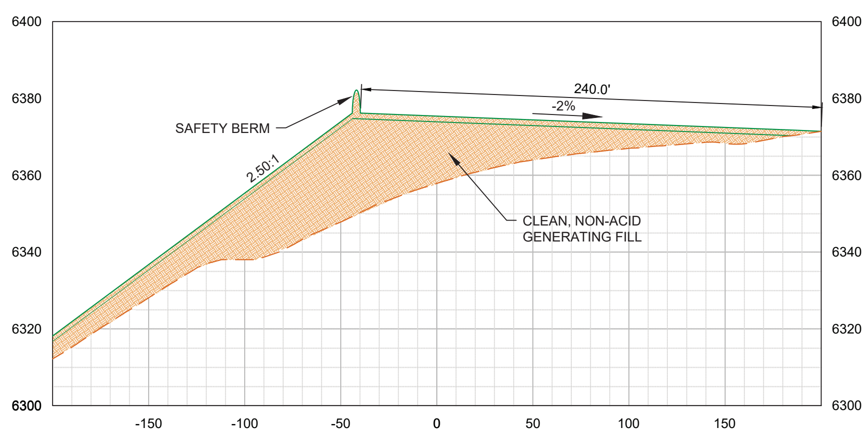
NORTHERN EMMA HAUL ROAD

OPERATIONAL LAYOUT

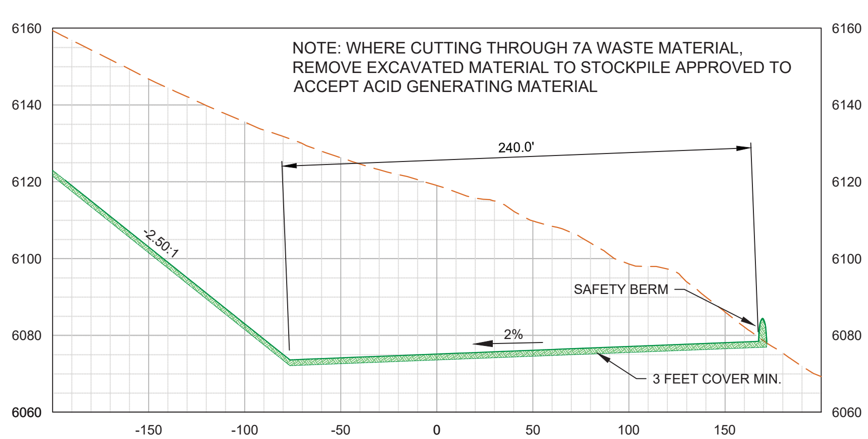
SHEET NUMBER: 2
REVISION NUMBER: 2

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

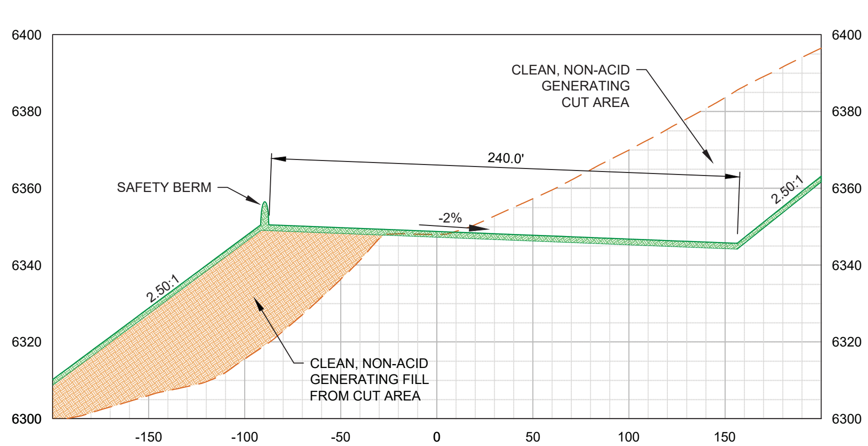
PREPARED FOR: FREEPORT-MCMORAN



CONCEPTUAL FILL SECTION

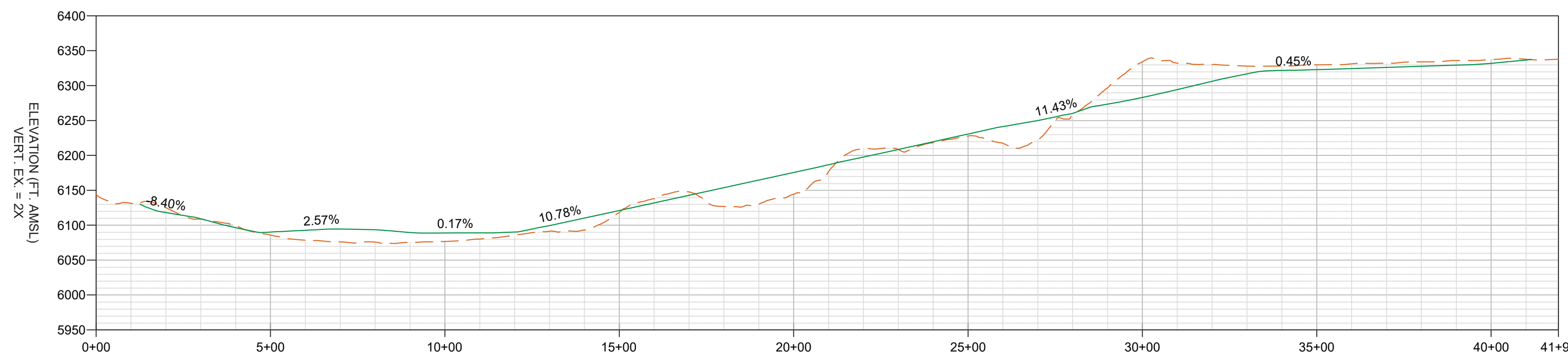


CONCEPTUAL CUT SECTION

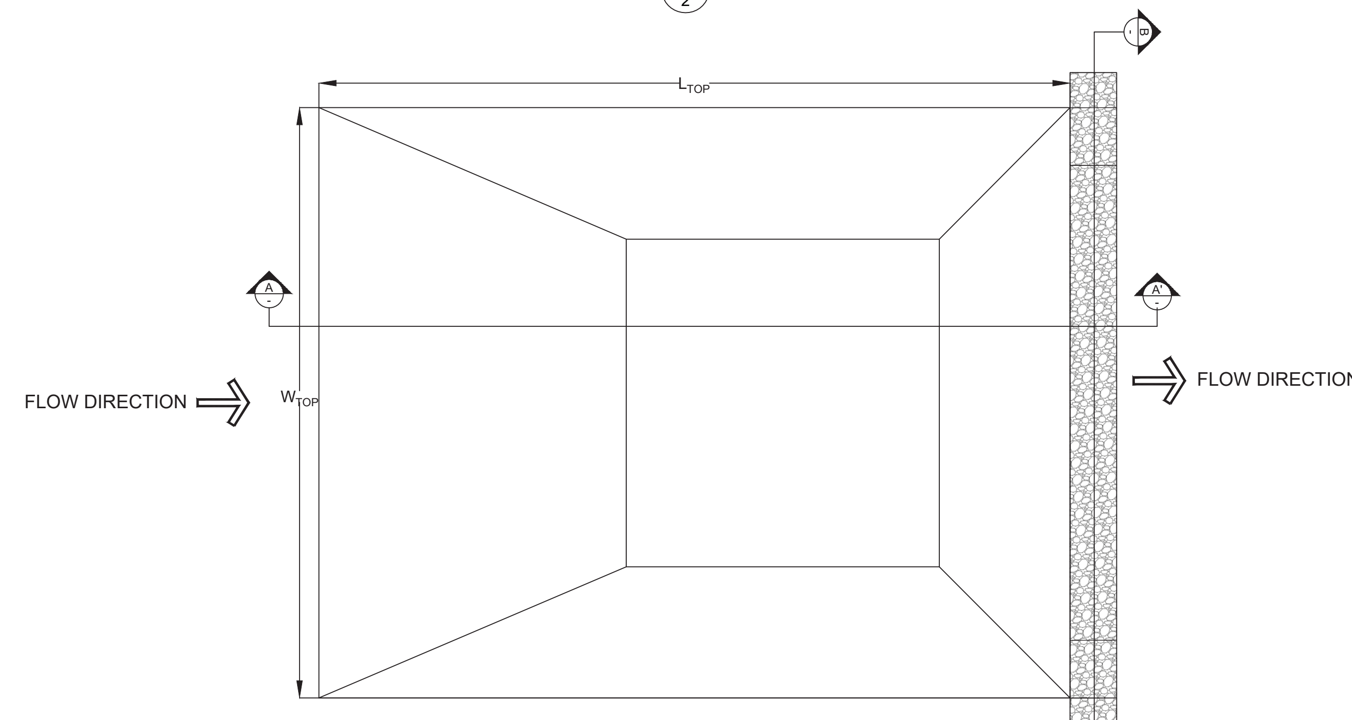


CONCEPTUAL CUT/FILL SECTION
ON NATIVE GROUND ONLY

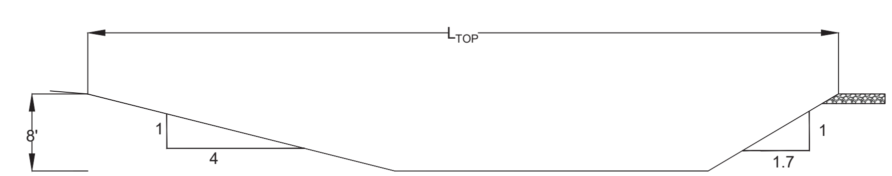
NORTHERN EMMA HAUL ROAD



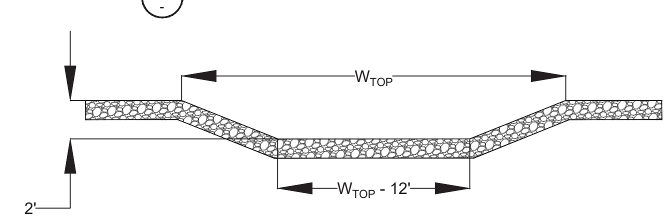
D 2 SECTION



TYPICAL SEDIMENT BASIN



A - TYPICAL SEDIMENT BASIN CROSS SECTION



B - TYPICAL SEDIMENT TRAP OUTLET

LEGEND / NOTES

2020 SURFACE

RECLAIMED SURFACE

NOTES:

1. HAUL ROADS CONSTRUCTED WITH CLEAN MATERIAL SUITABLE FOR COVER
2. HAUL ROADS CUT INTO RECLAIMED WASTE ROCK - EXCESS WASTE ROCK HAULED TO APPROVED WASTE ROCK FACILITY - ROADS COVERED WITH 3' MIN COVER MATERIAL

COORDINATE SYSTEM
TYRONE LOCAL

FOR DISCUSSION PURPOSES ONLY

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVED
0	FOR CLIENT REVIEW	9/27/21	JJM	TMT
1	FOR PERMITTING	10/14/21	JJM	WLN
2	ADD CLOSURE PLAN	11/2/21	TMT	WLN

DATE	11/2/2021
PROJECT	200552-001
TASK NUMBER	02/03
DRAWN BY	JJM/TMT
PROJECT ENGINEER	WLN
CHECKED BY	WLN

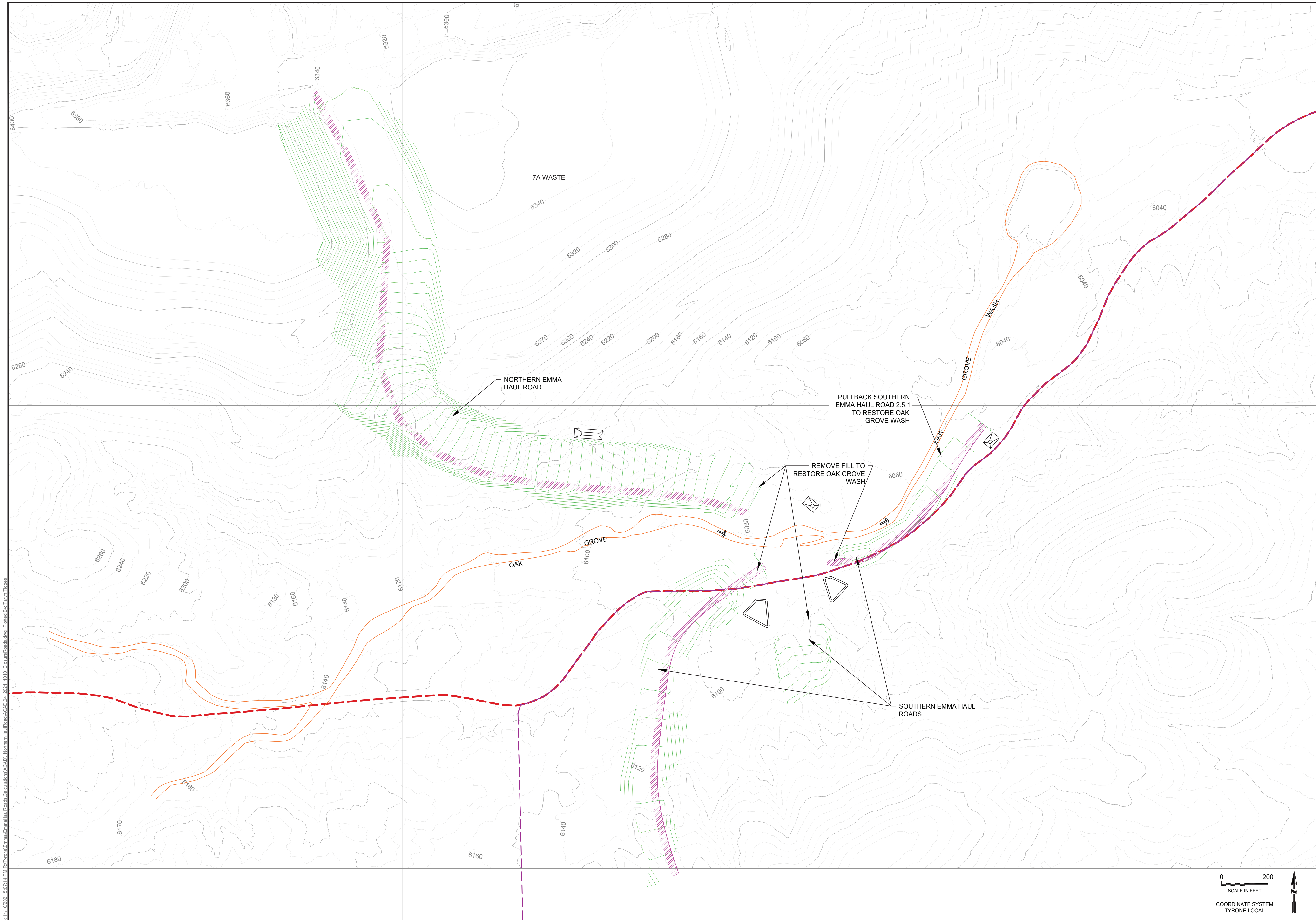
NORTHERN EMMA HAUL ROAD

OPERATIONAL/ RECLAMATION SECTION VIEWS

SHEET NUMBER: 3
REVISION NUMBER: 2

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

PREPARED FOR: FREEPORT-MCMORAN



LEGEND / NOTES

- TYRONE PERMIT BOUNDARY
- MAJOR CONTOUR (50 FT.)
- MINOR CONTOUR (10 FT.)
- PROPOSED MAJOR CONTOUR (10 FT.)
- PROPOSED MINOR CONTOUR (5 FT.)
- FLOW DIRECTION
- 30' MAINTENANCE CORRIDOR
- PROPOSED EXPANSION OF TYRONE MINE PERMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT

FOR DISCUSSION PURPOSES ONLY

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR CLIENT REVIEW	9/27/21	JJM	TMT
1	FOR PERMITTING	10/14/21	JJM	WLN
2	ADD CLOSURE PLAN	11/2/21	TMT	WLN

DATE	11/2/2021
PROJECT	200552-001
TASK NUMBER	02/03
DRAWN BY	JJM/TMT
PROJECT ENGINEER	WLN
CHECKED BY	WLN

NORTHERN EMMA HAUL ROAD

CLOSURE PLAN

SHEET NUMBER: 4
REVISION NUMBER: 2

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

PREPARED FOR: FREEPORT-MCMORAN

APPENDIX B

Earthwork Cost Basis Document

Earthwork Cost Estimate
Process Summary Report

Emma Project
Closure/Closeout Plan

Prepared for

Freeport-McMoRan Tyrone Inc.
P.O. Box 571
Tyrone, New Mexico 88065

Prepared by

Telesto Solutions, Inc.
750 14th Street SW
Loveland, CO 80537

November 2021

Signature Page

Earthwork Cost Estimate Process Summary Report

Emma Project Closure/Closeout Plan

November 2021

TELESTO
SOLUTIONS • INCORPORATED

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Taryn Tigges, P.E. – Primary Author

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1.0 INTRODUCTION

The New Mexico Environmental Department, Groundwater Bureau (NMED) and the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division (MMD) regulations require that financial assurance (FA) be posted for facilities that have to be reclaimed at closure (New Mexico Administrative Code NMAC 20.6.7.29 and NMAC 19.10.12, respectively). This report details the scope of earthwork associated with closure/closeout activities and includes appendices that describe the base assumptions and approach used to determine the FA and associated earthwork reclamation cost estimate (RCE) for the proposed Emma Project (Emma).

Telesto Solutions Inc. (Telesto) presents the earthwork RCE for Freeport McMoRan Tyrone Inc. (Tyrone) for the proposed Emma area. The reclamation drawings that provide the basis for the cost estimate can be found in Appendix A of the CCP. The reclamation designs and earthwork quantity takeoffs were prepared by Golder Associates with the exception of those associated with the Northern and Southern Emma Haul Roads, which were prepared by Telesto.

1.1 Reclamation Overview

The earthwork RCE is based on the configuration of facilities as described in the end-of-year (EOY) 2026 mine plan (Year 5 of mining), and assumes design for reclamation would take place during the first year with reclamation starting the following year. A recent evaluation of the five year mining sequence (for this report it is assumed 2022 to 2026) by Golder Associates determined that 2026 is the appropriate mine configuration to be utilized for calculating reclamation designs and cost for financial assurance purposes. It was shown that Year 2026 used as the basis of this estimate will yield a higher cost than other years.

A summary of the mine facilities at Emma, including reclamation status, is provided in Table 1. The earthwork RCE assumes that the Upper East area of the Emma Pit is reclaimed by EOY 2026.

1.2 Report Layout

This report consists of the following sections:

- **Section 1.0** provides an introduction and overview of the RCE prepared for Tyrone.
- **Section 2.0** presents the data and assumptions used for estimating earthwork processes and equipment costs, indirect and O&M costs, and quotes and unit costs.
- **Section 3.0** summarizes the information used to complete the earthwork RCE.
- **Section 4.0** presents the results including a listing by location for direct and indirect capital costs and site-wide direct and indirect O&M costs.
- **Section 5.0** lists the references cited in this report

The following appendices provide supporting information and calculations:

- **Appendix A** presents the engineering take-offs used in the calculations.
- **Appendix B** presents the key equations and documentation of the calculations used in the reclamation cost spreadsheet.
- **Appendix C** provides the letter and table documenting the FA Work Group agreement for indirect costs used in the RCE.
- **Appendix D** presents supporting data for the cost estimation, including labor rates, equipment data, direct quotes, and information for fuel costs.
- **Appendix E** presents the RCE spreadsheet.

Table 1 Reclamation Overview

Feature	Notes
Stockpiles	
EMW Waste	Reclaim by grading outslopes, hauling cover, constructing stormwater channels, and revegetating. For FA purposes it is assumed EMW will receive 1 foot cover (from the Soil Stockpile salvaged prior to pit and stockpile development at Emma) until the material is approved for use as RCM. Tyrone intends to use the borrow material placed in EMW Waste for future reclamation projects. At closure, the borrow material within the stockpile will be excavated for use in reclamation or regraded in a manner that facilitates reclamation.
6HW Waste	Stockpile partially located in pit waiver area; Reclaim areas outside of the pit waiver area by grading outslopes, hauling 1 foot of soil cover, constructing stormwater channels, and revegetating. For FA purposes it is assumed 6HW will receive 1 foot cover until the material is approved for use as RCM. Tyrone intends to use the borrow material placed in 6HW Waste for future reclamation projects at Tyrone.
Soil Stockpile	Reclaim by grading to drain, ripping, and revegetating.
Pits	
Emma Pit	Collection Sump - Reclaim by hauling and placing fill from EMW Waste, install fence to prevent access to sump, install floating cover balls over remaining water surface. Main South, Upper North, and Upper South - Reclaim by hauling 1 foot soil cover, final grading, and revegetating. Upper East - Vegetation maintenance
Other	
Northern Emma Haul Road	Reclaim by ripping and revegetating. Remove Oak Grove crossing culverts. Remove fill to restore Oak Grove Wash.
Southern Emma Haul Road	Reclaim by ripping and revegetating.
Allowance for Other Disturbed Areas	Reclaim by minor regrading, hauling 1 foot of cover (for FA purposes), ripping and revegetating.

2.0 DATA AND ASSUMPTIONS

The reclamation design used as the basis for the earthwork RCE is presented in CCP Appendix A. The cost estimate is included in a standalone calculation sheet in Appendix E of this report.

Data and key assumptions used throughout the cost estimate calculations for earthwork processes and equipment, indirect and O&M costs, and direct quotes are listed in this section and provided in more detail in Appendix D. The sub-appendices in Appendix D are organized as follows:

- **Appendix D.1** tabulates the 2021 labor rates from the New Mexico Department of Labor (NMDOL).
- **Appendix D.2** contains copies of the EquipmentWatch (Penton Media, 2021) sheets from which equipment unit rates were obtained.
- **Appendix D.3** provides the curve fits used in the production sheets for dozers and haul trucks.
- **Appendix D.4** provides copies of the pertinent information from RSMeans (R.S. Means, 2021) and pages from several editions of the Caterpillar Performance Handbook (CPH).
- **Appendix D.5** provides direct quotes used in the cost estimates.
- **Appendix D.6** provides data and calculations used to prepare the fuel cost.

2.1 Earthwork Processes and Equipment

Data and assumptions used in the RCE for earthwork processes and equipment include the following:

- **Dozer Push Distances:** Dozer push distances represent the distance from the centroid of the cut block to the centroid of the fill block.
- **Cover Placement**: Trucks and loaders or hydraulic shovels with dozer assist, water truck, and motor grader perform cover loading and distribution. The economic optimum number of trucks per loader or hydraulic shovel is used for each haul route.
- **Haul Distances**: Haul distances are calculated along a preferred route and assumed to originate at the approximate centroid of the source and terminate

at the approximate centroid of the reclamation area. Each haul route uses a maximum of three segments.

- **Borrow Areas:** For the purposes of calculation of the FA cost estimate, reclamation cover material will be sourced from the Soil Stockpile. Fill material will be sourced from EMW Waste.
- **Scraper Operations**: Where scrapers are used for grading, grading will be completed using a Caterpillar 657G scraper and Caterpillar D9T dozer, or similar models.
- **Truck and Shovel Operations**: All truck and shovel operations will be completed using a Hitachi EX3600-5 hydraulic shovel and Komatsu 730E dump truck.
- **Dust Suppression and Road Maintenance:** A water truck and a motor grader are included as part of the fleet during reclamation (Table 2). The water truck and grader task time is equal to loader or hydraulic shovel task time.
- **Labor Rates:** All labor rates will be developed based on the NMDOL Type H (Heavy Engineering) rates. These rates will include the base, fringe benefit, and apprenticeship contribution rates.
- **Equipment Rates:** The equipment unit operating costs will be taken from EquipmentWatch Custom Cost Evaluator.
- **Hourly Adjustment:** The RCE is based on 50 minutes of work per hour. Cost information presented in EquipmentWatch is based on 50 minutes of work per hour. Because the hourly adjustment is made in the RCE calculations, an hourly adjustment to a 60-minute work hour is applied to the EquipmentWatch data.
- **Revegetation and Scarification:** The revegetation unit cost is based on R.S. Means, EquipmentWatch, and direct quotes. Scarifying the final surface takes place at the same time as revegetation.
- **Equipment Production Factors:** Table 2 summarizes equipment production factors from the Caterpillar Handbook (CPH), and EquipmentWatch. Productivity curves are also developed from the Caterpillar references.
- **Fuel Costs:** The fuel cost is based on discussions with the FA Work Group in the fall of 2018 as agreed in January 2019; historical local quotes are correlated with public data to estimate the fuel cost.
- **Miscellaneous Unit Costs:** Other miscellaneous unit costs shown in Table 4 were taken from several sources. Supporting documentation from direct quotes is included in Appendix D.5.

2.2 Indirect and O&M Costs

The RCE handles indirect and O&M costs as follows:

- **Capital Indirect Costs**: Total indirect costs of 30% are applied to the capital direct costs based on discussions involving the FA Work Group completed in December 2018. The indirect costs include but are not limited to Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and State Procurement Cost. Appendix C presents the letter and table documenting the FA Work Group agreement for FNMO's RCEs to use 30% to calculate indirect costs.
- **Operations and Maintenance Indirect Costs**: Total indirect costs of 17.5% are applied for long-term O&M, also as agreed by the FA Work Group for FNMO's RCEs. The indirect costs include but are not limited to Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and State Procurement Cost (see Appendix C).
- **Reclamation Timeframe:** For purposes of updating Tyrone Mine's total Net Present Value, this earthwork cost estimate assumes that earthwork occurs relatively evenly (in terms of dollars spent) over a 15-year period (including 1 year of pre-construction work and 1 year of post-construction work). Revegetation monitoring are assumed to be completed at the end of 12 years in each area after the initial revegetation. Other earthwork reclamation and facility monitoring and O&M are assumed to be fully completed at the end of 100 years (i.e., year 99 or 2126). This reclamation timeframe corresponds with Tyrone Mine's reclamation timeframe.

2.3 Direct Quotes

Direct quotes are used in the RCE as a source of information to prepare unit costs which will be presented in the RCE cost spreadsheet. Direct quotes include the following:

- **Articulated Concrete Blocks (ACBs):** ACB material and installation unit costs
- **Revegetation Materials:** Costs for seed and hay mulch used for reclamation

Table 2 Earthwork Equipment Production Factors

Parameter	Value	Comment/Reference
Swell Factor(1)	0% for native rock and compacted fill 8% for cover load & haul sites	Regraded material and compacted fill has no swell factor. Cover material volumes are calculated based on the reclaimed area and the cover depth. A swell factor is included in the cost estimate while calculating the bank cover volume.
Coarse Regrading Tops and Outslopes (D11T CD)		
Operator Factor (1)	1.0	Due to large job size assume operator with excellent skills (CPH 48: 19-55, excellent)
Material Factor	1.2 1.0	(CPH 48: 19-55) 1.2 for fine grading cover, other surfaces, and channel, 1.0 for coarse regrading stockpiles and tailing
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Grade Factor - Outslopes(1)	1.6	(CPH 48: 19-55) 3H:1V Slopes
Material Weight (lb/cy)	3,600	Stockpiles & Cover Materials
Production Method/Blade Factor	1.2	(CPH 48: 19-55) Slot dozing
Visibility Factor	1.0	(CPH 48: 19-55) Clear, dust controlled by water trucks
Elevation Factor	1.0	(CPH 48: 30-7) Horsepower reduction table
Direct Drive Transmission	1.0	-
Fine Grading Cover, Other Surfaces, and Channels (D11T CD, D9T, D6T, 16M, 14M)		
Material Factor	1.2	(CPH 48: 19-55) fine grading cover
Grade Factor	1.0	(CPH 48: 19-55) 1-5% slopes
Grade Factor – Outslopes(1)	1.6	(CPH 48: 19-55) 3H:1V Slopes
Material Weight (lb/cy)	3,600	Fine grading cover material
Production Method/Blade	1.2 1.0	(CPH 48: 19-55, slot dozing) No correction applied channels, downdrains, and benches
Effective Blade Width (feet [ft])	22.0 ft D11T CD 14.08 ft D9T Semi Universal Blade 16 ft 16M, 14 ft 14M 10.67' D6T SU	(CPH 48: 19-17, 19-49) (CPH 48: 19-47) (CPH 48: 11-17) (CPH 48: 19-10, 19-43)
Speed (miles/hr)	2.5 mph D11T CD, 16M, and 14M 1.0 mph D9T and D6T	(CPH 48: 11-19, 19-24, 19-25) maximum equipment speeds based on information provided in the Cat Handbook and Safe mining practices
Operator Factor(1)	0.75	(CPH 48: 19-55) Average operator skill
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Visibility Factor	1.0	(CPH 48: 19-55) Clear, dust controlled by water trucks
Elevation	1.0	(CPH 48: 30-7)

Parameter	Value	Comment/Reference
Direct Drive Transmission	1.0	-
Ripper (D11T CD Multi-shank [w/MSR-359H])		
Ripping Length (ft)	1,000	-
Penetration (in)	18	-
Pocket Spacing (in)	59	(CPH 48: 19-72)
Number of Pockets	3	(CPH 48: 19-72)
Turn Time (min/pass)	0.25	(CPH 48: 19-72 to 19-75)
Speed (mph)	1	(CPH 48: 19-72 to 19-75)
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Distance between passes (in)	59	Maintain pocket spacing value between passes
Loader (992K)		
Heaped Capacity (cy)	16.0	(CPH 48: 23-223, 23-365)
Loader Cycle Time (load, dump, and maneuver; min)	0.65	(CPH 48: 23-287)
Bucket Fill Factor	0.875	(CPH 48: 23-287) ≥ 1" Loose Material
Speed (mph)	7.6 12.8	(CPH 48: 23-18) 7.6 mph loaded, forward 2nd gear; 12.8 mph empty, forward 3rd gear
Work Hour (min/hr)	50	(CPH 48: 19-55)
Loaders (988H, 980H)		
Heaped Capacity (cy)	8.3 (988H) 7.5 (980H)	(CPH 41: 19-75) (CPH 48: 23-213, 23-214)
Loader Cycle Time (load, dump, and maneuver; min)	0.575 (988H) 0.525 (980H)	(CPH 44: 23-223) (CPH 48: 23-287)
Bucket Fill Factor	0.875	(CPH 48: 23-287) ≥ 1" Loose Material
Speed (mph)	7.3 12.9	(CPH 41: 12-7 [988H], 48:23-17 [980H]) 7.3 mph loaded, forward 2nd gear; 12.9 mph empty, forward 3rd gear
Work Hour (min/hr)	50	(CPH 48: 19-55)
Loader (966H)		
Heaped Capacity (cy)	5.5	(CPH 48: 23-209, 23-210)
Loader Cycle Time (load, dump, and maneuver; min)	0.525	(CPH 48: 23-287)
Bucket Fill Factor	0.875	(CPH 48: 23-287) ≥ 1" Loose Material
Speed (mph)	7.8 13.7	(CPH 48: 23-16) 7.8 mph loaded, forward 2nd gear; 13.7 mph empty, forward 3rd gear
Work Hour (min/hr)	50	(CPH 48: 19-55)
Shovel (Hitachi EX3600-5/CAT 5230B FS) (2)		
Heaped Bucket Capacity (cy)	27.4	EquipmentWatch Spec for Hitachi EX3600-5
Loader Cycle Time (min)	0.45	(CPH 35: 4-236)
Bucket Fill Factor	1.025	(CPH 48: 30-2) assuming rock dirt mixture factor range from 1.00 to 1.05
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Trucks (CAT 789D/Komatsu 730E) (3)		
Struck Capacity (cy)	101	EquipmentWatch Spec for Komatsu 730E
Heaped Capacity (cy)	145	EquipmentWatch Spec for Komatsu 730E
Rolling Resistance	2.5%	(CPH 48: 30-2) Radial tires, dirt road maintained fairly regularly, watered, flexing

Parameter	Value	Comment/Reference
		slightly
Truck Exchange Time (min)	0.7	(CPH 48: 10-20) Avg. 0.6-0.8
Dump/Maneuver Time (min)	1.1	(CPH 48: 10-20) Avg. 1.0-1.2
Speed (mph)	35.5	(CPH 48: 10-14) top speed (loaded)
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Trucks (CAT 769D)		
Struck Capacity (cy)	22.2	(CPH 29: 9-2) Capacity assumed for bench channel materials
Heaped Capacity (cy)	31.7	(CPH 29: 9-2) Capacity assumed for bench channel materials
Rolling Resistance	2.5%	(CPH 48: 30-2) Radial tires, dirt road maintained fairly regularly, watered, flexing slightly
Truck Exchange Time (min)	0.7	(CPH 48: 10-20) Avg. 0.6-0.8
Dump/Maneuver Time (min)	1.1	(CPH 48: 10-20) Avg. 1.0-1.2
Speed (mph)	47	(CPH 29: 9-2) top speed (loaded)
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Trucks (CAT 725)		
Struck Capacity (cy)	14.5	EquipmentWatch spec
Heaped Capacity (cy)	19.0	EquipmentWatch spec
Rolling Resistance	2.5%	(CPH 48: 30-2) Radial tires, dirt road maintained fairly regularly, watered, flexing slightly
Truck Exchange Time (min)	0.7	(CPH 48: 10-20) Avg. 0.6-0.8
Dump/Maneuver Time (min)	1.1	(CPH 48: 10-20) Avg. 1.0-1.2
Speed (mph)	34	(CPH 48: 1-2) top speed (loaded)
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Scraper (657G) Push-Pull		
Heaped Capacity (cy)	44	(CPH 48: 24-4)
Struck Capacity (cy)	32	(CPH 48: 24-4)
Rated Load (lb)	104,000	(CPH 48: 24-4)
Rolling Resistance	2.5%	(CPH 48: 30-2) Radial tires, dirt road maintained fairly regularly, watered, flexing slightly
Load Time (min)	0.85	(CPH 48: 24-17) 0.6 to 1.1
Maneuver & Spread Time (min)	0.65	(CPH 48: 24-17) 0.6 to 0.7
Push Cycle Time (min)	0.10 Boost Time 1.19 return time (140% of scraper load time) 0.15 maneuver time	(CPH 48: 28-10)
Speed (mph)	33	(CPH 48: 24-4)
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency

Parameter	Value	Comment/Reference
Excavator (319D L)		
Work Hour (min/hr)	50	(CPH 48: 19-55) Job efficiency
Heaped Capacity (cy)	1	EquipmentWatch spec
Sheepsfoot Roller Length (ft)	3	Estimated
Maximum Reach at Ground Level (in)	380	EquipmentWatch spec
Swing Time (Loaded) (min)	0.09	(CPH 48: 7-247)
Swing Time (Empty) (min)	0.07	(CPH 48: 7-247)
Deere 7430 (and Finn B260 Mulcher, MSR-189H Ripper)		
Operating Width (ft)	12	Assigned based on typical width of revegetation equipment/implements
Speed (mph)	3	Assigned as average speed of tractor pulling revegetation equipment/implements
Work Hour (min/hr)	50	Assigned for consistency with other earthwork operations

CPH = Caterpillar Performance Handbook (Multiple Editions)
(1) The swell and operator factors used are consistent with factors presented to MMD and NMED in meetings with Tyrone on June 11, 2012, November 2, 2012, and a letter to MMD and NMED from Tyrone dated September 5, 2012 (Freeport-McMoRan Copper & Gold, 2012). Furthermore, these were agreed to in discussions on Chino expansion projects.
(2) Performance information for the CAT 5230B FS is used for parameters unavailable for the Hitachi EX3600-5.
(3) Performance information for the CAT 789D is used for parameters unavailable for the Komatsu 730E.

Table 3 Labor and Equipment Unit Costs

Equipment Description	Type	Fuel Cost ($/hr)	Total Rental Cost (w/o fuel) ($/hr)	NMDOL Operator Group	NMDOL Labor Rates	Total Cost ($/hr)
Cat D11T CD	Dozer	$71.92	$233.66	Equipment Operator IV	$28.65	$334.24
Cat D9T, SU Blade	Dozer	$35.31	$203.92	Equipment Operator IV	$28.65	$267.89
Cat D6T, SU Blade	Dozer	$17.75	$64.33	Equipment Operator IV	$28.65	$110.73
Cat D6T XL, SU Blade	Dozer	$17.45	$86.02	Equipment Operator IV	$28.65	$132.12
Cat 319D L	Excavator	$6.59	$47.77	Equipment Operator VI	$28.95	$83.31
Cat 992K	Loader	$52.82	$231.84	Equipment Operator VII	$28.97	$313.62
Cat 988H	Loader	$24.74	$121.23	Equipment Operator VII	$28.97	$174.94
Cat 980H	Loader	$14.50	$85.07	Equipment Operator VII	$28.97	$128.54
Cat 966H	Loader	$10.46	$66.00	Equipment Operator VII	$28.97	$105.43
Cat 16M - Final Grading	Motor Grader	$25.75	$85.54	Equipment Operator VIII	$30.93	$142.21
Cat 16M - Rough Grading	Motor Grader	$25.75	$85.54	Equipment Operator VI	$28.95	$140.23
Cat 14M - Final Grading	Motor Grader	$22.47	$88.60	Equipment Operator VIII	$30.93	$141.99
Cat 14M - Rough Grading	Motor Grader	$22.47	$88.60	Equipment Operator VI	$28.95	$140.01
Finn B260	Mulcher	$11.19	$16.00	Truck Driver III	$24.57	$51.76
Cat D11T CD Multi-shank (w/MSR-359H)	Dozer w/Ripper	$71.92	$250.85	Equipment Operator IV	$28.65	$351.42
Ripper (MSR-189H)	Ripper	0	$6.78	-	-	$6.78
Cat 657G	Scraper	$131.03	$232.47	Equipment Operator IV	$28.65	$762.33
Hitachi EX3600-5	Shovel	$224.17	$509.18	Equipment Operator VII	$28.97	$762.33
Deere 7430	Tractor	$16.21	$27.63	Truck Driver III	$24.57	$68.40
Cat 769D	Truck	$22.52	$100.18	Truck Driver VII	$24.57	$147.27
Cat 725	Truck	$16.31	$74.29	Truck Driver VI	$24.57	$115.18
Komatsu 730E	Truck	$77.51	$221.35	Truck Driver VIII	$25.16	$324.02
Off-Hwy Water Truck,6,000-gal.	Water Truck	$30.49	$74.67	Truck Driver V	$24.65	$129.81
1 Deck Screening Plant (5X16, 48X60)	Screening Plant	$13.14	$74.61	Laborer I	$23.88	$111.63
3 Deck Screening Plant (5X16, 42X60)	Screening Plant	$13.14	$110.28	Laborer I	$23.88	$147.30

Table 4 Miscellaneous Unit Costs

Activity	Base Per Unit Cost	Fuel Per Unit Cost	Units	Source	Reference
Fuel	$2.71	$-	gal	-	Diesel fuel cost is estimated by correlating historical local quotes with public data, as agreed upon in November 2018 discussions with the agencies. Fuel cost includes direct and indirect costs at $2.71/gal, calculated 9/02/2021.
Revegetation	$852.45	$4.46	ac	Revegetation Unit Cost Sheet	See unit rates calculations - Cost is based on a calculated unit rate that includes tractor rental and maintenance, fuel, scarifying, discing, drill seeding, mulching, crimping, seed, and mulch.
Seed	$222.85	$0.00	ac	Quote	Rocky Mountain Reclamation, 4/2018, est. cost for seed at 8.9 PLS/ac, $210/ac. Escalated 2% 2018-2021= $222.85/ac
Mulch	$260.00	$0.00	ton	Quote	Rocky Mountain Reclamation, 4/2018, est. cost for hay mulch (nox. weed free, native), $245/ton). Escalated 2% 2018-2021= $260.00/ton
Bench Grading Stockpile	$1.60	$0.42	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
Downdrain Construction	$392.04	$-	ft	Downdrain Unit Cost Sheet	See unit rates calculations
Downdrain Dissipater	$15,106.89	$0.00	ea	Downdrain Unit Cost Sheet	See unit rates calculations
Channel Construction w/ Riprap	$7.04	$1.25	ft	Channel Unit Cost Sheet	See unit rates calculations
Channel Construction w/o Riprap	$0.48	$0.13	ft	Channel Unit Cost Sheet	See unit rates calculations
Erosion Control	$2,919.12	$344.71	day	Modified Crew B-13A	Erosion control for O&M - includes 1 foreman, 2 laborers, 1 equipment operator, 2 truck drivers, 1 loader (4 cy), 2 dump trucks (8 cy)
Disc harrow attachment, for tractor	$670.65	$-	month	Means Line Item 015433.20 1500	Equipment rental costs
Cast-In-Place Concrete	$262.58	$-	cy	Means Line Item 033053.40 6200	Structural concrete, in place, gravity retaining wall (3000 psi), includes forms and reinforcement
Road Maintenance	$877.44	$224.36	month		Road maintenance for O&M - includes one 14M motor grader and one 6,000-gal water truck
Berming	$0.36	$-	ft	See Berm Unit Cost Sheet	See unit rates calculations
Chain Link Fencing	$24.65	$-	ft	Means Line Item 323113.20 0800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire
Vehicle Gates, Pit Perimeters	$957.01	$-	ea	Means Line Item 323113.20 5070	Fence, chain link industrial, double swing gates, 6' high, 20' opening, includes excavation, posts & hardware in concrete
Signs every 500 ft., pit perimeters	$73.63	$-	ea	Means Line Item 101453.20 0600	Signs, guide and directional signs, reflectorized, 12" x 18", excludes posts
Culvert Removal	$12.46	$-	ft	Means Line Item 024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation
Grade Control Wall	$170.79	$-	cy	Means Line Item 033053.40 3945	Structural concrete, in place, continuous strip footing (3000 psi), 36" wide x 12" deep, unreinforced, includes forms(4 uses), concrete (Portland cement Type I), placing and finishing, excludes reinforcing
Earth Fill Removal (dozer excavate, haul, spread)	$5.20	$-	cy	Means Line Item 312316.46 6070	Excavating, bulk, dozer, open site, bank measure, common earth, 700 HP dozer, 300' haul
Electric Rate	$0.06	$-	kWh	-	Industrial rate data 9/27/2021 (http://www.electricitylocal.com/states/new-mexico/silver-city/)
Shade Covers	$8.25	$-	sf	-	Unit rate from published project (https://www.nationalgeographic.com/science/article/150812-shade-balls-los-angeles-California-drought-water-environment)

Means data are obtained from RS Means online (2021) with location adjustment for Las Cruces.

3.0 CALCULATIONS

This section describes the elements included in estimating the earthwork reclamation costs for Emma, utilizing the data and assumptions discussed in Section 2.0. Key equations and calculations that will be used for the cost estimate calculations are presented in Appendix B. Design parameters, assumptions, and other information are also provided within the spreadsheet to support the cost estimation. The steps to complete the earthwork RCE are as follows:

1. Project the effort required to perform each of the various reclamation activities (i.e., material quantities, distances, slopes, equipment choices, work type).
2. Based on construction industry information and labor and fuel costs, estimate the unit cost of each reclamation activity.
3. Multiply the corresponding quantities by the unit costs to calculate the sub-total cost for each reclamation activity and sum for a total.
4. Multiply the indirect percentage rate to the total to complete the cost estimate.

Overall, the cost estimating process follows the typical, standard approach used in the engineering and construction industries. The earthwork cost estimate is an iterative process based on the required loading and hauling operations and haul distance. Telesto utilizes the unit costs associated with equipment in the fleet to calculate the total reclamation cost utilizing the spreadsheets. Figure 1 summarizes the costing steps used for one piece of equipment in developing the fleet.

The main reclamation activities for the earthwork RCE are discussed in this section for stockpiles, open pits, and other miscellaneous costs. Key reclamation activities for each facility are shown in Table 5.

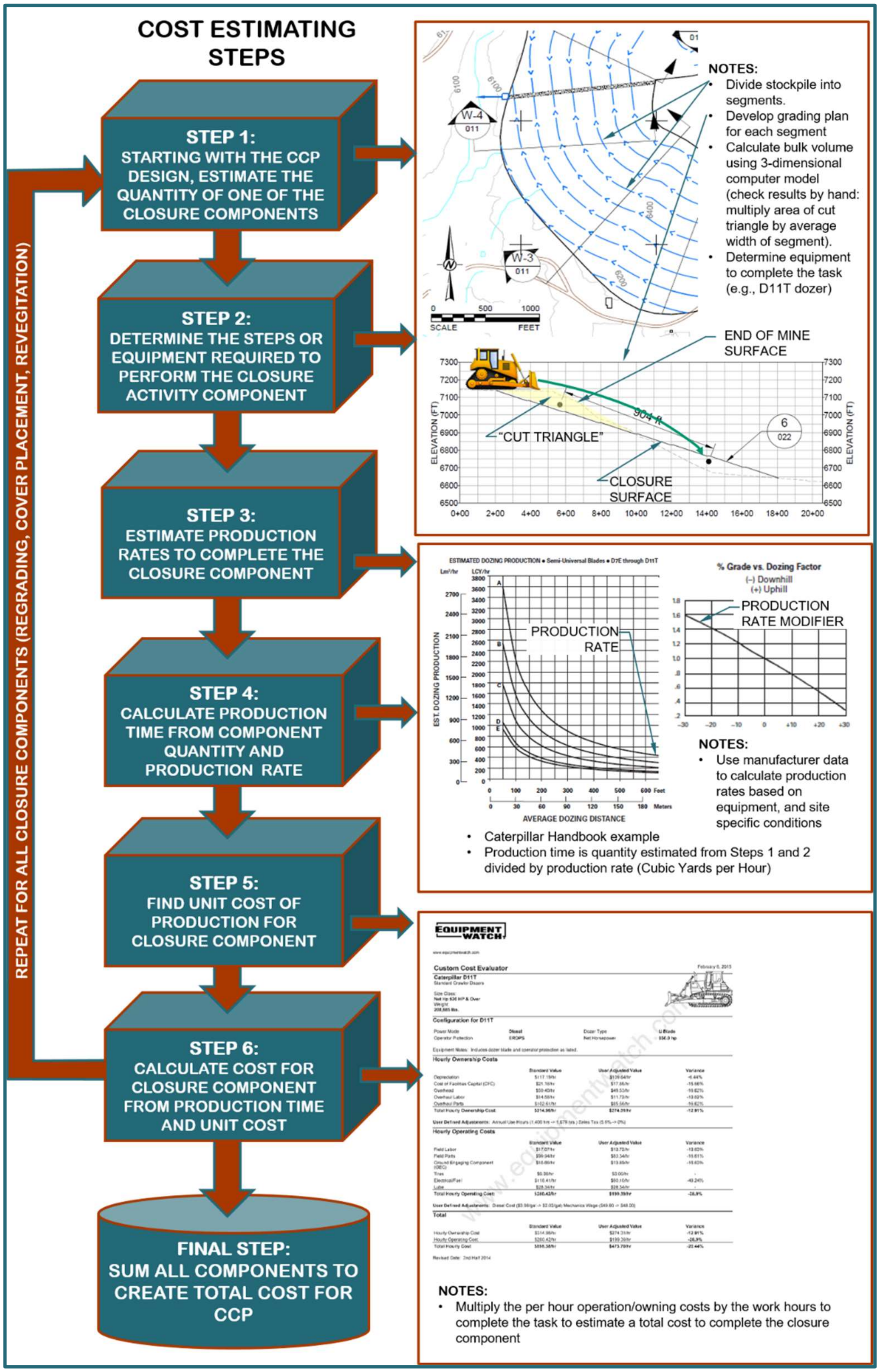


Figure 1 Earthwork Cost Estimating Process

Table 5 Reclamation Activity by Facility

Facility	Rip	Regrade 1%	Regrade 3.5:1	Cover Placement [1]	Channels	Downdrains	Revegetation	Fencing	O&M	Demolition
EMW Waste[1]										
Outslope			X	X	X	X	X		X	
6HW Waste[1]										
Outslope			X	X	X	X	X		X	
Soil Stockpile	X	X					X		X	
Emma Pit[1,2,4]			X	X			X	X	X	
Emma Haul Roads[3]	X						X		X	X
Allowance for Other Disturbed Areas	X	X		X			X		X	

[1] Cover placement at 1 foot where applicable
[2] Accessible pit flat areas are defined as pit haul road driving surfaces and flat areas 50-feet or greater from a highwall. However, areas with PAG material in benches above accessible pit flat areas are not reclaimed.
[3] Includes removal of Oak Grove Crossing
[4] See Section 3.1 for reclamation activities by pit area

The primary design elements for the cost estimate for areas to be closed include the following:

- **Regrading/Grading**: Slopes are regraded to an overall outslope gradient of 3.5H:1V with inter-bench slope lengths of 200 ft and 3H:1V interbench slopes. Grading is done in a manner to ensure positive drainage.
- **Channel Construction:** Bench and other channels are constructed with 5-foot base width and 3:1 (inner) and 2.5:1 (outer) side slopes, 2.0% maximum cross-bench slope, and 2.0% longitudinal bench slope; cover material is placed at 1-ft thickness; and filter material and riprap are placed for erosion control.
- **Downdrain Construction:** Downdrains utilize ACBs and dissipators, when needed, for erosion protection.
- **Cover**: The cost estimate includes the cost for hauling and placing 1' of fine-grained cover, from a local source (for FA purposes it is assumed the Soil Stockpile) as described in Table 3.
- **Scraper Operations**: Scrapers with dozer assist may be used to grade material at 6HW Waste.
- **Truck and Shovel:** Trucks and loaders with dozer assist perform backfill in the pit areas.
- **Cover Placement:** Trucks and loaders or hydraulic shovels with dozer assist perform all cover loading and distribution. The economic optimum number of trucks per loader or hydraulic shovel is used for each haul route.

- **Revegetation and Scarification:** The revegetation unit cost is based on R.S. Means, EquipmentWatch, and direct quotes. Scarifying of the final surface is performed at the same time as the revegetation and is included in the revegetation cost.
- **Haul Road Reclamation:** Rip and revegetate haul road areas to be reclaimed.
- **Fencing Installation:** 6-foot chain link fence will be located along the Emma Pit sump boundary for wildlife protection.

3.1 Emma Pit

The EOY 2026 pit configuration has four depressions that will be filled during mining and one depression filled during reclamation. These areas are referred to as Collection Sump, Main South, Upper North, Upper East, and Upper South. The Collection Sump is located in the deepest portion of the open pit. The other areas are located at higher elevations, with catchment areas during operations between approximately 5 and 20 acres.

The cost estimate includes the cost for hauling and placing fill from EMW Waste for the Collection Sump. The other areas (Main South, Upper North, Upper East, Upper South) will be backfilled and rough graded towards the pit during operations. Upper East will be completely reclaimed during mining (including placement of 1 foot of cover from the Soil Stockpile). Main South, Upper North, and Upper South will be covered with 1 foot of approved RCM (for FA purposes it is assumed the Soil Stockpile) during reclamation. Trucks and loaders or hydraulic shovels with dozer assist perform all fill and cover loading and distribution. The economic optimum number of trucks per loader or hydraulic shovel is used for each haul route.

The conceptual designs presented in the CCP for pit fill are based on an overall outslope gradient of 3.5H:1V and inter-bench slope of 3H:1V with the exception of the fill in the pit water management sump which is designed steeper (2:1) because that will yield the smallest possible water surface for water management at closure.

A 6-foot chain link fence will be constructed at the water management sump to prevent access by wildlife. The fill in the Collection Sump will not be revegetated because it is in an acidic environment with PAG highwalls around it. The purpose of this fill is simply to minimize the exposed surface of contact water. Additionally, costs are included in the estimate to cover the exposed water surface with floating plastic balls to prevent birds from being attracted to the water surface.

See Table 5, for a list of activities that will occur in closing the Emma Pit.

3.2 Stockpiles

Stockpile surfaces targeted for reclamation under this plan include all surfaces of waste stockpiles that are located outside the Tyrone Mine OPSDA and the Revised Conditional Waiver Area associated with the EOY 2026 mine plan year topography. The conceptual designs presented in the CCP for the stockpiles are based on an overall outslope gradient of 3.5H:1V, 5-foot base width bench channels with 3:1 side slopes, and 200-foot inter-bench slope lengths to allow for flexibility in the final design of the terrace benches and associated surface water conveyance channels. With these designs, the inter-bench slope is 3H:1V.

The EMW Waste and 6HW Waste will be present at Emma at the EOY 2026. Both of these stockpiles will be composed of NPAG overburden waste rock. The cost estimate includes cost for hauling and placing of 1' of fine-grained cover from a local source (for FA purposes it is assumed the Soil Stockpile). Trucks and loaders or hydraulic shovels with dozer assist perform all cover loading and distribution. The economic optimum number of trucks per loader or hydraulic shovel is used for each haul route.

The EMW Waste will be constructed at angle of repose and Tyrone intends to use the borrow material placed in the proposed EMW Waste for future reclamation projects. At closure, the borrow material within the stockpile will be excavated for use in reclamation or regraded in a manner that facilitates reclamation. The sites that are likely to receive material from the EMW Waste include 1C Haul Road, 2 Leach, 6B Leach, 6C Leach, 7B Leach Stockpiles, and San Salvador Pit within the Tyrone Mine permit boundary. The haul distance to these stockpiles is closer than the currently approved Tyrone Mine's CCP haul distance to access cover material.

Part of the outslope of 6HW Waste lies within the Tyrone Mine OPSDA and Revised the Conditional Waiver Area based on the EOY 2026 mine plan configuration. This outslope area will remain at approximate angle of repose.

Once material from the Soil Stockpile is used for reclamation, remaining surfaces will be graded to drain, ripped, and revegetated.

See Table 5, for a list of activities that will occur in closing the waste stockpiles.

3.3 Haul Roads

Existing haul roads will be reduced to 30' width to allow one-lane use for maintenance activities, including maintenance of the powerline corridor. Reclamation activities will include ripping and revegetating.

Oak Grove Wash will be restored to its original location. Fill will be removed from the Oak Grove Wash channel at a slope of 2.5:1 and used as cover.

3.4 Infrastructure and Other Miscellaneous Facilities

This category includes miscellaneous estimated closure costs such as demolition and unplanned disturbed areas.

3.4.1 Demolition

Oak Grove crossing will be demolished when the Emma Haul Road is reclaimed. Fill and culverts will be removed and debris will be buried in place.

No utility or additional structure demolition will be needed (all infrastructure will be used for O&M).

3.4.2 Allowance for Other Disturbed Areas

Tyrone will include costs in the CCP earthwork cost estimate to account for the dynamic nature of mining. This approach is intended to allow for greater flexibility in meeting the mine planning schedule and reduce the number of FA amendments. Unplanned disturbed areas may include but are not limited to small staging areas, utility corridors, small access roads, pull-offs, or other miscellaneous infrastructure locations such as pit slope monitoring equipment. See Table 5, for a list of activities that will occur in closing the unplanned disturbed areas for an additional 10 acres.

3.5 Operations and Maintenance

O&M costs related to periodic erosion control, water quality monitoring, road maintenance, and vegetation maintenance are included in the spreadsheet calculations (Appendix E). Operations and maintenance costs are assumed to diminish with time and are allocated over time periods of years 0 to 19, 20 to 39, and 40 to 99, coinciding with Tyrone Mine O&M. O&M for this cost estimate includes the following:

Erosion Control and Monitoring: Emma annual erosion control and monitoring cost estimates are based on an erosion control crew engaged for half a day (4 hours) per year for years 0-19, 3 hours per year for years 20-39, and 2 hours per year for years 40-99.

Water Quality Monitoring and Reporting: Monitoring of site water quality will be accomplished through sampling and analysis of potentially impacted water at site locations including 3 monitoring wells, the pit sump, and 2 surface water samplers.

Road Maintenance: Road maintenance will be monthly during monsoon season (4 months/yr) and is assumed to consist of a motor grater engaged for 4 hours a month.

Vegetation Maintenance: Vegetation maintenance of reclaimed areas assumes a 2% failure every year for a total of 12 years per facility, starting the year reclamation is completed.

4.0 RESULTS

The total current dollar cost for earthwork reclamation is estimated to be $5,319,875 plus $2,517,459 O&M for a total of $7,837,334. A summary of the cost estimate is provided in

Table 6. The costs presented in this RCE are current (2021) dollar costs.

Table 6 Earthwork Cost Estimate Summary

Item	Direct Cost	Indirect Cost	Total Estimated Cost
Facility		**30% of Direct**	
EMW Waste	$1,136,320	$340,896	$1,477,216
6HW Waste	$2,395,888	$718,766	$3,114,654
Soil Stockpile	$8,113	$2,434	$10,547
Stockpile Subtotal	***$3,540,320***	***$1,062,096***	***$4,602,416***
Haul Roads	***$64,216***	***$19,265***	***$83,481***
Emma Pit	***$462,079***	***$138,624***	***$600,702***
Allowance for Other Disturbed Areas	***$25,596***	***$7,679***	***$33,275***
Closure Costs Total	**$4,092,212**	**$1,227,663**	**$5,319,875**
O&M		**17.5% of Direct**	
Full Site O&M Costs Total	**$2,142,519**	**$374,941**	**$2,517,459**
Total Cost (Closure + O&M)	**$6,234,730**	**$1,602,604**	**$7,837,334**

5.0 REFERENCES

Caterpillar, Inc. (1998). *Caterpillar Performance Handbook, Edition 29.* Peoria, Illinois: Caterpillar, Inc.

Caterpillar, Inc. (2004). *Caterpillar Performance Handbook, Edition 35.* Peoria, Illinois: Caterpillar, Inc.

Caterpillar, Inc. (2011). *Caterpillar Performance Handbook, Edition 41.* Peoria, Illinois: Caterpillar, Inc.

Caterpillar, Inc. (2014). *Caterpillar Performance Handbook, Edition 44.* Peoria, Illinois: Caterpillar, Inc.

Caterpillar, Inc. (2017). *Caterpillar Performance Handbook, Edition 47.* Peoria, Illinois: Caterpillar, Inc.

Caterpillar, Inc. (2018). *Caterpillar Performance Handbook, Edition 48.* Peoria, Illinois: Caterpillar, Inc.

Freeport-McMoRan Copper & Gold. (2012). *Letter to NMED and MMD - Reclamation Cost Estimate Update (September 5).* Tyrone, NM.

Golder Associates. (2021). *Emma Project Closure/Closeout Plan.* Tyrone, New Mexico: Prepared for Freeport-McMoRan Tyrone, Inc. October.

NMDOL. (2021). *Prevailing Wage Poster H 2021*. Retrieved May 6, 2020, from New Mexico Department of Labor: https://www.dws.state.nm.us/Portals/0/DM/LaborRelations/Prevailing_Wage_Poster_H_2021.pdf

Penton Media. (2021, October). *EquipmentWatch Construction Estimator*. Retrieved May 8, 2020, from EquipmentWatch: https://equipmentwatch.com

R.S. Means. (2021, September). *Heavy Construction Cost Data, Version 8.7*. Retrieved from R.S. Means Data Online: https://www.rsmeansonline.com

APPENDICES

Appendix A

Engineering Take-Offs/ Quantities

	Item	Quantity	Units	Quantity	Units	Notes
Emma Pit Backfill	Upper North Backfill	265,180	square feet	-	-	Material hauled and regraded during mining
	Collection Sump	134,081	square feet	76,780	cubic yards	Material hauled as part of closure activities
	Collection Sump Pump Operating Surface Area	31,865	square feet	-	-	Shade Balls for Bird Determent
	South Main Pit Backfill	576,047	square feet	-	-	Material hauled and regraded during mining
	Upper South Pit Backfill	844,754	square feet	-	-	Material hauled and regraded during mining
	Upper East Pit Backfill	205,884	square feet	-	-	Reclaimed during operations- vegetation maintenance only
	Fence - Collection Sump	120	linear feet	-	-	Requires one lockable double gate
Haul Roads	Fill Removed from Emma Haul Road[1]	28,733	cubic yards	-	-	Oak Grove Wash
	Northern Emma Haul Road[1]	1,071,807	square feet	3,018	linear feet	Rip & Reveg
	Nothern Emma Haul Road[1]	90,540	square feet	3,018	linear feet	30' Maintenance Corridor
	Southern Emma Haul Road[1]	418,727	square feet	2,859	linear feet	Rip & Reveg
	Southern Emma Haul Road[1]	74,490	square feet	2,483	linear feet	30' Maintenance Corridor
	In-Pit Haul Road	211,200	square feet	2,200	linear feet	Rip & Reveg
	In-Pit Haul Road	66,000	square feet	2,200	linear feet	30' Maintenance Corridor
6HW	Regrade	2,200,000	cubic yards	3,102,014	square feet	Balanced cut to fill
	Scraper Haul	1,820	linear feet	15.7%	grade	Material is moved from x-sect G to x-sect I
	Conditionally Waived Area	257,004	square feet	-	-	
	Bench Channel Riprap	8,200	cubic yards	13,200	linear feet	9 individual channels leading to one downdrain
	Bench Channel Filter	4,100	cubic yards	13,200	linear feet	
	Downdrain ACBs	15,300	square feet	781	linear feet	One downdrain
	Downdrain Gravel	280	cubic yards	781	linear feet	
	Downdrain Geotextile	15,300	square feet	781	linear feet	
	Downdrain Prepared Subgrade	15,300	square feet	781	linear feet	
	Downdrain Engergy Dissipator	1	each	-	-	
EMW	West slope pullback	3,800,000	cubic yards	1,479,242	square feet	Cut material
	Remaining Outslope	1,569,700	cubic yards	1,750,601	square feet	Balanced cut to fill
	Bench Channel Riprap	8,300	cubic yards	13,438	linear feet	16 individual channels
	Bench Channel Filter	4,200	cubic yards	13,438	linear feet	
	Downdrain ACBs	46,100	square feet	1325	linear feet	Two downdrains
	Downdrain Gravel	430	cubic yards	1325	linear feet	
	Downdrain Geotextile	46,100	square feet	1325	linear feet	
	Downdrain Prepared Subgrade	46,100	square feet	1325	linear feet	
	Downdrain Engergy Dissipator	2	each			
Other	Soil Stockpile	361,548	square feet	547,600	cubic yards	Stockpile used for cover material - Rip & reveg remaining footprint
	Allowance for other disturbed areas	435,600	square feet			Rip, regrade, cover, reveg

[1]The reclamation designs and earthwork quantity takeoffs associated with the Northern and Southern Emma Haul Roads were prepared by Telesto; all other reclamation designs and earthwork quantity takeoffs prepared by Golder Associates

Appendix B

Key Equations and Calculations

Earthwork RCE Calculation Summary

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes a spreadsheet developed by the New Mexico Mining and Minerals Division (MMD) to estimate the earthwork's closure costs associated with the Emma Closure/Closeout Plan (CCP). The spreadsheet calculations are intricate and complex and require careful study to master their structure. Each worksheet groups similar activities, and each line on each worksheet documents one construction step required to complete reclamation. All lines totaled equal the entire earthworks for the CCP. The sheer amount of information in the spreadsheet makes review of the cost estimate difficult for a complex site.

Objective:

1. Provide a guide to the earthwork spreadsheets.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine. The example screenshots shown are from the Tyrone Mine CCP.

Approach:

1. Identify worksheets within the spreadsheet.
2. Provide a general equation or explanation of the calculation performed in each worksheet.
3. Use a graphic of each worksheet to illustrate the equations and augment the explanations pertaining to the specific worksheet.

Results:

The following worksheets are included within the earthwork RCE spreadsheet and covered in this calculation documentation:

Databases:
1. Quantities
2. Activity-Material Codes
3. Unit Rates
4. Equipment

Earthwork Calculations:
1. General
2. Demo
3. Material
4. Earthwork
5. Dozer
6. Road Maint
7. Ripper
8. Excavator
9. Trucks
10. Loader Shovel
11. Scrapers
12. M'grader
13. Earth Sum
14. Revegetation
15. Other
16. Summary
17. Facility Characteristics

Results:
The following worksheets are included within the earthwork RCE spreadsheet and covered in separate calculation documentations or are self-explanatory:

Equipment Optimization:
1. Truck Optimization

O&M:
1. Full Site Vegetation Maintenance
2. Full Site O&M
3. Full Site O&M Summary

Unit Costs:
1. Bench Grading
2. Bench Channel (and Riprap/Gravel)
3. Downdrain
4. Revegetation

Results Cont'd

Sheet 1 – General: A summary of the overall costs (before escalation and discounting for the time-value of money) are included on this sheet along with the applicant's information.

	A	B	C
1			Tyrone Mine
2			Stockpile Spreadsheet Worksheet #1
3	***General Information***		4/29/2019
4			
5	Applicant	Tyrone Mine Company	
6		Tyrone, New Mexico 88065	
7			
8			
9			
10			
11	Disturbed Surface Area (acres)	3,031	
12	*(does not include previously reclaimed areas)*		
13			
14	Type of Operation	Existing/Surface/Copper	
15			
16			
17			
18	*Current value of earthwork and O&M before escalation and discounting*	**$101,470,627**	
19			
20			
21			
22			
23			**Stockpiles, Tailing,**
24			**Reservoirs, Haul Roads**
25			**and Disturbed Areas**

Quantities Sheet: This sheet assigns an item code to a facility and corresponding sub-area code with a description of the facility and sub-area. This sheet provides raw data and factors (such as area, volume, distances, grades, etc.) to be used in calculations within all the other worksheets. Each facility is broken down into sub-areas to account for differing reclamation quantities to more accurately determine the amount of work required for each facility. The Quantities sheet includes 36 columns of hard-wired (hand entered) data associated with each facility. Columns A through H for 1A and 1B Leach, 1C, 2A Leach and 2B Waste, and 3A/3B Stockpiles are shown as an example:

	A	B	C	D	E	F	G	H
1								
2	1	2	3	4	5	6	7	8
3	**Item**	**Facility**	**Sub Area or Destination for Cover Material**	**Description**	**Area (sf)**	**Volume (cy)**	**Push Distance (ft) Berm Length (ft) or Fence Length(ft)**	**Coarse Regrading and Fine Grading (%)**
4	1000	1A and 1B Leach	1A1B-0	Entire Stockpile	11,891,880	1,548,670	-	-
5	1001	1A and 1B Leach	1A1B-1	Top	740,520	79,000	430	1.0%
6	1002	1A and 1B Leach	1A1B-2	Outslopes - Regrade benches from pullback	-	1,329,670	90	-29.0%
7	1003	1A and 1B Leach	1A1B-3	Outslopes - Area outside of pullback	11,151,360	140,000	250	-29.0%
8	1100	1C	1C-0	Top (Haul Road)	740,700	-	-	
9	1200	2A Leach and 2B Waste	2A2B-0	Entire Stockpile	21,213,358	8,203,000	-	-
10	1201	2A Leach and 2B Waste	2A2B-1	Top	1,568,160	143,000	370	1.0%
11	1202	2A Leach and 2B Waste	2A2B-2	Outslopes	19,645,198	8,060,000	470	-29.0%
12	1300	3A / 3B	3A3B-0	Entire Stockpile	19,819,800	5,289,064	-	-
13	1301	3A / 3B	3A3B-1	Top	1,437,480	199,000	560	1.0%
14	1302	3A / 3B	3A3B-2	Outslopes Pullback	-	17,500,000	-	-29.0%
15	1303	3A / 3B	3A3B-3	Outslopes - Regrade benches from pullback	-	1,590,064	90	-29.0%
16	1304	3A / 3B	3A3B-4	Outslopes (total area, volume outside of pullback)	18,382,320	3,500,000	560	-29.0%

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Activity-Material Codes Sheet: This sheet assigns an activity code (column A) to each activity (column B)

	A	B	C
1	**Item**	**Activity**	**Description**
2	-	-	Place holder for item
3	A	Grade	Rough grading original material or fine grading cover material
4	B	Dozer Assist	Dozer is used to assist loader or shovel at cover stockpile or assist scrapers during rough grading
5	C	Load	Cover material is loaded at borrow areas onto haul trucks
6	D	Haul	Haul trucks transport cover material from borrow areas to destination stockpiles
7	E	Rip	Tops of stockpiles are ripped before placing cover to compensate for compaction of soil during rough grading. Stockpiles are also ripped before rough grading with a scraper. Borrow stockpile ripped
8	F	Grade Benches	Benches are graded at stockpiles and tailings after fine grading
9	G	Construct Downdrains	Downdrains are constructed after fine grading and consist of articulated concrete blocks (ACB's)
10	Gb	Construct Downdrain Dissipators	Energy dissipators are specified as part of the downdrains
11	H	Construct Bench Channels w/ Riprap	Bench channels are constructed along benches after bench grading. Construction includes excavation and wasting, riprap production, riprap and filter placement, and final grading.
12	Hb	Construct Bench Channels w/o Riprap	Bench channels are constructed along benches after bench grading. Construction includes excavation and wasting and final grading.
13	I	Construct Top/Outslope Channels	Top and outslope channels are not part of this RCE
14	J	Revegetate	Occurs after final grading and channel construction and includes tractor rental and maintenance, fuel, scarifying, discing, drill seeding, mulching, crimping, seed, and mulch
15	K	Perforate Liner	Reservoir liners are perforated prior to reclamation
16	L	Replace Infrastructure	Replacing infrastructure is not part of this RCE
17	M	Post-Closure O&M	Includes vegetation maintenance for 12 years after reclamation and erosion control, road maintenance, and groundwater monitoring for 100 years after reclamation
18	N	Plug and Abandon Well	Well borehole is backfilled with cement grout
19	O	Replace Well	Includes borehole drilling, casing, and cementing
20	P	Road Maintenance	Dust suppression and road maintenance with water truck and motor grader
21	Q	Construct Haul Road	For shorter hauls etc.
22	R	Construct Berms	Berming for stormwater runoff control
23	S	Fencing	Fencing for pits
24	T	Build Grade Control Walls	Grade control in each drainage of Tailing Launder Line removal
25	U	Vehicle Gates	Limited access at 1-mile intervals around open pits
26	V	Signs Every 500 ft	Warning signs posted every 500 feet around open pits

The same is done by assigning a material code (column A) to differentiate the materials used in the spreadsheet.

	A	B	C
28			
29	**Item**	**Material**	**Description**
30	-	-	Placeholder
31	a	Existing Ground	Existing ground before rough grading
32	b	Cover	Cover material from cover stockpiles, before being placed at destination location
33	c	Rough Graded Material	Exisiting ground after rough grading
34	d	Placed Cover	Cover material after being placed at destination location
35	e	Final Grade	Facility material and cover material after rough grading and fine grading
36	f	Backfill/Stockpile Material	Material used to backfill pit/ponds or stockpile material used in pullback
37			

These codes are used to assign an ID to each task, on the Materials sheet. The codes dictate which earthwork calculation is used for each row of work.

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Unit Rates Sheet: This sheet applies the same concept as the Quantities and Activity-Material Codes sheets whereby unit rates for particular activities utilized in the development of costs within the spreadsheet are identified and assigned a unit rate code. The unit rates are used throughout the RCE spreadsheet and are referenced from this sheet.

	A	B	C	D	E	F	G
10	Code	Activity	Base Per Unit Cost	Fuel Per Unit Cost	Units	Source	Reference
11	U1	Fuel	$ 2.34	$ -	gal	-	Diesel fuel cost is estimated by correlating historical local quotes with public data, as agreed upon in November 2018 discussions with the agencies. Fuel cost
12	U2	Revegetation	$ 820.12	$ 3.85	ac	Revegetation Unit Cost Sheet	See unit rates calculations - Cost is based on a calculated unit rate that includes tractor rental and maintenance, fuel, scarifying, discing, drill seeding, mulching,
13	U3	Bench Grading Stockpile	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
14	U4	Bench Grading Tailings Pond	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
15	U5	Downdrain Construction	$ 374.38	$ -	ft	Downdrain Unit Cost Sheet	See unit rates calculations
16	U6	Downdrain Dissipater	$ 14,556.48	$ -	ea	Downdrain Unit Cost Sheet	See unit rates calculations
17	U7a	Bench Channel Construction w/	$ 6.60	$ 1.39	ft	N/A	See unit rates calculations
18	U7b	Bench Channel Construction w/o	$ 0.41	$ 0.10	ft	N/A	See unit rates calculations
19	U8	Erosion Control	$ 2,923.36	$ 382.26	day	Modified Crew B-13A	Erosion control for O&M - includes 1 foreman, 2 laborers, 1 equipment operator, 2 truck drivers, 1 loader (4 cy), 2 dump trucks (8 cy)
20	U9	Structure Demolition	$ 0.25	$ -	cf	Means Line Item 024116.13 0100	Building demolition, large urban projects, mixture of types, excludes foundation demolition, dump fees
21	U10	Concrete Slab Demolition	$ 0.62	$ -	sf	Means Line Item 024116.17 0400	Building footings and foundations demolition, floors, concrete slab on grade, plain concrete, 6" thick, excludes disposal costs and dump fees
22	U11	Storage Tank Demolition	$ 1,005.97	$ -	ea	Means Line Item 130505.75 0530	Selective Demolition - Storage Tanks, steel tank, single wall, above ground, not including foundations, pumps or piping, 5,000 thru 10,000 gallon
23	U12	Storage Tank Demolition	$ 2,168.93	$ -	ea	Means Line Item 130505.75-0540	Steel tank, single wall, above ground, 15,000 thru 30,000 gallon, selective demolition, excluding foundation, pumps or piping
24	U13	Storage Tank Demolition	$ 3,934.80	$ -	ea	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping; scaled for a 45,500 gal tank
25	U14	Power Line Demolition	$ 0.63	$ -	ft	Means Line Item 260505.10 0370	in cost to overhead powerlines.
26	U15	Power Pole Demolition	$ 216.24	$ -	ea	Means Line Item 024113.80 0200	Selective Demolition - wood utility poles 35-45 ft high
27	U16	Pipeline (small HDPE pipe)	$ 2.29	$ -	ft	Means Line Item 024113.38 1700	excludes excavation
28	U17	Pipeline (medium HDPE pipe)	$ 3.82	$ -	ft	Means Line Item 024113.38 1800	excludes excavation
29	U18	Pipeline (large HDPE pipe)	$ 5.72	$ -	ft	Means Line Item 024113.38 1900	excludes excavation
30	U19	Well Plug & Abandon	$ 10.55	$ -	ft	N/A	Layne Christensen Company, 7/31/18 Tyrone estimate is $10,000 mobilization and demobilization plus $5,704.94 (escalated at 2% to $5819.04) for one 1500 ft well
31	U20	Well Replacement	$ 67.76	$ -	ft	N/A	Wilcox Professional Services, 8/2011, est. cost for 5 ¼ in bore, $173,500 for 3000 ft total ($57.83/ft). Escalated 2% 2011-2019= $67.76/ft
32	U21	Reinforced Concrete Wall Demolition	$ 199.20	$ -	hr	Means Crew B-12C	Standard Union Crew: 1 equipment operator (crane), 1 laborer, 1 hydraulic excavator, 2 cy, approximately 40 hrs to demo 200 ft reinforced concrete dam.
33	U22	Disc harrow attachment, for tractor	$ 616.33	$ -	month	Means Line Item 015433.20 1500	Equipment rental costs
34	U23	Cast-In-Place Concrete	$ 254.97	$ -	cy	Means Line Item 033053.40 6200	reinforcement
35	U24	Cleanup & Disposal of Wastes Requiring Special Handling	$ 335.20	$ -	ton	Means Line Item 028120.10 1120/1130	Solid pickup; average of minimum and maximum
36	U25	Tranportation of Wastes Requiring Special Handling	$ 4.78	$ -	mile	Means Line Item 028120.10 1260/1270	Transporation to disposal site (Truckload = 80 drums or 25 cy or 18 tons); average of minimum and maximum
37	U26	Road Maintenance	$ 4,945.96	$ 1,240.32	month		water truck
38	U27	Tailing Cover Maintenance	$ 2,144.29	$ 269.57	day	Modified Crew B-13A	1 dump truck (12 ton)
39	U28	Berming	$ 0.06	$ -	ft		per ft. to 0.13 cy/ft; Finish grade volume is 1/3 X 'Excavation Volume' or 0.04 ft/lf; The berm will be made from cover material; only applicable to the types of berms at the reclaimed borrow areas - These berms are only used to move water along an
40	U29	Fencing	$ 23.05	$ -	ft	Means Line Item 323113.20 0800	
41	U30	Vehicle Gates, Pit Perimeters	$ 1,002.88	$ -	ea	Means Line Item 323113.20 5070	Fence, chain link industrial, double swing gates, 6' high, 20' opening, includes excavation, posts & hardware in concrete
42	U31	Signs every 500 ft., pit perimeters	$ 65.19	$ -	ea	Means Line Item 101453.20 0600	Signs, guide and directional signs, reflectorized, 12" x 18", excludes posts
43	U32	Fire Hydrant Demolition	$ 396.73	$ -	ea	Means Line Item 024113.33 0900	Utility removal, hydrants, fire, remove only, excludes hauling
44	U33	Seepage Collection Replacement	$ 133,355.94	$ -	ea	Seepage Collection Unit Cost Sheet	See unit rates calculations
45	U34	Culvert Removal	$ 12.69	$ -	ft	Means Line Item 024113.40 0190	excludes excavation
46	U35	Grade Control Wall	$ 165.59	$ -	cy	Means Line Item 033053.40 3945	deep, unreinforced, includes forms(4 uses), concrete (Portland cement Type I), placing and finishing, excludes reinforcing
47	U36	Steel Trestle Demolition	$ 30,689.10	$ -	ea	Means Line Item 024116.33 0200	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide
48	U37	Sludge Removal	$ 306.69	-	ea	Means Line Item 026510.30 0320	remove sludge, water and remaining product from tank bottom of tank with vacuum truck, 9,000 - 12,000 gallon tank
49	U38	Substation Demo	$ 12,470.55	$ -	ea	Substation Demo Unit Cost	See unit rates calculations

Unit rates are either derived from separate calculations, RSMeans pages, or direct quotes. The unit costs are broken into base per unit cost (column C) and fuel per unit cost (column D) when applicable. If a unit cost is obtained from RSMeans, the Las Cruces, New Mexico, area cost is utilized.

Results Cont'd

Equipment Sheet: This sheet assigns a code to the various types of heavy equipment (bulldozers, wheeled loaders, excavators, etc.) used for mine closure activities. It also delineates a multitude of equipment costs and factors as well as labor costs based on the 2019 New Mexico Department of Labor hourly labor rates associated with each piece of equipment.

Equipment Code

Rental & Operating Equipment Costs

See Dozer sheet (Sheet 5) for development of the Productivity Equation

$$\boldsymbol{Productivity}_{normal} = C * (Distance_{Pu}{}^{b})$$

C = Multiplier Constant and b = Exponent Constant

EARTHWORK AND O&M EQUIPMENT

Code (1)	Equipment Description (2)	Equipment Type (3)	Fuel Consumption (gal/hr) (4)	Fuel Cost ($/hr) (5)	Lube Cost ($/hr) (6)	Field Parts ($/hr) (7)	Tire Cost ($/hr) (8)	Ground Engaging Component Cost ($/hr) (9)	Monthly Rental Rate ($/month) (10)	Field Labor Time Cost ($/hr) (11)	Rental Cost (w/o fuel, lube, tires, or field parts) ($/hr)[6] (12)	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr) (13)	Dozing Production (lcy/hr)[1] Production = C(Avg. dozing distance in ft)^b: C (14)	b (15)
Comb1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	Combo 1	19.54	$ 45.72	$ 12.72	$ 3.75	$ 13.46	$ 1.16	$ 20,078.37	$ 9.23	$ 114.08	$ 154.40	-	-
Dz1	Cat D11T, U Blade	Dozer	29.75	$ 69.62	$ 26.23	$ 13.89	$ -	$ 12.22	$ 34,408.41	$ 6.60	$ 195.50	$ 254.44	155,881.59	-0.889952
Dz2	Cat D11T CD, U Blade	Dozer[7]	29.75	$ 69.62	$ 26.23	$ 13.89	$ -	$ 12.22	$ 34,408.41	$ 6.60	$ 195.50	$ 254.44	162,758.76	-0.866691
Dz3	Cat D9T, SU Blade	Dozer	14.35	$ 33.58	$ 11.22	$ 5.49	$ -	$ 3.98	$ 30,109.48	$ 6.60	$ 171.08	$ 198.37	52,161.03	-0.845532
Dz4	Cat D6T, SU Blade	Dozer	7.22	$ 16.89	$ 4.83	$ 2.10	$ -	$ 2.10	$ 8,939.42	$ 3.83	$ 50.79	$ 63.65	13,582.45	-0.74851
Dz5	Cat D6T XL, SU Blade	Dozer	7.80	$ 18.25	$ 5.28	$ 2.32	$ -	$ 2.36	$ 9,104.55	$ 3.83	$ 51.73	$ 65.52	13,582.45	-0.74851
Ex1	Cat 319D L	Excavator	5.25	$ 12.29	$ 3.47	$ 1.19	$ -	$ 0.84	$ 7,450.15	$ 4.55	$ 42.33	$ 52.38	-	-
Ld1	Cat 992K	Loader	25.63	$ 59.97	$ 22.35	$ 4.43	$ 35.39	$ 4.99	$ 25,527.98	$ 4.02	$ 145.05	$ 216.23	-	-
Ld2	Cat 988H	Loader	15.20	$ 35.57	$ 11.40	$ 2.11	$ 16.85	$ 1.93	$ 16,272.06	$ 4.02	$ 92.45	$ 128.76	-	-
Ld3	Cat 980H	Loader	10.80	$ 25.27	$ 6.70	$ 1.13	$ 7.69	$ 1.03	$ 10,030.76	$ 4.02	$ 56.99	$ 77.56	-	-
Ld4	Cat 966H	Loader	8.38	$ 19.61	$ 5.33	$ 0.84	$ 5.71	$ 0.75	$ 9,937.50	$ 4.02	$ 56.46	$ 73.11	-	-
Ld5	Cat 993K	Loader	30.40	$ 71.14	$ 26.70	$ 5.32	$ 42.47	$ 4.73	$ 25,527.98	$ 4.02	$ 145.05	$ 228.29	-	-
Mg1	Cat 16M	Motor Grader	9.50	$ 22.23	$ 8.69	$ 3.26	$ 10.13	$ 1.76	$ 11,906.70	$ 2.02	$ 67.65	$ 93.51	-	-
Mg2	Cat 14M	Motor Grader	8.29	$ 19.40	$ 6.57	$ 2.27	$ 7.04	$ 1.16	$ 11,906.70	$ 2.02	$ 67.65	$ 86.71	-	-
Rp1	Cat D11T CD Multi-shank (w/ MSR-359H)	Ripper	29.75	$ 69.62	$ 26.60	$ 14.20	$ -	$ 1.56	$ 36,753.56	$ 8.16	$ 208.83	$ 259.35	-	-
Sc1	Cat 637G	Scraper	38.00	$ 88.92	$ 17.07	$ 6.27	$ 7.57	$ 1.28	$ 25,070.00	$ 12.80	$ 142.44	$ 187.43	-	-
Sc2	Cat 657G	Scraper	42.86	$ 100.29	$ 20.41	$ 7.73	$ 9.34	$ 2.31	$ 25,070.00	$ 12.80	$ 142.44	$ 195.03	-	-
Sh1	Hitachi EX3600-5	Shovel[2]	82.72	$ 193.56	$ 59.15	$ 24.25	$ -	$ 16.56	$ 69,269.00	$ 14.45	$ 393.57	$ 507.98	-	-
Tc1	Deere 7430	Tractor	5.98	$ 13.99	$ 2.84	$ 0.61	$ 2.42	$ -	$ 5,210.05	$ 2.53	$ 29.60	$ 38.00	-	-
Tk1	Komatsu HD-1500 5	Truck[3]	28.12	$ 65.80	$ 19.90	$ 1.79	$ 25.19	$ -	$ 25,211.93	$ 7.47	$ 143.25	$ 197.60	-	-
Tk2	Cat 769D	Truck	9.74	$ 22.79	$ 8.77	$ 1.48	$ 13.72	$ -	$ 14,042.50	$ 4.25	$ 79.79	$ 108.01	-	-
Tk3	Cat 725	Truck	6.02	$ 14.09	$ 5.74	$ 0.94	$ 7.11	$ -	$ 9,849.60	$ 3.36	$ 55.96	$ 73.11	-	-
Tk4	Komatsu 730E	Truck[4]	33.48	$ 78.34	$ 20.49	$ 1.80	$ 21.21	$ -	$ 29,356.98	$ 11.49	$ 166.80	$ 221.79	-	-
Tk5	Cat 777F	Truck	18.76	$ 43.90	$ 19.31	$ 3.03	$ 26.81	$ -	$ 56,160.00	$ 6.38	$ 319.09	$ 374.62	-	-
Tw1	Off-Hwy Water Tanker Truck,6,000-gal.	WaterTruck	11.25	$ 26.33	$ 6.15	$ 1.48	$ 6.42	$ -	$ 8,171.67	$ 7.21	$ 46.43	$ 67.69	-	-
Tw2	Off-Hwy Water Tanker Truck,10,000-gal.	WaterTruck	15.43	$ 36.11	$ 9.04	$ 2.43	$ 10.47	$ -	$ 12,949.87	$ 10.30	$ 73.58	$ 105.82	-	-
X1	2 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.39	$ 1.15	$ 0.40	$ -	$ 5,738.88	$ 4.46	$ 32.61	$ 41.01	-	-
X2	3 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.43	$ 1.24	$ 0.39	$ -	$ 5,994.24	$ 4.62	$ 34.06	$ 42.74	-	-
X3	1 Deck Screening Plant (5X16, 48X60)	ScreenPlant	4.85	$ 11.35	$ 2.37	$ 1.14	$ 0.39	$ -	$ 5,671.66	$ 4.46	$ 32.23	$ 40.59	-	-
X4	3 Deck Screening Plant (5X16, 42X60)	ScreenPlant	4.85	$ 11.35	$ 2.38	$ 1.16	$ 0.37	$ -	$ 5,743.36	$ 4.62	$ 32.63	$ 41.16	-	-

The equipment sheet also contains the production equation coefficients for dozing (columns N-O) and scraper haul travel time coefficients (columns P-AI)

See Trucks sheet (Sheet 9) for development of the Haul Travel Time Equation

Haul Travel Time (min/m)*=A(Eff. Grade %)^4 + B(Eff. Grade %)^3 + C(Eff. Grade %)^2 + D(Eff. Grade %) + E*

where effective grade is the sum of the measured grade and rolling resistance

EARTHWORK AND O&M EQUIPMENT

Haul Travel Time (min/m) = A(Eff. Grade %)^4 + B(Eff. Grade %)^3 + C(Eff. Grade %)^2 + D(Eff. Grade %) + E

Code	Equipment Description	Equipment Type	Loaded Uphill A	B	C	D	E	Empty Uphill A	B	C	D	E	Loaded Downhill A	B	C	D	E	Empty Downhill A	B	C	D	E
Comb1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	Combo 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz1	Cat D11T, U Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz2	Cat D11T CD, U Blade	Dozer[7]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz3	Cat D9T, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz4	Cat D6T, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dz5	Cat D6T XL, SU Blade	Dozer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ex1	Cat 319D L	Excavator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld1	Cat 992K	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld2	Cat 988H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld3	Cat 980H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld4	Cat 966H	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ld5	Cat 993K	Loader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg1	Cat 16M	Motor Grader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg2	Cat 14M	Motor Grader	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rp1	Cat D11T CD Multi-shank (w/ MSR-359H)	Ripper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sc1	Cat 637G	Scraper	3.2483	-1.9562	0.4337	-0.0026	0.001	0	-0.3247	0.1601	-0.0038	0.0011	0.6464	-0.6147	0.1749	-0.0004	0.0011	0	0	0.0367	0.0018	0.0009
Sc2	Cat 657G	Scraper	0.3036	-0.4512	0.2181	-0.0034	0.0013	0	-0.1016	0.0774	-0.0013	0.0012	0	-0.1612	0.1031	-0.0081	0.0016	0	0.1668	-0.094	0.0207	0.0004
Sh1	Hitachi EX3600-5	Shovel[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tc1	Deere 7430	Tractor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tk1	Komatsu HD-1500 5	Truck[3]	4.494	-2.4571	0.6319	-0.0051	0.0011	0	-0.2561	0.1351	-0.0004	0.001	0	0	0.0856	0.0135	0.0009	0	0	0	0.0143	0.0005
Tk2	Cat 769D	Truck	0.5429	-0.487	0.1823	0.0151	0.0007	0	0.0224	-0.0076	0.0141	0.0007	0	0	-0.0808	0.426	-0.0008	5.6146	-3.6353	0.7823	-0.0535	0.002
Tk3	Cat 725	Truck	0.1363	0.1636	-0.04	0.0342	0.0009	0	-0.024	0.0309	0.0099	0.001	0	2.5262	-0.7562	0.095	-0.002	0	0	0	0.0103	0.0009
Tk4	Komatsu 730E	Truck[4]	7.5599	-2.711	0.4209	0.005	0.0011	0	-0.0689	0.0501	0.0052	0.001	-	-1.1878	0.325	0.0042	0.001	-3.4907	2.4171	-0.55	0.0643	-0.0011
Tk5	Cat 777F	Truck	6.43	-3.2933	0.6548	-0.005	0.0009	0	-0.0197	0.0276	0.011	0.0008	2.147	-1.9812	0.5102	-0.0158	0.0009	0.7651	-0.3831	0.0898	-0.001	0.0008
Tw1	Off-Hwy Water Tanker Truck,6,000-gal.	WaterTruck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tw2	Off-Hwy Water Tanker Truck,10,000-gal.	WaterTruck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X1	2 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X2	3 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X3	1 Deck Screening Plant (5X16, 48X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X4	3 Deck Screening Plant (5X16, 42X60)	ScreenPlant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

For example use only. Values may not match the current spreadsheet.

Results Cont'd

Equipment Sheet cont'd:

Other equipment specifications listed in the equipment sheet can also be found in the RCE report. It is important to note that each piece of equipment is assigned an operator group by which labor rates are assigned according to the most up to date labor rates from NMDOL.

50	**EARTHWORK AND O&M LABOR**	
51	NMDOL Type A	Rate
52	Operator Group	($/hr)
53	Equipment Operator IV	$ 27.41
54	Equipment Operator V	$ 27.52
55	Equipment Operator VI	$ 27.70
56	Laborer I	$ 23.09
57	Laborer II	$ 23.84
58	Truck Driver III	$ 24.27

Sheet 2 – Demolition: Costs are based on square footage (ex: buildings), linear footage (ex: pipeline or power line length), or lump sum per item (ex: power pole, well casing). The costs are derived from the 2019 R.S. Means Online Heavy Construction cost data or actual on-site experience and bids.

Example calculation: (10,300 feet of powerline) x ($0.63 per linear foot)=$6,489

	A	B	C	D	E	F	G	H	I
1									Tyrone Mine
2									Stockpile Spreadsheet Worksheet #2
3	***Demolition***								4/29/2019
4									
5	Building Demolition costs are calculated in "1 BuildingDemo", "2 BuildingCover", "3 BuildingVeg", and "4BuildingWaste" and summarized on the last line of this table.								
6									
7									
8									
9									
10	**Item**	**Activity**	**Quantity**	**Unit**	**Unit Cost ($/unit)**	**Direct Item Cost ($)**	**Reference**	**Means Line Item**	**Description**
11	Power line Demolition (3 PLS to 1x1 Pond installed 2012)	-	10,300	ft	$0.63	$6,489	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
12	Power pole Demolition (3 PLS to 1x1 Pond installed 2012)	-	36	ea	$216.24	$7,785	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
13	Power line Demolition (San Salvador Pit)	-	5,222	ft	$0.63	$3,290	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
14	Power pole Demolition (San Salvador Pit)	-	17	ea	$216.24	$3,676	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
15	Power lines to substations or spurs for buildings to be demolished	-	66,200	ft	$0.63	$41,706	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
16	Power Poles to substations or spurs for buildings to be demolished	-	135	ea	$216.24	$29,192	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
17	Telephone Lines around buildings to be demolished	-	1,400	ft	$0.63	$882	Means	Means Line Item 260505.10 0370	Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead power lines.
18	Light Poles around to be demolished buildings	-	13	ea	$216.24	$2,811	Means	Means Line Item 024113.80 0200	wood utility poles 35-45 feet high
19	Fire Hydrants Mainly by SXEW	-	14	ea	$396.73	$5,554	Means	Means Line Item 024113.33 0900	Minor Site Demolition; remove fire hydrants
20	Little Rock Dewatering Pipeline Alignment #1 and #2 (Year 34 of Closure)	6"-8" Diameter Plastic	4,940	ft	$1.88	$9,266	-	-	See Pipeline UC
21	Water Treatment Pipelines (Year 99 of Closure)	assume 20-36-inch diameter	74,500	ft	$4.57	$340,282	-	-	See Pipeline UC
22	Sewer Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	1,414	ft	$4.57	$6,459	-	-	See Pipeline UC
23	PLS Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	18,893	ft	$4.57	$86,295	-	-	See Pipeline UC
24	2A East PLS Tank and 2A West PLS Tank (Year 6 of Closure)	Tank Demolition	2	ea	$3,934.80	$7,870	Means	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping, 15,000 thru 30,000; scaled for a 45,500 gal tank - assuming 22 ft diameter and 16 ft high
25	1A and 1B PLS Tanks (Year 99 of Closure)	Tank Demolition	2	ea	$3,934.80	$7,870	Means	Scaled Means Items	Storage Tanks, steel tank, single wall, above ground, not incl fdn, pumps or piping, 15,000 thru 30,000 gal; scaled for a 45,500 gal tank - assuming 22 ft diameter and 16 ft high
26	Culverts at Tailing Launder Line	Culvert Removal	22	ea	$12.69	$279	Means	Means Line Item 024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes
27	Steel Trestle at Tailing Launder Line	Steel Trestle Demo	1	ea	$30,689.10	$30,689	-	-	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide
28	Substation Removal at Mangus Pumphouse	Substation Demo	1	ea	$12,470.55	$0	-	-	See Substation Demo UC
29	Buildings and Associated Facilities	Demolition	See Demo Sheets	-	-	$4,499,228	-	-	-
30									
31					**Total Direct Cost:**	$5,089,622			

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 3 – Material: No calculations are included on this sheet. Four codes, which can be referenced from the Quantities, Activity-Material Codes, and Equipment or Unit Rates sheets, are entered by hand for each row in Columns A – D. The column labeled ID concatenates the codes. The ID contains the codes for facility location (with sub-area if applicable), work activity, material and equipment used for that particular row of work. This combination determines which equipment production and cost equations are used in the rest of the spreadsheet. The other columns on this sheet then reference the ID to lookup the description from the Activity Material Codes sheet, the source and destination locations from the Quantities sheet, the total haul or push distance and grade from the Quantities sheet, and the equipment (when applicable) from the Equipment sheet.

All activities for the Tyrone RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The description (F123) lists the activity, top or outslope (if applicable), and the material. The source location (G123) lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile (H123). Push or haul distance (I123) is used as part of calculating equipment production on Sheets 5, 9, and 11. Grade (J123 - haul grade or facility slope) is used as part of calculating equipment production on Sheets 5, 9, 11, and 12. Equipment (K123) lists the name of the equipment referenced in the ID. Blank cells indicate that that column is not relevant to a particular activity.

The ID for the example below is 1300-D-b-Tk4. This indicates that a Komatsu 730E truck (Tk4) will be used to haul (D) cover material (b) from the Gila Borrow Area to the 3A/3B (1300). The total haul distance from STS2 to the Raffinate Pond is 11,221 feet, with an average haul grade of 1.3%.

2300-Facility and 23-Sub-area

D-Activity and b-Material

Tk4-Equipment to be used

Tyrone Mine
Stockpile Spreadsheet Worksheet #3
4/29/2019

Material Handling Plan Summary Sheet

All activities for the Tyrone RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The column labeled ID contains the codes for the facility location, activity, material and equipment used for that particular row of work. The description lists the activity, top or outslope (if applicable), and the material. The source location lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile. Blank cells indicate that that column is not relevant to a particular activity.

Notes and Assumptions:

1 - Haul/Push Distance based on 2015 Tyrone RCE Submittal or measured/assumed as shown in documentation
2 - Weighted Average Haul Grades based on 2015 Tyrone RCE Submittal
3 - Grade Factors from 2015 Tyrone RCE Submittal
4 - Cover haul distance for 2A/3B stockpile is volume weighted average of Gila Borrow Area (1/3) & 9AX Stockpile (2/3)

Row	Item	Activity	Material	Eq	ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
123	1300	D	b	Tk4	1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	11,221	1.3%	Komatsu 730E
124	1500	D	b	Tk4	1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	4,750	1.9%	Komatsu 730E
125	2200	D	b	Tk4	2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	12,570	1.8%	Komatsu 730E
126	2300	D	b	Tk4	2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	5,730	1.6%	Komatsu 730E
127	1400	D	b	Tk4	1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	17,830	5.0%	Komatsu 730E
128	1800	D	b	Tk4	1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	13,990	3.9%	Komatsu 730E
129	1900	D	b	Tk4	1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	5,730	1.6%	Komatsu 730E
130	1600	D	b	Tk4	1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	10,050	2.0%	Komatsu 730E
131	1700	D	b	Tk4	1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	11,833	2.5%	Komatsu 730E
132	2701	D	b	Tk4	2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	10,811	2.9%	Komatsu 730E
133	3300	D	b	Tk4	3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	10,811	2.9%	Komatsu 730E
134	2100	D	b	Tk4	2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	6,343	7.7%	Komatsu 730E
135	2600	D	b	Tk2	2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	17,721	-1.8%	Cat 769D
136	2900	D	b	Tk2	2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Mangus Pumphouse	14,100	-1.8%	Cat 769D

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 4 – Earthwork: Repeats the ID, Description, Source Location, and Destination Location for each row from the Materials sheet. The acreage (I123), cover depth (J123), swell factor (L123), and loose/stockpile volume (M123) are referenced from the Quantities sheet. The in-place (i.e., bank) volume (K123) is calculated from the loose/stockpile volume by dividing by the swell factor. Swell is assumed to occur when cover material is moved from the borrow stockpile to the haul truck. Material left in place is assumed to have no swell, meaning the bank and loose volumes are equal.

$$Volume_{loose\_cover} = area * depth_{cover}$$

$\boxed{I325*J325/12*43560/27}$

	E	F	G	H	I	J	K	L	M
1									Tyrone Mine
2									Stockpile Spreadsheet Worksheet #4
3	*Earthwork Quantity Worksheet*								04/29/19
4									
5	**Notes and Assumptions:**								
6	1 - Acres and volumes based on 2015 Tyrone RCE Submittal								
7	2 - Cover Material Swell: The 'Loose Volume' is calculated based on the acreage to be covered, cover depth, and accounts for appropriate swell factor.								
8	3 - No swell factor for Tyrone								
9	4 - Has been agreed upon with State agencies that swell occurs when cover material is moved from source to haul truck but not from the truck to placement on stockpile								
10									
11									
12									
13									
14	ID	Description	Source Location 1	Destination Location 2	Area (ac)[1]	Cover Depth (in)	Bank/Stockpile Volume (bcy)[1,4]	Swell Factor (%)[3]	Loose/Stockpile Volume (lcy)[2]
123	1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	455.0	36	2,039,074	8%	2,202,200

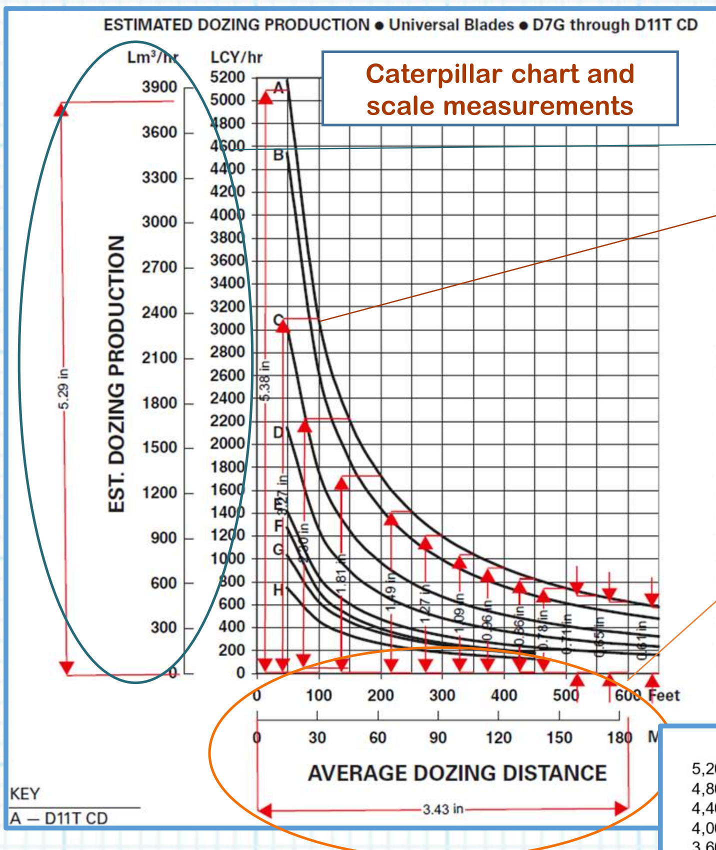
$\boxed{M325/(1+L325)}$

$$Volume_{bank} = \frac{Volume_{loose}}{(1 + F_{swell})_{bank}}$$

Sheet 5 – Dozer: Dozers are used for rough grading facilities, assisting loaders or shovels at borrow stockpiles, or pushing scrapers for grading facilities. See page 11 of this calculation documentation for a screenshot of the Dozer sheet. Columns E through K repeats ID, activity, locations, equipment from Sheet 3 (Material) and volumes from Sheet 4 (Earthwork). Columns O, P, and Z are the results of the dozer productivity calculations for grading (the multiplier and exponent coefficients C and b, respectively, for the normal productivity equation can be found in columns N and O of the Equipment sheet). Column T is the calculated task time. If the task is for dozer assist of scrapers or loaders/shovels, the dozer task time is equal to the task time of the scraper or loader/shovel, respectively. Columns Q, R, and S are calculated on the scraper and loader sheets and repeated on the dozer sheet. The remaining columns are the input factors that produce the calculation result of bulldozer material handling productivity in cubic yards per hour or acres per hour based on material weight, grade, dozing type, push distance, and operating conditions such as visibility, operator experience, and elevation.

Results cont'd:

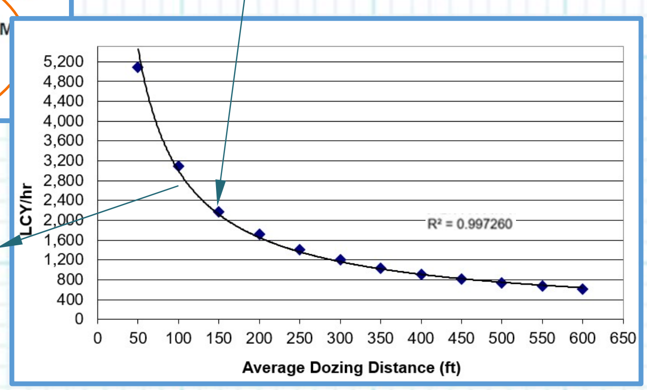
Sheet 5 – Dozer cont'd: Input values, power curves and capacities are taken from the 2017 and 2018 Caterpillar (Cat) Performance Handbook (CPH) (Editions 47 and 48) for the specific model dozer. Determining actual productivity starts by calculating the *normal* production factor using a formula derived by curve fit to productivity graphs provided in the CPH for the specific dozer. This is accomplished by scaling values from the figures and using the curve fitting tools within Microsoft Excel:



	A	B	C	D	E	F	G	H
1	D11T CD							
2	Dozer production data (based on Caterpillar Handbook)							
3						PDF		
4	Maximum					Caterpillar Image Conversions		
5	Push	Adobe	Normal			Scaled Value (in)	Chart Value	
6	Distance	Measuremer	Production			5.29	5000	LCY
7	(feet)	(in)	(cy/hr)			3.43	600	Ft
8								
9	50	5.38	5,085					
10	100	3.27	3,091					
11	150	2.3	2,174					
12	200	1.81	1,711					
13	250	1.49	1,408					
14	300	1.27	1,200					
15	350	1.09	1,030					
16	400	0.96	907					
17	450	0.86	813					
18	500	0.78	737					
19	550	0.71	671					
20	600	0.65	614					
21	650	0.61	577					

=B10/F6*G6

Graph these two columns and find best fit equation



$$Productivity_{normal} = 159{,}372.008958 * Distance_{Push}^{-0.862481}$$

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 5 – <u>Dozer cont'd</u>: The *normal* production curves assume a flat surface with a pushed material density of 2,300 lb/cy and a material that is not loose. To account for slope, operator experience, equipment specifications, and other site-specific factors, the CPH modifies the normal production curve by multiplying various factors to obtain the overall productivity:

Productivity and Hours Required for Dozer Use---Earthmoving

Notes and Assumptions:
- Uses volumes of outslope sections and dam breaches to calculate productivity
- Uses push distances of outslope sections for grading productivity
- Uses scraper push cycle time for dozer assist with scraper
- Uses loader cycle time for dozer assist with loader at cover stockpiles
- Grade Factor = -0.02(Grade %) + 1
- May filter on equipement (D14) to show pertinent rows

Number of Dozers per Assist = 1

2 dozers per assist at 3A/3B and San Salvador Pit (manually entered)

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Type of Equipment to Assist (ID)	Type of Equipment to Assist (Name)	Number of Dozers per Assist	Loose /Stockpile Volume (cy)	Area (ac)	Productivity (cy/hr)	Productivity (ac/hr)
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	Cat D11T CD	--	--	--	6,300,000	308	768	-

Tyrone Mine
Stockpile Spreadsheet Worksheet #5
04/29/19

$$Production_{normal} = C * Distance_{Push}^{b}$$

PERFORMANCE FACTORS

Scraper Pusher Cycle Time (min)	Cycles per Scraper per Hr	Loader/ Shovel/ Excavator Cycle Time	Total Task Time (hrs)	Material Factor	Grade Factor	Material Weight (lb/cy)	Production Method/ Blade	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Effective Blade Width (ft)	Speed (mph)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Direct Drive Trans.	Cut to Fill Haul Grade (%)
-	-	-	8,204.8	1.0	1.6	3,300	1.2	540	697	22	3	1.00	50	1.0	1.0	1.0	-29%

$$Productivity\left(\frac{cy}{hr}\right) = F_{mat'l} * F_{grade} * F_{prod-method} * F_{operator} * F_{visibility} * F_{elev} * F_{drive} * \frac{WorkHour}{60min/hr} * \frac{2,300\ lb/cy}{Mat'l\ Weight} * Production_{normal}$$

=U39*V39*X39*AC39*AE39*AF39*AG39*(AD39/60)*(2300/W39)*Z39

Sheet 6 –<u>Road Maint</u>: This sheet calculates the time required for a water truck and motor grader to be used for dust suppression and site maintenance during earthwork reclamation. Columns E through I repeats ID, activity, locations, and equipment. The Operational Maintenance Time (Column J) is assumed to be equal to the loader/shovel task time.

Tyrone Mine
Stockpile Spreadsheet Worksheet #6
04/29/19

Productivity and Hours Required for Dust Suppression and Road Maintenance

Notes and Assumptions:
- 6,000 gal water truck and 14M motor grader for dust suppression and site maintenance (water truck hours and 14M hours tied to loading time for cover material)
- May filter on equipement (D14) to show pertinent rows

Sheet to which to tie hrs 10 Loader Shovel

Equipment for hrs Sh1

Equipment for hrs Ld2

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Operational Maintenance Time
1000-P-b-Comb1	Road Maintenance	Gila Borrow Area	1A and 1B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	423

Equals loading time on Loader/Shovel sheet

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540a	Client: Freeport NM Operations	
Task: Earthwork RCE	Computed By: Taryn Tigges	Date: 4/30/19
	Checked By: Fred Charles	Date: 4/30/19

Results cont'd:

Sheet 7 – Ripper: Rippers are used after rough grading, before placing cover, at all facilities (or before revegetation at borrow stockpiles) to promote revegetation. Rippers are also used to loosen the existing ground before rough grading with scrapers. Columns E through J repeat the ID, title of the activity, locations, equipment and areas from Sheets 3 & 4. Columns K and L are the results of the dozer ripper productivity calculations. The remaining columns are the inputs that allow the calculation of bulldozer ripper productivity in acres per hour based on ripper performance factors:

Tyrone Mine
Stockpile Spreadsheet Worksheet #7
04/29/19

Productivity and Hours Required for Ripper---Equipped Dozer Use

Notes and Assumptions:
Uses area to calculate task time
88 ft/min = 1 mph
May filter on equipement (D14) to show pertinent rows
Task time is less than 1 hour for areas smaller than productivity rate (ac/hr)

							PERFORMANCE FACTORS									
	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
14	Task Description	Source Location 1	Destination Location 2	Equipment	Area (ac)	Productivity (ac/hr)	Task Time (hrs)	Ripping Length (ft)	Ripper Penetration (in)	Pocket Spacing (in)	Distance b/n Passes	Number of Shank Pockets	Turn Time (min/pass)	Work Hour (min/hr)	Speed (mph)	1000 Ft or 100 Ft Passes/Acre	Ripped Width Plus Distance b/n Passes (ft)
64	Rip-Top-Rough Graded Material	1A and 1B Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	17	2.9	5.8	1,000	18	59	59	3	0.25	50	1.0	1.5	30

=S64/((M64/(5280*T64/60)+R64)*U64)

=43560/(M64*V64)

=J64/K64

=Q64*(P64+O64)/12

Unit conversion factors

Sheet 8 – Excavator: An excavator with a sheepsfoot attachment is used for perforating liners before reclamation of lined impoundments. Columns E through J repeat the ID, title of the activity, locations, equipment and areas from Sheets 3 & 4. Task time (column Q) to complete compacting the entire area is calculated using the inputs from columns J-P, which are referenced from the Equipment sheet.

Tyrone Mine
Stockpile Spreadsheet Worksheet #8
#####

Productivity and Hours Required for Hydraulic Excavator

Notes and Assumptions:
Uses area to calculate time for perforating liners
3' sheepsfoot roller
Can be used for excavating and loading, or sheepsfoot compaction using a roller
May filter on equipment (D14) to show pertinent rows

	E	F	G	H	I	J	K	L	M	N	O	P	Q
13	5	6	7	8	9	10		11		12	13		14
14	ID	Task Description	Source Location 1	Destination Location 2	Equipment	Area (ac) or Volume (lcy)	Unit (ac or lcy)	Sheepsfoot Roller Width (ft) or Bucket Capacity (cy)	Unit (ft or cy)	Maximum Reach at Ground Level (ft)	Cycle Time (min)	Work Hour (min/hr)	Task Time (hr)
78	2701-K-a-Ex1	Perforate Liner-Surface Impoundments	Surface Impoundments closed at year 99; some closed year 6	-	Cat 319D L	21.2	ac	3.0	ft	31.7	0.16	50.00	31.15

=O78*(J78*43560)/(L78*N78)/P78

Unit conversion factor

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 9 – Trucks: Trucks are used to haul cover material from borrow stockpiles to destination facilities. Columns E through J repeat the ID, title of the activity, locations, equipment and volumes from Sheets 3 & 4. Column K sums the truck cycle, which includes the haul time loaded, return time empty, loading time, truck exchange time, and the dump/maneuver time. Column L reports the optimum number of trucks as limited by the number and size of loaders (calculated on the Truck Optimization sheet, as shown in the Equipment Optimization calculation summary). Column M lists the loader or shovel net bucket capacity, referenced from the Shovel sheet. Column O lists the loader or shovel task time, referenced from the Shovel sheet. Columns N and P calculate the overall productivity and time required of the load-haul-dump operations, respectively. Column P calculates the time for the truck to complete that task and compares that time to the loader task time, because the truck will have to idle while the loader/shovel finishes loading if the loader/shovel task time is longer than the truck task time (or vice versa). If the loader task time is longer, the loader task time is listed. If the truck task time is longer, the truck task time is listed.

Productivity and Hours Required for Truck Use

Notes and Assumptions:

Uses haul distance to calculate haul and return time (total task time includes loading, manuevering, dumping, hauling and return time) - moves from cover stockpile to destination stockpile
Volume of cover material based on area of destination
Cycles per truck = the greater of Heaped capacity or Struck capacity divided by Loader's per bucket capacity
1 mph = 88 ft/min
1 m/min = 0.03728227153424 mph
See Truck Optimization optimum number of trucks per loader
Haul Grade (%) assumes postive is uphill while the Effective Haul Grade (%) and Effective Return Grade (%) are postive for downhill and uphill
May filter on equipement (D14) to show pertinent rows

E	F	G	H	I	J	K	L	M	N	O	P	Q
5	6	7	8	9	10	11	12	13	14	15	16	17
ID	Task Description	Source Location 1	Destination Location 2	Equipment	Loading Equipment ID	Loose/ Stockpile Volume (cy)	Truck Cycle Time (min)	Optimum Number of Trucks	Loader/Shovel/ Excavator Net Bucket Capacity (cy)	Productivity (cy/hr)	Loader/ Shovel/ Excavator Task Time(hrs)	Truck Task Time (hrs)
1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	Sh1	2,202,200	18.4	8	28.1	3,052.2	705.7	721.5

=SUM(AL123:AP123)

=AQ123*T123*N123*M123/L123

=IF(OR(K123=0,O123=0),0,IF(K123/O123<P123,P123,K123/O123))

Columns R and S are equipment specifications from the CPH. Column T calculates the loader or shovel cycles per truck, based on loader/shovel bucket capacity and truck capacity. The total haul distance (column U) can be divided into three segments (columns V-X) if the route varies greatly in slope. The average grade for each segment is calculated and entered in Columns Y-AA. Columns U through AA are obtained from the Quantities sheet. Column AB is the rolling resistance for the assumed underfooting and tires per the CPH. Columns AC-AE convert segment distances from feet to meters for application of the performance equations from the CPH.

Tyrone Mine
Stockpile Spreadsheet Worksheet #9
04/29/19

PERFORMANCE FACTORS

R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
18	19	20	21	22	23	24	25	26	27	28	29	30	31
Struck Capacity (cy)	Heaped Capacity (cy)	Loader/ Shovel Cycles per Truck	Total Haul Distance (ft)	Haul Distance Segment 1 (ft)	Haul Distance Segment 2 (ft)	Haul Distance Segment 3 (ft)	Haul Grade Segment 1 (%)	Haul Grade Segment 2 (%)	Haul Grade Segment 3 (%)	Rolling Resistance (%)	Haul Distance Segment 1 (meters)	Haul Distance Segment 2 (meters)	Haul Distance Segment 3 (meters)
101.0	145.0	5.0	11,221	4,411	6,810	-	-7.0%	6.6%	0.0%	2.5%	1,344	2,076	-

=TRUNC(R123/ N123)

=SUM(V123:X123)

For example use only. Values may not match the current spreadsheet.

Results cont'd

Sheet 9 – Trucks cont'd: Columns AF through AK calculate the effective grade of the segment (physical grade plus the rolling resistance). Haul time (column AL) and return time (column AM) are calculated by multiplying travel times (per distance) by haul/return distance. Loading time (column AN) is based on loader/shovel productivity (Sheet 10). Times in columns AO, AP, and AQ are referenced from the Equipment sheet.

=AR123*AC123+AS123*AD123+AE123*AT123

	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
13	32	33	34	35	36	37	38	39	40	41	42	43
14	Effective Haul Grade Segment 1 (%)	Effective Haul Grade Segment 2 (%)	Effective Haul Grade Segment 3 (%)	Effective Return Grade Segment 1 (%)	Effective Return Grade Segment 2 (%)	Effective Return Grade Segment 3 (%)	Haul Time (min)	Return Time (min)	Loading Time (min)	Truck Exchange Time (min)	Dump/Maneuver Time (min)	Work Hour (min/hr)
123	4.5%	9.1%	2.5%	9.5%	4.1%	2.5%	9.6	4.7	2.25	0.7	1.1	50

=IF(Y123>=$AB123, Y123+$AB123, ABS(Y123+$AB123))

=IF(-Y123>=$AB123, -Y123+$AB123, ABS(-Y123+$AB123))

=AU123*AC123+AV123*AD123+AE123*AW123

Columns AR through AW calculate the travel time (per distance) from a curve fit based on CPH production factors, as explained on the following page. Travel time is dependent on effective grade. If the haul grade is positive (uphill), the loaded or empty uphill travel time is calculated, within the maximum speed of the truck. If the grade is negative (downhill), the loaded or empty downhill travel time is calculated, within the maximum speed of the truck.

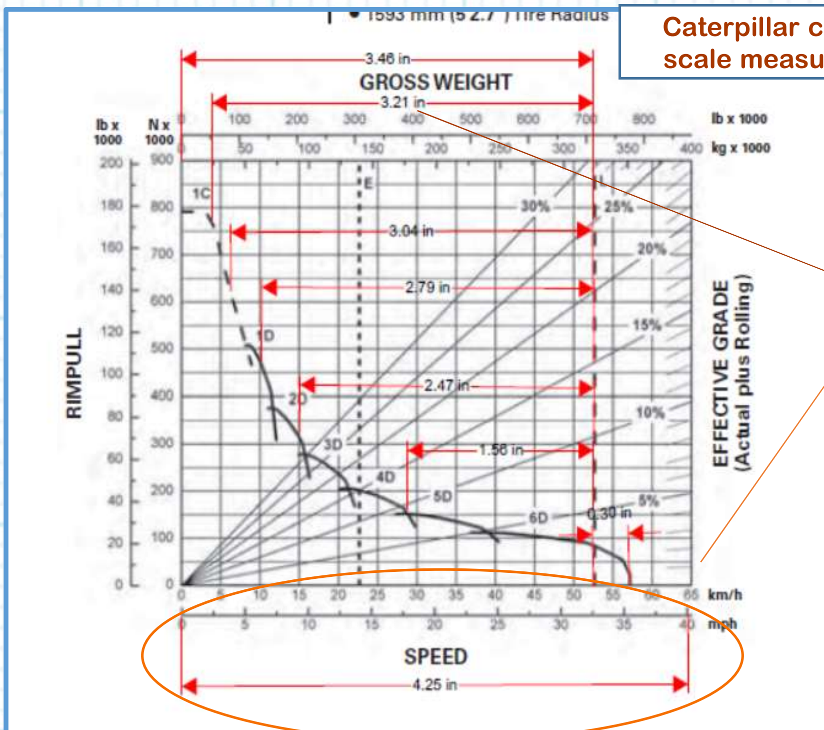
	AR	AS	AT	AU	AV	AW
1						Tyrone Mine
2						Stockpile Spreadsheet Worksheet #9
3						04/29/19
13	44	45	46	47	48	49
14	Travel Time Loaded Segment 1 (min/m)	Travel Time Loaded Segment 2 (min/m)	Travel Time Loaded Segment 3 (min/m)	Travel Time Empty Segment 1 (min/m)	Travel Time Empty Segment 2 (min/m)	Travel Time Empty Segment 3 (min/m)
123	0.00174	0.00352	0.00145	0.00189	0.00105	0.00105

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED	Job No: 200540a	Client: Freeport NM Operations	
	Task: Earthwork RCE	Computed By: Taryn Tigges	Date: 4/30/19
		Checked By: Fred Charles	Date: 4/30/19

Results cont'd

Sheet 9 – <u>Trucks cont'd</u>: Haul times are calculated for the trucks by using rimpull-speed-gradeability curves and retarding curves to create a relationship for travel time vs. effective resistance for travel uphill and downhill, respectively. A formula is derived by curve fit to the rimpull-speed-gradeability curves and retarding curves provided in the CPH for the specific truck. Similar to the dozer productivity curves, this is accomplished by scaling values from the figures and using the curve fitting tools within Microsoft Excel. Input values are taken from the 1998, 2011, 2017 and 2018 Caterpillar (Cat) Performance Handbook (CPH) (Editions 29, 41, 47, and 48) for the specific model truck. The example below shows how travel time is calculated for uphill routes, assuming a loaded truck:

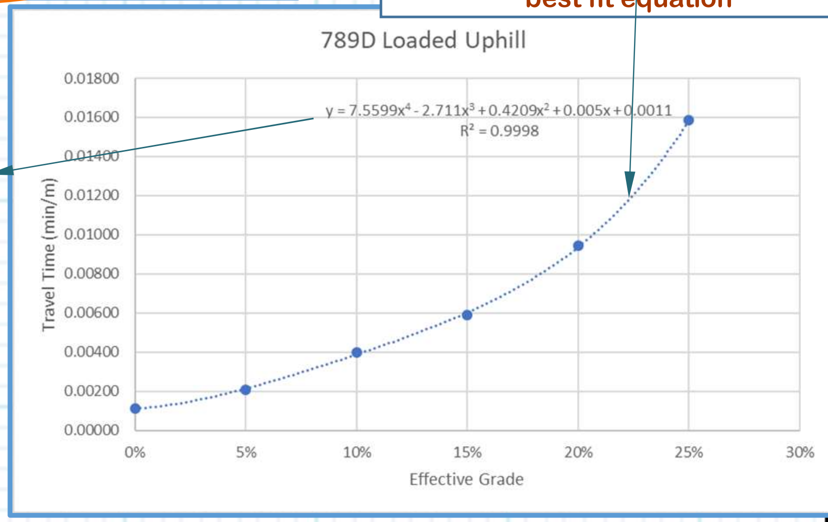


Caterpillar chart and scale measurements

	B	C	D	E	F
1	Loaded Up Hill				
2	Measurement	Speed (mph)			
3	4.25	40			
4	3.46	32.6			
5					
6	Measurement	Speed (mph)	Travel Time (min/m)	Effective Grade	
7	3.21	2.35	0.01585	25%	
8	3.04	3.95	0.00943	20%	
9	2.79	6.31	0.00591	15%	
10	2.47	9.32	0.00400	10%	
11	1.56	17.88	0.00209	5%	
12	0	32.56	0.00114	0%	

Graph these two columns and find best fit equation

Haul Travel Time (min/m)=7.5599(Eff. Grade %)⁴ + -2.711(Eff. Grade %)³ + 0.4209(Eff. Grade %)² + 0.005(Eff. Grade %) + 0.0011



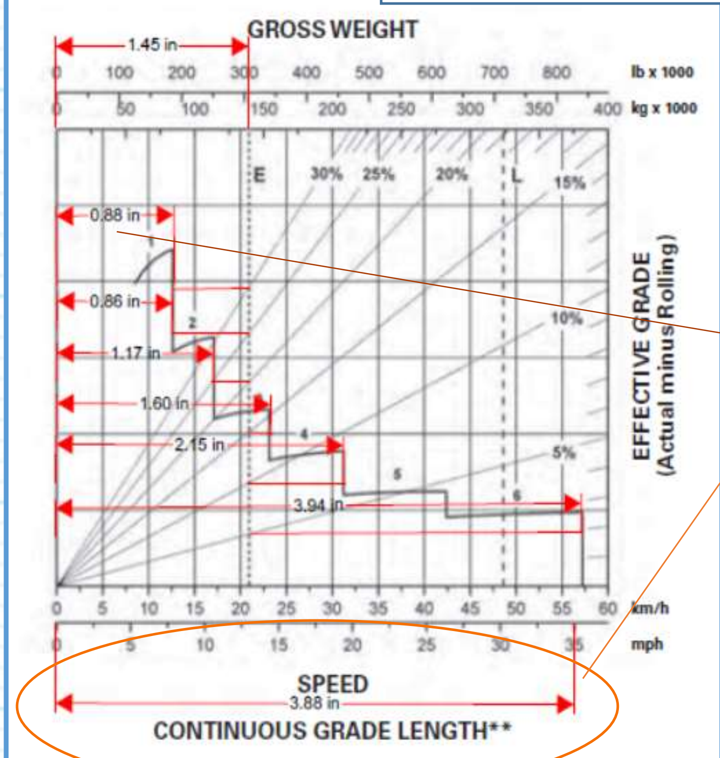
These coefficients are listed for each type of truck in columns P-AI of the Equipment sheet.

For example use only. Values may not match the current spreadsheet.

Results cont'd

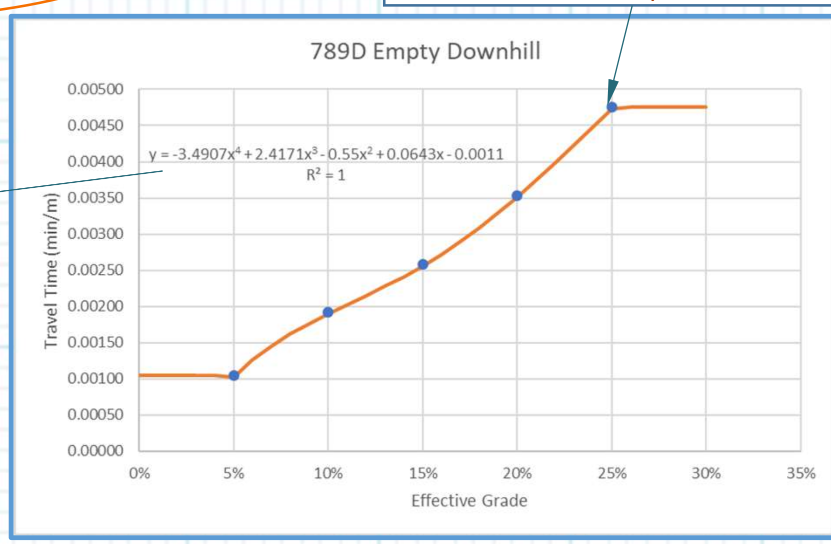
Sheet 9 – Trucks cont'd: The example below shows how travel time is calculated for downhill routes, assuming an empty truck:

Caterpillar chart and scale measurements



	B	C	D	E	F
1					
2	Measurement	Speed (mph)			
3	3.88	35			
4					
5	Measurement	Speed (mph)	Travel Time (min/m)	Effective Grade	
6	0.87	7.85	0.00475	30%	
7	0.87	7.85	0.00475	25%	
8	1.17	10.55	0.00353	20%	
9	1.6	14.43	0.00258	15%	
10	2.15	19.39	0.00192	10%	
11	3.95	35.63	0.00105	5%	
12	3.95	35.63	0.00105	0%	
13					

Graph these two columns and find best fit equation



Haul Travel Time (min/m)= -3.4907(Eff. Grade %)^4 + 2.4171(Eff. Grade %)^3 + 0.0643(Eff. Grade %)^2 + 0.0643(Eff. Grade %) + 0.0011

Fit has been adjusted to only include travel times for effective grades 5%-25%. If statements have been included in truck sheet to make travel time constant if effective grade is above 25% or below 5% for this truck type.

These coefficients are listed for each type of truck in columns P-AI of the Equipment sheet.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 10 – Loader Shovel: Loaders or shovels are used to load cover material onto haul trucks at borrow stockpiles. Columns E through I repeat the ID, title of the activity, locations, and equipment from Sheet 3. Column J is the hauling equipment that is loaded by the loader or shovel. Column K is from Sheet 4 and contains the total amount of material to be loaded/moved. Loader/shovel cycle time (column L), net bucket capacity (column P), and work hour (column Q) are from the Equipment sheet. Per Loader/Shovel Productivity (cy/hr) (column M) and Loader/Shovel Task Time (hrs) (column N) are calculated directly. Similar to the truck task time calculation, the maximum of either the loader/shovel task time or the truck task time is used (column O).

	E	F	G	H	I	J	K	L	M	N	O	P	Q
1													Tyrone Mine
2	***Productivity and Hours Required for Front End Loader Use or Hydraulic Shovel Use***												Stockpile Spreadsheet Worksheet #10
3													4/29/2019
4	**Assumptions:**												
5	Uses cover volume to calculate loading time of cover material												
6	May filter on equipement (D14) to show pertinent rows												
7													
8													
9													
10													
11													
12												**PERFORMANCE FACTORS**	
13	5	6	7	8	9	10	11	12	13	14	15	16	17
14	**ID**	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Hauling Equipment ID**	**Loose/Stockpile Volume (cy)**	**Loader/ Shovel Cycle Time (min)**	**Per Loader/Shovel Productivity (cy/hr)**	**Loader/ Shovel Task Time (hrs)**	**Max of Loader/Shovel or Truck Task Time (hrs)**	**Net Bucket Capacity (cy)**	**Work Hour (min/hr)**
99	1000-C-b-Sh1	Load-Cover	Gila Borrow Area	1A and 1B Leach	Hitachi EX3600-5	Tk4	1,321,320	0.45	3,120.6	423.4	423.4	28.1	50

=P99/L99*Q99

=K99/M98

Sheet 11 – Scrapers: No scrapers are used in Tyrone RCE.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheet 12 – M'Grader: Motor graders are used for rough grading tops of stockpiles or for fine grading cover material. Columns E through I repeat the ID, title of the activity, locations, and equipment from Sheet 3. Column J is from Sheet 4 and contains the area of material to be graded. The grade factor (Column M) is calculated based on percent grade. Column K, shaping productivity, is calculated from the speed and effective blade width. Column L is calculated directly. Column N is an assumed material handling factor and Column U is a factor based on operator experience. Columns O-T are based on material properties and equipment information.

Tyrone Mine
Productivity and Hours Required for Motorgrader Use---Grading
Stockpile Spreadsheet Worksheet #12
4/29/2019

Notes and Assumptions:
Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Efficiency (*Cat. Handbook Edition 47* pg 11-27)
Max. safe slope for motor graders is 2:1 (50%), proposed final grade for Tyrone cover grading on stockpiles is 33%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

ID	Task Description	Source Location 1	Destination Location 2	Grading Equipment	Area (ac)	Grading Shaping Productivity (ac/hr)	Task Time (hrs)	Grade Factor	Material Factor	Material Weight (lb/cy)	Production Method/ Blade	Effective Blade Width (ft)	Pass Overlap (ft)	Speed (mph)	Work Hour (min/hr)	Operator Factor
1001-A-a-Mg1	Grade-Top-Existing Ground	1A and 1B Leach	-	Cat 16M	17	3	5.9	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00

=(T46/60)*N46*(2300/O46)*P46*U46*M46*S46*(Q46-R46)*5280/43560

=IF(K115>0,J115/K115,0)

Unit conversion factors

Soil weight (lb/cy) assumed in CPH

Sheet 13 – EarthSum: This sheet summarizes all of the quantities and production rates on the individual sheets (5, and 7 through 12) and applies costs from Equipment Watch, the New Mexico labor rates table, fuel quotes, etc. Columns E through I repeat the ID, title of the activity, locations, equipment from Sheet 3. Columns J through L list the fuel, rental and maintenance, and labor unit costs from the Equipment sheet for the associated piece of equipment. The number of units of equipment is assumed to be one except for trucks and scrapers, which use an optimum number of units, calculated on the truck and scraper optimization sheets. The time required is taken from each of the equipment sheets (Sheets 5-12). The fuel, rental and maintenance, and labor costs are calculated by multiplying the unit costs by the time required for each task. The total equipment cost (column R) is the sum of the fuel, rental and maintenance, and labor costs. The total production volumes and areas are repeated from Sheet 4.

Summarizes costs for line items involving earthworks
Summary Calculation of Earthmoving Costs
Notes and Assumptions:
Summarizes all earthmoving quantities and co
Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Effici
Max. safe slope for motor graders is 2:1 (50%), proposed final grade for Tyrone cover grading on stockpiles is 33
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

ID	Description	Source Location 1	Destination Location 2	Equipment	Fuel Cost ($/hr)	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr)	Labor Cost ($/hr)
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	Cat D11T CD	$69.62	$254.44	$27.41

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED			
Job No: 200540a	Client: Freeport NM Operations	Page 19 of 23	
Task: Earthwork RCE	Computed By: Taryn Tigges	Date: 4/30/19	
	Checked By: Fred Charles	Date: 4/30/19	

Results cont'd

Sheet 13 – EarthSum cont'd:

	M	N	O	P	Q	R	S	T
1								Tyrone Mine
2								Stockpile Spreadsheet Worksheet #13
3								04/29/19
4								
5	iency (*Cat. Handbook Edition 47* pg 11-27)							
6	3%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)							
14	Number of Units (Equipment)	Time Req'd (hrs)	Direct Fuel Cost ($)	Direct Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) (	Direct Labor Cost ($)	Total Equipment Cost ($)	Total Production Volume (CY)	Total Production Area (AC)
36	1	9,306.9	$647,897	$2,368,057	$255,101	$3,271,055	8,060,000	-

=SUM(O15:Q15)

=J15*N15*M15

Sheet 14 – Revegetation: Columns E through I repeat the ID, title of the activity, locations, and areas from Sheets 3 & 4. The calculated unit rates for revegetation (reveg fuel cost and reveg cost without fuel) are multiplied by the corresponding areas to calculate the associated direct revegetation costs for each location. The total revegetation direct cost is then the sum of all direct costs related to each location.

	E	F	G	H	I	J	K	L	M
1									Tyrone Mine
2	*Revegetation Costs*								Stockpile Spreadsheet Worksheet #14
3									04/29/19
4	**Description:**								
5	Includes scarifying (ripping), discing, rangeland drill seeding, mulching, crimping, and daily per diem								
6	May filter on equipement (D14) to show pertinent rows								
14	ID	Description	Source Location 1	Destination Location 2	Area (ac)	Fuel Unit Cost ($/ac)	Reveg w/o Fuel Unit Cost ($/ac)	Fuel Direct Cost ($)	Reveg w/o Fuel Direct Cost ($)
154	1000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	1A and 1B Leach	-	273.0	$ 3.85	$ 820.12	$ 1,051	$ 223,893
155	1100-J-e-U2	Revegetate-Top (Haul Road)-Final Grade	1C	-	17.0	$ 3.85	$ 820.12	$ 65	$ 13,945
156	1200-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	487.0	$ 3.85	$ 820.12	$ 1,874	$ 399,392
157	1300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	3A / 3B	-	455.0	$ 3.85	$ 820.12	$ 1,751	$ 373,155
158	1500-J-e-U2	Revegetate-Entire Stockpile-Final Grade	5A Overburden	-	371.0	$ 3.85	$ 820.12	$ 1,428	$ 304,265
159	2200-J-e-U2	Revegetate-Entire Pit-Final Grade	San Salvador Pit	-	115.0	$ 3.85	$ 820.12	$ 443	$ 94,314
160	2300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	65.0	$ 3.85	$ 820.12	$ 250	$ 53,308
161	1400-J-e-U2	Revegetate-Entire Stockpile-Final Grade	4C Leach	-	183.0	$ 3.85	$ 820.12	$ 704	$ 150,082
162	1800-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	375.0	$ 3.85	$ 820.12	$ 1,443	$ 307,545
163	1900-J-e-U2	Revegetate-Sludge Disposal Area-Final Grade	8C	-	47.4	$ 3.85	$ 820.12	$ 182	$ 38,841
164	1600-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6B	-	54.0	$ 3.85	$ 820.12	$ 208	$ 44,286
165	1700-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6C	-	66.0	$ 3.85	$ 820.12	$ 254	$ 54,128
166	2000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9A Overburden	-	129.0	$ 3.85	$ 820.12	$ 496	$ 105,796
167	2600-J-e-U2	Revegetate-Tailing Launder Line-Final Grade	Tailing Launder Line	-	7.4	$ 3.85	$ 820.12	$ 28	$ 6,072
168	2900-J-e-U2	Revegetate-Mangus Pumphouse-Final Grade	Mangus Pumphouse	-	7.0	$ 3.85	$ 820.12	$ 27	$ 5,741
169	2701-J-e-U2	Revegetate-Surface Impoundments closed at year 99; some closed year 6-	Surface Impoundments closed at year 99; some closed year 6	-	21.2	$ 3.85	$ 820.12	$ 82	$ 17,411
170	2702-J-e-U2	Revegetate-Surface Impoundments graded over at closure-Final Grade	Surface Impoundments graded over at closure	-	0.5	$ 3.85	$ 820.12	$ 2	$ 394
171	3300-J-e-U2	Revegetate-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	125.0	$ 3.85	$ 820.12	$ 481	$ 102,515
172	2100-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9AX	-	63.7	$ 3.85	$ 820.12	$ 245	$ 52,242
173	2803-J-e-U2	Revegetate-Revegetation Area-Final Grade	Tailing Repositories Borrow Areas	-	74.7	$ 3.85	$ 820.12	$ 287	$ 61,263
290									
291				TOTAL	####			$ 11,301	$ 2,408,586

=I173*J173

=SUM(M15:M290)

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540a | Client: Freeport NM Operations |

Task: Earthwork RCE | Computed By: Taryn Tigges | Date: 4/30/19

Checked By: Fred Charles | Date: 4/30/19

Sheet 15 – Other: This sheet contains the direct costs associated with miscellaneous (other) earthwork tasks. These tasks include grading benches, constructing downdrains, constructing downdrain dissipators, constructing bench channels (including filter and riprap production and placement), replacing infrastructure, plugging and abandoning wells, replacing wells, constructing berms, fencing (including vehicle gates and signs), and building grade control walls. Columns E through H repeat the ID, description, and locations from Sheet 3. Columns I and J document the quantity and unit associated with each quantity for each task (referenced from the Quantities sheet). The unit costs (columns K and L) are referenced from the Unit Cost sheet. The quantity multiplied by the unit costs give the direct costs for each activity. The direct costs are totaled at the bottom of the sheet.

Other Reclamation Activity Costs

Tyrone Mine
Stockpile Spreadsheet Worksheet #15
04/29/19

Assumptions:
1 - Cost to construct drain or channel on re-graded stockpile
2 - The downdrain, ACB, well plug & abandon, and well replacement costs include fuel
May filter on equipement (D14) to show pertinent rows

Row	ID	Description	Source Location 1	Destination Location 2	Quantity	Unit	Fuel Unit Cost ($/unit)	Unit Cost w/o Fuel ($/unit)[1]	Fuel Direct Cost ($)	Direct w/o Fuel Cost ($)
238	1700-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6C	-	550	ft	$ -	$ 374.38	$ -	$ 205,909
239	2000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	9A Overburden	-	2,500	ft	$ -	$ 374.38	$ -	$ 935,951
240	1000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	1A and 1B Leach	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
241	1200-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	5	ea	$ -	$ 14,556.48	$ -	$ 72,782
242	1300-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	3A / 3B	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
243	1500-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	5A Overburden	-	2	ea	$ -	$ 14,556.48	$ -	$ 29,113
244	2200-Gb-e-U6	Construct Downdrain Dissipators-Entire Pit-Final Grade	San Salvador Pit	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
245	1400-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	4C Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
246	1800-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
247	1600-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6B	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
248	1700-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6C	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
249	2000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	9A Overburden	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
250	1000-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	1A and 1B Leach	-	50,013	ft	$ 1.39	$ 6.60	$ 69,277.99	$ 330,108
251	1200-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	68,062	ft	$ 1.39	$ 6.60	$ 94,279.45	$ 449,240
252	1300-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	3A / 3B	-	65,980	ft	$ 1.39	$ 6.60	$ 91,395.47	$ 435,497
253	1500-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	5A Overburden	-	50,330	ft	$ 1.39	$ 6.60	$ 69,717.09	$ 332,200
254	2200-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Pit-Final Grade	San Salvador Pit	-	9,940	ft	$ 1.39	$ 6.60	$ 13,768.88	$ 65,608
255	1400-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	4C Leach	-	23,501	ft	$ 1.39	$ 6.60	$ 32,553.57	$ 155,117
256	1800-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	26,700	ft	$ 1.39	$ 6.60	$ 36,984.83	$ 176,232
257	1700-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	6C	-	4,100	ft	$ 1.39	$ 6.60	$ 5,679.32	$ 27,062
258	2000-H-e-U7a	Construct Bench Channels w/ Riprap-Entire Stockpile-Final Grade	9A Overburden	-	25,148	ft	$ 1.39	$ 6.60	$ 34,835.00	$ 165,988
259	2800-Hb-e-U7b	Construct Bench Channels w/o Riprap-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	13,501	ft	$ 0.10	$ 0.41	$ 1,381.33	$ 5,593
260	2800-R-e-U28	Construct Berms-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142	ft	$ -	$ 0.06	$ -	$ 195
261	2600-T-e-U35	Build Grade Control Walls-Tailing Launder Line-Final Grade	Tailing Launder Line	-	1,002	ft	$ -	$ 165.59	$ -	$ 165,992
291								TOTAL	$ 547,382	$ 19,979,626

=I259*K259

=SUM(M15:M261)

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540a | Client: Freeport NM Operations |

Task: Earthwork RCE | Computed By: Taryn Tigges | Date: 4/30/19

Checked By: Fred Charles | Date: 4/30/19

Results cont'd

Sheet 16 – Sum: This sheet summarizes the direct costs from Sheets 2, 13, 14 and 15. The indirect costs are added as a percentage of the direct costs.

	A	B	C	D	E
1					Tyrone Mine
2					Stockpile Spreadsheet Worksheet #16
3					4/29/2019
4					
5	***Tyrone Mine***				
6	Reclamation Summary Stockpiles, Haul Roads, Reservoirs, and Disturbed Areas				
7					
8				**Current Value**	
9	**DIRECT COSTS**	Facility and Structure Removal		$5,089,622	
10		Earthmoving		$43,140,197	
11		Revegetation		$2,419,888	
12		Other		$20,527,008	
13		**Subtotal, Direct Costs**		**$71,176,714**	
14					
15	**INDIRECT COSTS**	**Subtotal, Indirect Costs**	**30.0%**	**$21,353,014**	
16					
17					
18	**TOTAL COST**			**$92,529,729**	
19		Twelve Year Annual Expenditure		**$7,710,811**	
20					
21					
22	Notes:				
23	Indirect costs are based on 2019 agreement between FMI and agencies				
24	Indirect costs include but are not limited to mobilization and demobilization, engineering redesign fee,				
25	contingencies, contractor profit and overhead, project management fee, and state procurement cost				

='2 Demo'!F31

='13 EarthSum'!R295

='14 Revegetation'!M291+'14 Revegetation'!L291

='15 Other'!N291+'15 Other'!M291

=SUM(D9:D12)

=C15*D13

=(D13+D15)

=D18/12

Total indirect costs of 30% are applied to the capital direct costs based on discussions involving the FA Work Group completed in December 2018 and as agreed in January 2019. The FA Work Group involved representatives of Freeport-McMoRan New Mexico Operations (FNMO), MMD, NMED, and Gila Resources Information Project (GRIP). The indirect costs incorporate Mobilization and Demobilization, Contingencies, Engineering Redesign Fee, Contractor Profit and Overhead, Project Management Fee, and other administrative costs. The RCE report provides further information on the FA Work Group agreement.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Sheets 17-Facility Characteristics- This sheet summarizes direct and indirect cost for each facility in the Tyrone RCE spreadsheet. The first four facilities listed on this sheet are shown below:

	A	B	C	D	E	F
1						
2						
3	**Facility Characteristics**					
4	Facilities are categorized in this listing to meet the MMD reporting					
5	requirement					
6			1000	1100	1200	1300
7		**Facility**	**1A and 1B Leach**	**1C**	**2A Leach and 2B Waste**	**3A / 3B**
8						
9		**Reclaimed Acres[6]**	273.00	17.00	486.99	455.00
10						
11		**Item**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**
12	Direct Costs	Cover Material Excav, Haul, Grade[1]	$1,262,102	$95,723	$3,231,529	$3,105,876
13		Pullback or Backfill	$0	$0	$0	$13,577,409
14		Top/Outslope Adjustment Grading[2]	$164,600	$0	$3,277,233	$1,659,024
15		Scarify, Seed & Mulch, Reveg[3]	$224,943	$14,011	$401,266	$374,906
16		Channels & Benches[4]	$1,928,349	$0	$3,709,623	$2,966,998
17		Demolition	$0	$0	$0	$0
18		Other[5]	$0	$0	$0	$0
19		**Capital Cost Totals**	**$3,579,994**	**$109,734**	**$10,619,651**	**$21,684,211**
20		**Capital Cost/Acre**	**$13,114**	**$6,453**	**$21,807**	**$47,658**
21						
22	Indirect Costs	Cover Material Excav, Haul, Grade1	$378,631	$28,717	$969,459	$931,763
23		Pullback or Backfill	$0	$0	$0	$4,073,223
24		Top/Outslope Adjustment Grading[2]	$49,380	$0	$983,170	$497,707
25		Scarify, Seed & Mulch, Reveg[3]	$67,483	$4,203	$120,380	$112,472
26		Channels & Benches[4]	$578,505	$0	$1,112,887	$890,099
27		Demolition	$0	$0	$0	$0
28		Other[5]	$0	$0	$0	$0
29		**Indirect Cost Totals**	**$1,073,998**	**$32,920**	**$3,185,895**	**$6,505,263**
30		**Indirect Cost/Acre**	**$3,934**	**$1,936**	**$6,542**	**$14,297**
31						
32						
33						
34		**Total Cost**	**$4,653,992**	**$142,654**	**$13,805,546**	**$28,189,475**
35		Total Cost Cover	$1,640,733	$124,440	$4,200,988	$4,037,638
36		Pullback or Backfill	$0	$0	$0	$17,650,631
37		Total Cost Top/Outslope Adjustment	$213,980	$0	$4,260,403	$2,156,731
38		Total Cost Earthwork	$1,854,712	$124,440	$8,461,391	$23,845,001
39		Capital Cost Re-Veg	$292,426	$18,214	$521,645	$487,377
40		Capital Cost Other[5]	$0	$0	$0	$0
41						
42		**Total Cost/Acre**	**$17,048**	**$8,389**	**$28,349**	**$61,955**
43		Total Cost/Acre Cover	**$6,010**	**$7,318**	**$8,626**	**$8,874**
44		Pullback or Backfill	**$0**	**$0**	**$0**	**$38,793**
45		Total Cost/Acre Top/Outslope Adjustment	**$784**	**$0**	**$8,748**	**$4,740**
46		Total Cost/Acre Earthwork	**$6,794**	**$7,318**	**$17,375**	**$52,407**
47		Capital Cost/Acre Re-Veg	**$1,071**	**$1,071**	**$1,071**	**$1,071**
48		Capital Cost/Acre Other[5]	**$0**	**$0**	**$0**	**$0**
49						

The Direct and Indirect Costs are each broken down into the following sections: Cover Material, Pullback or Backfill, Top/Outslope Adjustment Grading, Revegetation, Channels & Benches, Demolition, and Other. Demolition is not divided by location but is given as a total.

For example use only. Values may not match the current spreadsheet.

Results cont'd:

Remaining Sheets: The remaining sheets and data supporting the earthwork calculations described in this calculation documentation are described in the following calculation summaries:

- Equipment Optimization
- O&M
- Bench Grading Unit Cost
- Bench Channel Unit Cost (and Riprap/Gravel Unit Cost)
- Downdrain Unit Cost
- Revegetation Unit Cost
- Fuel Unit Cost

Fuel Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes fuel price information as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). A reliable estimate of the local 2021 fuel price is needed, based on local and national data for past years.

Objective:

1. Develop an equation to predict the current estimated local fuel price for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

1. Identify existing data used for the calculation.
2. Correlate local and national data for fuel price, paired by year.
3. Estimate current fuel price for use in the earthwork closure costs.

Data and Assumptions:

1. Data used for the calculations are shown below (1995-2018 as example) and include (a) U.S. No. 2 Diesel Retail Prices (annual national) and (b) FMI quotes (for specific dates within a year) for the local Silver City area. All prices are in $/gallon.

Fuel Price Data

Data 1: U.S. No 2 Diesel Retail Prices (Dollars per Gallon)

Date	U.S. No 2 Diesel Retail Prices[1]
1995	1.109
1996	1.235
1997	1.198
1998	1.044
1999	1.121
2000	1.491
2001	1.401
2002	1.319
2003	1.509
2004	1.81
2005	2.402
2006	2.705
2007	2.885
2008	3.803
2009	2.467
2010	2.992
2011	3.84
2012	3.968
2013	3.922
2014	3.825
2015	2.707
2016	2.304
2017	2.65
2018	3.178

Date	U.S. No 2 Diesel Retail Prices[1]
Jan 2019	2.98

FMI Fuel Quotes[2]

Site	Date	Dyed, low-sulfur diesel	Notes
Continental	1/21/2005	$1.40	Tom Shelley - quote from fuel broker
Chino & Tyrone	5/9/2007	$2.41	Porter Oil Quote (7500 gal capacity)
Continental	1/23/2009	$1.80	Porter Oil Quote (7500 gal capacity)
Tyrone (Little Rock)	1/14/2010	$2.49	Porter Oil Quote (7500 gal capacity)
Tyrone	7/7/2012	$3.13	Western Refining Oil
Continental	6/18/2014	$3.22	Western Refining Oil
Chino (North Lampbright)	11/5/2015	$1.74	Western Refining Oil
Chino	5/20/2016	$1.66	Western Refining Oil
Tyrone (Little Rock)	4/24/2017	$1.90	Western Refining Oil
Continental	3/12/2018	$2.75	Griffin Propane
Chino	10/10/2018	$2.75	Griffin Propane

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

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TELESTO SOLUTIONS INCORPORATED	Job No: 200544a-001-02	Client: Freeport NM Operations	Page 2 of 4
	Task: Fuel Cost	Computed By: Fred Charles	Date: 2/19/2019
		Checked By: Taryn Tigges	Date: 2/19/2019

Data and Assumptions (continued):

2. The local FMI fuel quotes and annual national retail fuel (U.S. No. 2) prices are assumed to trend similarly – if the national prices increase the local prices also increase.
3. A correlation between national and local fuel prices is assumed to be a reasonable predictor of local fuel prices for any time period (e.g., annual, monthly, etc).

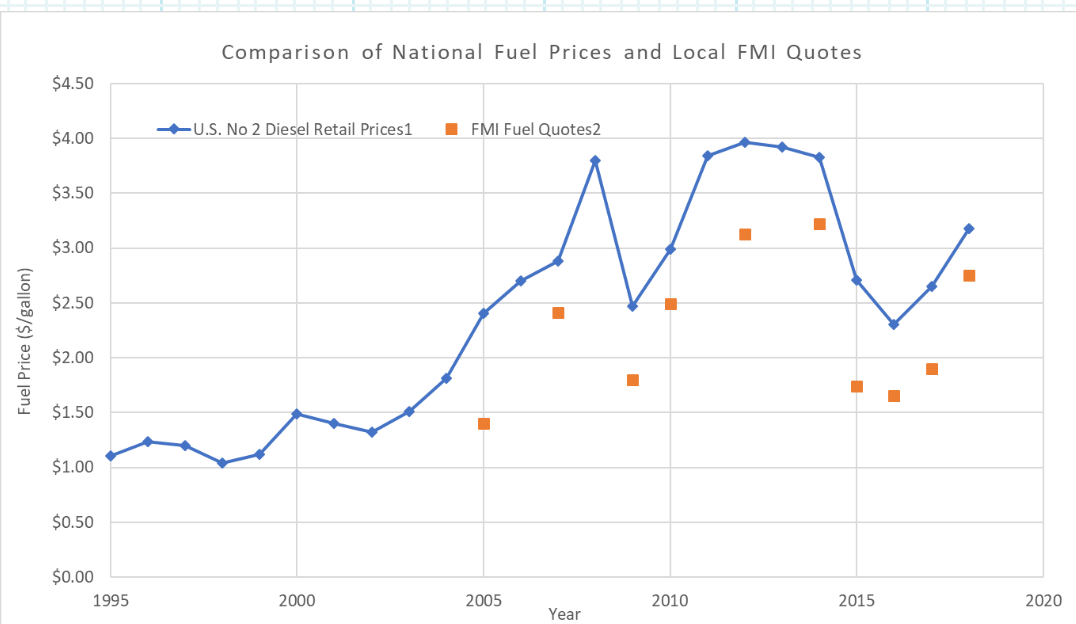
Calculations and Results:

1. The annual national retail fuel prices (U.S. Energy Information Administration) dataset is tabulated and plotted for comparison with the available annual local FMI fuel quotes (note that quotes are not available for blank years).

Year	U.S. No 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]
1995	1.109	
1996	1.235	
1997	1.198	
1998	1.044	
1999	1.121	
2000	1.491	
2001	1.401	
2002	1.319	
2003	1.509	
2004	1.81	
2005	2.402	$1.40
2006	2.705	

Year	U.S. No 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]
2007	2.885	$2.41
2008	3.803	
2009	2.467	$1.80
2010	2.992	$2.49
2011	3.84	
2012	3.968	$3.13
2013	3.922	
2014	3.825	$3.22
2015	2.707	$1.74
2016	2.304	$1.66
2017	2.65	$1.90
2018	3.178	$2.75

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)



For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

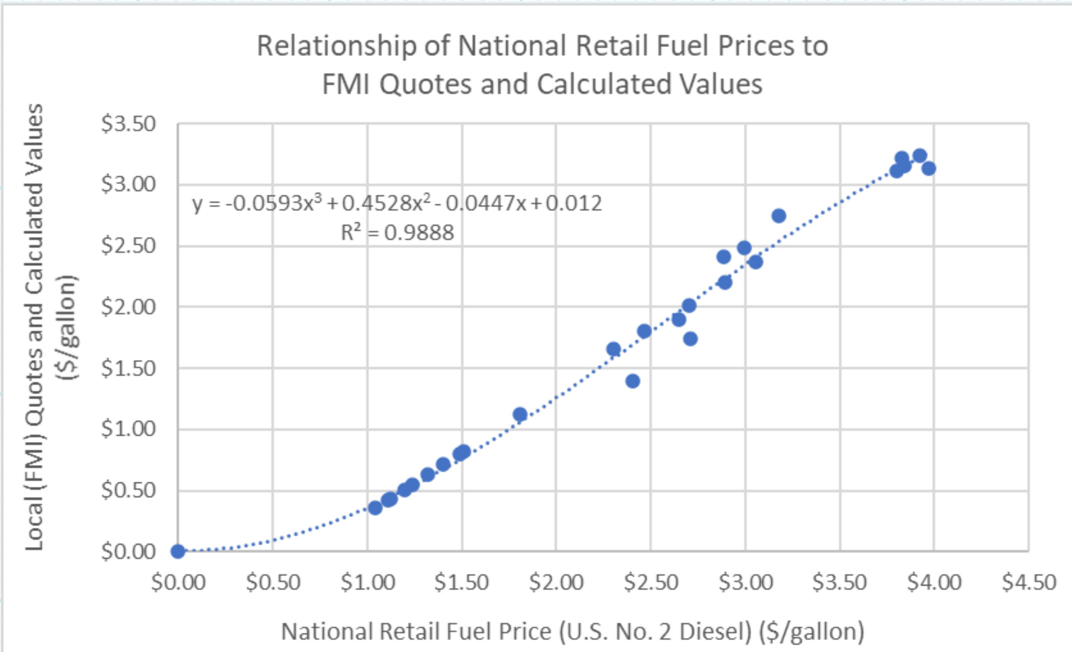
2. The annual national fuel retail prices are ranked from lowest to highest, and corresponding local FMI fuel quotes are listed for matching years in which they are available. (see Col. A and B, below)
3. The difference between the national fuel retail prices and FMI fuel quotes is calculated for each pairing. Note that FMI fuel quotes are all lower than the corresponding national fuel retail prices. The differences for all pairs are averaged. (Col. C)
4. For each year without an FMI quote, the average difference ($0.69) is subtracted from the national fuel retail prices. This results in a calculated FMI value for each unpaired data year. (Col. D)
5. The available FMI fuel quotes and calculated FMI values are combined into one column for a full listing of calculated FMI values and FMI quotes. (Col. E)
6. The annual national fuel retail prices (Col. A) are plotted vs FMI calculated values and quotes (Col. E), and a correlation is developed with national fuel prices as the independent variable and FMI values and quotes as the dependent (i.e., estimated) variable. (see Col. F and graph below)

A	B	C	D	E	F
U.S. No. 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]	Difference Between Retail Prices and FMI Quotes	Calculated FMI Values Based on Average Difference	Calculated FMI Values and Quotes	y = -0.0617x3 + 0.4659x2 - 0.0611x + 0.0148
$0.00				$0.00	$0.01
$1.11			$0.42	$0.42	$0.44
$1.24			$0.55	$0.55	$0.53
$1.20			$0.51	$0.51	$0.50
$1.04			$0.36	$0.36	$0.39
$1.12			$0.43	$0.43	$0.44
$1.49			$0.80	$0.80	$0.75
$1.40			$0.71	$0.71	$0.67
$1.32			$0.63	$0.63	$0.60
$1.51			$0.82	$0.82	$0.77
$1.81			$1.12	$1.12	$1.06
$2.40	$1.40	$1.00		$1.40	$1.70
$2.71			$2.02	$2.02	$2.04
$2.89	$2.41	$0.47		$2.41	$2.23
$3.80			$3.11	$3.11	$3.13
$2.47	$1.80	$0.67		$1.80	$1.77
$2.99	$2.49	$0.50		$2.49	$2.35
$3.84			$3.15	$3.15	$3.16
$3.97	$3.13	$0.84		$3.13	$3.25
$3.92			$3.23	$3.23	$3.22
$3.83	$3.22	$0.61		$3.22	$3.14
$2.71	$1.74	$0.97		$1.74	$2.04
$2.30	$1.66	$0.65		$1.66	$1.59
$2.65	$1.90	$0.75		$1.90	$1.98
$3.18	$2.75	$0.43		$2.75	$2.89
	Average	$0.69			

1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):



7. The prediction equation (and coefficient of determination, R^2) is shown in the above graph where x = national retail fuel price ($/gallon) and y = predicted local fuel price ($/gallon).
8. Based on this equation, and a national retail fuel price in December of 2020 of $2.59, the predicted local FMI fuel price for U.S. No. 2 diesel (December) is

$$Local\ fuel\ price = (-0.0593)(2.59)^3 + (0.4528)(2.59)^2 - (0.0447)(2.59) + 0.012 = \$1.90/gallon$$

Summary and Conclusions:

1. National and local (FMI) fuel price data were used to develop a strongly-correlated (R^2 = 0.9888) prediction equation by which local FMI fuel prices can be predicted from national fuel price data. Note that the relationship developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. The following prediction equation developed in these calculations can be used to predict the estimated December 2020 local fuel price for use in earthwork closure costs:

$$Local\ fuel\ price = -0.0593x^3 + 0.4528x^2 - 0.0447x + 0.012$$

where x = national retail fuel price ($/gallon) and y = predicted local fuel price ($/gallon)

Bench Grading
Unit Cost

TELESTO SOLUTIONS • INCORPORATED	Job No: 200540A	Client: Freeport NM Operations	Page 1 of 3
	Task: Bench Grading Unit Cost	Computed By: Fred Charles	Date: 2/27/2019
		Checked By: Taryn Tigges	Date: 3/14/2019

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes unit cost information for bench grading on side slopes of stockpiles and tailing ponds as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). The unit costs need to account for the earthwork process and site-specific conditions, equipment productivity, equipment rental rates, and associated equipment maintenance, fuel costs, and labor rates.

This calculation set presents a summary of the approach and results for estimating the unit cost for bench grading. Detailed information is presented in the earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop a bench grading unit cost ($/ft) for stockpile side slopes and tailing pond side slopes for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Account for equipment and fuel costs in the estimate.

Approach:

1. The data, assumptions, calculations, and results for the bench grading unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in a sheet (tab) named "Bench Grading_UC".
2. The approach for estimating bench grading unit costs is as follows:
   - Compile data and assumptions used in the calculations. Data obtained from the CCP or Scope of Work include:
     - Material factors
     - Grade factors
     - Soil weight
     - Production method/blade factors
     - Centroid to centroid push distance
     - Operator factor
     - Work hour
     - Visibility factor
     - Elevation factor
     - Transmission factor
     - Number of passes to finish grade
     - Speed
     - Volume

For example use only. Values may not match the current spreadsheet.

Approach:

- Equipment costs are referenced from the Equipment Sheet
- Estimate the unit cost for bench grading on sides slopes of the stockpiles and tailing ponds. The unit cost for bench grading operations is calculated based on two construction steps: excavate and final grade.
  - Productivity in cy/hr is calculated for excavation using the following equation:

$$Productivity\ (cy/hr) = Normal\ Production\ (cy/hr) * Operator * Material * \frac{Work\ Hour\ (min/\ hr)}{60\ (min/\ hr)} * Grade\ Factor * \frac{2300\ (lbs/cy)}{Material\ Weight\ (lbs/cy)} * Prod.\ Method * Visibility * Elev. * Drive\ Trans.$$

  - Productivity in hrs/ft is calculated for finish grade by using the following equation:

$$Productivity\ (hrs/ft) = \left(Operator * Material * Grade\ Factor * \frac{Work\ Hour\ (min/\ hr)}{60\ (min/\ hr)} * \frac{2300\ \left(\frac{lbs}{cy}\right)}{Material\ Weight\ \left(\frac{lbs}{cy}\right)} * Prod.\ Method * Visibility * Elev. * Drive\ Trans. * Speed\ (mi/hr) * 5280\ (ft/mi) * \frac{1}{\#\ Passes} \right)^{-1}$$

Results:

1. The results of the bench grading unit cost calculations are shown below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.

Bench Grading Unit Cost

Bench Grading - Stockpiles

Task Description	Equipment	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)		
Excavate	Cat D11T CD	$1.43	$0.35		
Finish Grade	Cat D6T XL, SU Blade	$0.09	$0.02		
		$1.52	$0.37	**$1.89**	**Total**

Bench Grading -Tailings

Task Description	Equipment	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)		
Excavate	Cat D11T CD	$1.43	$0.35		
Finish Grade	Cat D6T XL, SU Blade	$0.09	$0.02		
		$1.52	$0.37	**$1.89**	**Total**

For example use only. Values may not match the current spreadsheet.

Bench Channel Unit Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes bench channel unit cost information as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). The unit cost for bench channel construction (including production and placement of riprap and filter material) needs to account for the earthwork process and site-specific conditions, equipment productivity, equipment rental rates, and associated equipment maintenance, fuel costs, and labor rates.

Objectives:

1. Develop a bench channel unit cost ($/ft) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the bench channel unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in sheets (tabs) named "Bench Channel_UC" and "Riprap_Gravel_UC".
2. The approach for the calculations is as follows:
    - Estimate the unit cost for each of the five following bench channel construction steps:
        - Earthwork excavate and waste
        - Load and transfer riprap and filter
        - Haul riprap and filter
        - Place riprap and filter
        - Finish grade channel and riprap
    - Estimate the cost to produce riprap and filter where these materials are obtained.
    - Combine equipment and fuel costs for the bench channel operations and riprap and filter production for a total bench channel unit cost.

For example use only. Values may not match the current spreadsheet.

Data and Assumptions:

1. Bench channel cross-section data and earthwork quantities are defined in the reclamation design, with additional calculations presented below in Calculations and Results. Basic channel dimensions are shown in Table 1.

Table 1

BENCH CHANNELS		
Dimensions:		
Left Side Slope:	3.00	H:1V
Left Side Slope:	2.50	H:1V
Depth:	2.00	ft
Left Side Slope Length:	3.61	
Right Side Slope Length:	3.20	
Bottom Width:	5.00	ft
Left Anchor	0.00	ft
Right Anchor	0.00	ft
Perimeter:	11.81	ft
Excavation Area:	21.00	sf
Filter Area[1] (cross-sectional)	5.90	sf or cf/ft [2]
Riprap Area (cross-sectional)	11.81	sf or cf/ft

1. Bench cross width* 6" filter thickness
2. Volume (cy) =Area(sf)*Length(ft)/27

2. Equipment and fuel cost information used for bench channel unit cost calculations is developed in the Equipment sheet of the separate Earthwork RCE spreadsheet (summary) calculation set.
3. Equipment rates from Equipment Watch include overhaul labor, parts, and time, and are corrected for a 50-minute work hour.
4. Other equipment parameters used in the calculations are assigned based on previous use at other FMI New Mexico operations.
5. The work day is set at 8 hours/day, 50 minutes/hour.
6. The following assumptions/data inputs apply to riprap and filter production:
   - For riprap and filter production, the primary plant is fed directly by two 769D haul trucks, 300 to 400 yd haul.
   - 400 tons input/hr (per Rusty McCauley, equipment peak production is 900 tons/hr).
   - 30% - 60% waste depending on smallest rip rap size used. (per Rusty McCauley, consistent w/ McCain Springs waste rate of 43% - 1" minus).
   - 3650 lb/cy (Caterpillar Performance Handbook p. 27-4, consistent with 1.8 tons/cy riprap unit weight).

Data and Assumptions (continued):

7. Key assumptions/data inputs for riprap and filter production equipment and labor are shown in Table 2.

Table 2

Equipment & Labor	Rate ($/hr)	Comment
One 988H Loader with Operator (bucket = 8.3 cy)	$ 156.46	Used to load stockpiled material to 769D trucks and 777 haul trucks
Three 769D haul trucks with drivers (22 cy, 36 ton payload each)	$ 396.83	Option: Two used to directly feed primary screening plant, one used to move material from end of conveyor
One 1 Deck Portable Screening Plant w/ 5x16 screen & 48"x60' conveyor + 1 Operator	$ 63.68	Primary screening plant, grizzly used to split oversized, 6" - 12" and 6" minus (2 conveyers) One operator required in tower to run screening plant
		One operator required in tower to run screening plant
One 3 Deck Portable Screening Plant w/ 5x16 screen & 42"x60' conveyor + 1 Operator	$ 64.25	Fed with 6" minus, Produce 6" - 6", 1.5" - 3", 3/8" - 1.5", 3/8 minus One operator required in tower to run screening plant
Two Cat 980H Loaders with Operator (bucket = 7.5 cy)	$ 210.53	Used move material to conveyors or load trucks
Zero Cat 992K Loaders with Operator (bucket = 16 cy)	$ -	Unused loader option
One Cat 966H Loader with Operator (bucket = 5.5 cy)	$ 100.81	Used to move material from end of conveyors & load trucks
One Water Truck with Driver (10,000 gal)	$ 91.96	Dust suppression
One Foreman	$ 23.84	

Calculations and Results:

The unit costs for each of the five following bench channel construction steps are developed:

- Earthwork excavate and waste
- Load and transfer riprap and filter
- Haul riprap and filter
- Place riprap and filter
- Finish grade channel and riprap

1. Excavate and waste (earthwork) operations comprise the first construction step (shown in "Bench Channel_UC" sheet). The unit cost is calculated based on both operations using a Cat D11T CD, U Blade dozer. Table 3 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the "Excavate" row.

Table 3

	B	C	D	E	F	G	H	I	J
5		Task Description	Equipment	Volume (cy/ft)	Productivity (cy/hr)	Material Factor²	Grade Factor²	Material Weight² (lb/cy)	Production Method/ Blade Factor²
6	Bench Channels	Excavate	Cat D11T CD, U Blade	0.78	1123	1.20	1.0	2900	1.00
7	Bench Channels	Waste	Cat D11T CD, U Blade	0.78	1001	1.20	1.0	2900	1.00

	B	C	K	L	M	N	O	P	Q
5		Task Description	Centroid to Centroid Push Distance² (feet)	Normal Production (cy/hr)	Operator Factor²	Work Hour² (min/hr)	Visibility Factor²	Elevation Factor²	Transmission Factor²
6	Bench Channels	Excavate	175	1851	0.75	50	1.00	1.00	1.00
7	Bench Channels	Waste	200	1649	0.75	50	1.00	1.00	1.00

	B	C	R	S	T	U	V	W	X	Y
5		Task Description	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)	Total $/ft
6	Bench Channels	Excavate	0.0007	69.62	254.44	27.41	281.85	0.20	0.05	
7	Bench Channels	Waste	0.0008	69.62	254.44	27.41	281.85	0.22	0.05	
8								0.41	0.10	$ 0.52

The following parameters used in the calculations are based on previous use at other FMI New Mexico operations – also see Equipment sheet in the separate Earthwork RCE (summary) spreadsheet calculation set: Material Factor (Col. G), Grade Factor (Col. H), Material Weight (Col. I), Production Method/Blade Factor (Col. J), Centroid to Centroid Push Distance (Col. K), Operator Factor (Col. M), Work Hour (Col. N), Visibility Factor (Col. O), Elevation Factor (Col. P), and Transmission Factor (Col. Q).

Calculations and Results (continued):

1. Excavate and waste (earthwork) calculations (continued)

$$Volume(Col.E) = \frac{(Excav\ Area, sf\ [Bench\ channel, Table\ 1])}{(27\ cf/cy)} = \frac{21.00\ sf}{27\ cf/cy} = 0.78\ cy/ft$$

$$Productivity(Col.F) = \text{Col.}\, L\ x\ M\ x\ G\ x \left(\frac{N}{60}\right) x\ H\ x \left(\frac{2300}{I}\right) x\ J\ x\ O\ x\ P\ x\ Q =$$

$$1851 \frac{cy}{hr}\ x\ 0.75\ x\ 1.20\ x \left(\frac{50\ min/hr}{60\ min}\right) x\ 1.0\ x \frac{2300\ lb/cy}{2900\ lb/cy}\ x\ 1.00\ x\ 1.00\ x\ 1.00\ x\ 1.00 =$$

1123 cy/hr

Normal Production (Col. L): If Centroid to Centroid Push Distance is not 0, then, for the equipment used, look up the production curve fit parameters C and b for equation: $C\ x\ (Average\ dozing\ distance\ [ft])^b = 162{,}758.76\ x\ (175\ ft)^{-0.86691} =$ *1851 cy/hr*

$$Productivity(Col.R) = \frac{\left(Volume, \frac{cy}{ft} [Col.E]\right)}{\left(Productivity, \frac{cy}{hr} [Col.F]\right)}$$ = (0.78 cy/ft)/(1123 cy/hr) = 0.00069 hr/ft (or 0.0007 hr/ft)

Fuel Cost (Col. S), Equipment Cost (Col. T), and Operator (IV) Cost (Col. U) are from Equipment cost calcs (presented in the Earthwork RCE spreadsheet calculation set).

$$Dozer\ Cost\ (Col.\ V) = \frac{\$254.44}{hr}(equipment) + \frac{\$27.41}{hr}(operator) = \frac{\$281.85}{hr}$$

Bench equipment cost (Col. W) =

$$\left(Dozer\ cost, \frac{\$}{hr}[Col.V]\right) x \left(Productivity, \frac{hr}{ft}[Col.R]\right)$$ = (\$281.85/hr) x (0.00069 hr/ft) = *\$0.20/ft*

Bench Fuel Cost (Col. X) =

$$\left(Fuel\ cost, \frac{\$}{hr}[Col.S]\right) x \left(Productivity, \frac{hr}{ft}[Col.R]\right)$$ = (\$69.62/hr) x (0.00069 hr/ft) = *\$0.05/ft*

The total unit cost for the earthwork (excavate and waste) = \$0.52/ft

Calculations and Results (continued):

2. Load riprap and filter, and transfer for placing, unit cost is calculated based on the following separate operations (see “Riprap_Gravel_UC” sheet): load riprap, load filter, transfer riprap for placing, and transfer filter for placing. A Cat 992K is used for these operations. Table 4 (split into 2 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the “Load Riprap” row.

Table 4

	B	C	D	E	F	G	H	I	J
4	Earthwork								
5	Loading per cy								
6	Task Description	Equipment		Load, Dump, Maneuver Time (min)	Work Time (min)	Loads/ hr	Net Bucket (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour
7	Load riprap	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
8	Load filter	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
9	Transfer riprap for placing	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63
10	Transfer filter for placing	Cat 992K		0.65	50	76.92	14.00	1076.92	25.63

	B	K	L	M	N	O	P	Q
4	Earthwork							
5	Loading per cy							
6	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Loader+Oper Cost ($/hr)	Load+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
7	Load riprap	59.97	216.23	27.70	243.93	0.23	0.06	0.28
8	Load filter	59.97	216.23	27.70	243.93	0.23	0.06	0.28
9	Transfer riprap for placing	59.97	216.23	27.70	243.93	0.23	0.06	0.28
10	Transfer filter for placing	59.97	216.23	27.70	243.93	0.23	0.06	0.28

The following parameters used in the calculations are developed in the Equipment sheet as described for the separate Earthwork RCE (summary) spreadsheet calculation set: Load, Dump, Maneuver Time (min) (Col. E); Net Bucket (cy/load) (Col. H); Fuel Use Gal per Hour (Col. J); Fuel Cost ($/hr) (Col. K); Equipment Cost ($/hr) (Col. L); and Operator Cost ($/hr) (Col. M).

Calculations and Results (continued):

2. Load/transfer riprap and filter (continued)

Work Time (Col. F) = 50 min per hour

Loads/hr (Col. G) = (Col. F)/(Col. E) = 50/0.65 = 76.92 loads/hr

Production Rate (cy/hr) (Col. I) = (Col. H) x (Col. G) = 14.00 x 76.92 = 1076.92 cy/hr

Loader + Operator Cost/hr (Col. N) = Equipment Cost (Col. L) + Operator Cost (Col. M) = $216.23/hr + $27.70/hr = $243.93/hr

Loader + Operator Cost/cy (Col. O) = [Loader Cost, $/hr (Col. N)]/[Production Rate, cy/hr (Col. I)] = ($243.93/hr)/(1076.92 cy/hr) = $0.23/cy

Fuel Cost/cy (Col. P) = [Fuel Cost/hr (Col. K)]/[Production Rate, cy/hr (Col. I)] = ($59.97/hr)/(1076.92 cy/hr) = $0.06/cy

The total unit cost for the loading and transferring (for placing) riprap and filter = total for equipment + total for fuel = $0.23/ft + $0.06/ft = $0.28/ft (difference due to rounding)

Calculations and Results (continued):

3. Haul riprap and filter unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): haul riprap and haul filter. A Komatsu 730E is used for these operations. Table 5 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations. This table is followed by the calculations (or assigned parameters) for the "Haul Riprap" row.

Table 5

	B	C	D	E	F	G	H	I	J
12									
13	Hauling								
14	Task Description	Equipment		Exchange Time (min)	Delivery Travel Time[1] (min)	Unload and Maneuver Time (min)	Return Travel Time[1] (min)	Load Time (min)	Total Time (min)
15	Haul riprap from source to site	Komatsu 730E		0.70	8.62	1.10	3.47	6.73	20.62
16	Haul filter from source to site	Komatsu 730E		0.70	8.62	1.10	3.47	6.73	20.62

	B	K	L	M	N	O	P
12							
13	Hauling						
14	Task Description	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour	Fuel Cost ($/hr)
15	Haul riprap from source to site	50	2.42	145	352	33.48	78.34
16	Haul filter from source to site	50	2.42	145	352	33.48	78.34

	B	Q	R	S	T	U	V
12							
13	Hauling						
14	Task Description	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck+Op Cost ($/hr)	Truck + Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
15	Haul riprap from source to site	221.79	24.27	246.06	0.70	0.22	0.92
16	Haul filter from source to site	221.79	24.27	246.06	0.70	0.22	0.92

The following parameters used in the calculations are developed in the Equipment sheet as described for the separate Earthwork RCE (summary) spreadsheet calculation set: Exchange Time (min) (Col. E); Unload and Maneuver Time (min) (Col. G); Heaped Capacity (cy/load) (Col. M); Fuel Use Gal per Hour (Col. O); Fuel Cost ($/hr) (Col. P); Equipment Cost ($/hr) (Col. Q); and Operator Cost ($/hr) (Col. R).

Delivery Travel Time (Col. F) and Return Travel Time (Col. H) are based on site-wide average borrow haul time.

Calculations and Results (continued):

3. Haul riprap and filter (continued)

Load Time (Col. I)
= Dump, Maneuver Time (Col. E in load/transfer riprap)
x [Heaped Capacity, cy/load (Col. M)]/[Net Bucket, cy/load (Col. H in load/transfer riprap)]
= 0.65 min x (145 cy/load)/(14.00 cy/load) = 6.73 min

Total Time (Col. J) = Exchange Time (Col. E) + Delivery Travel Time (Col. F) + Unload and Maneuver Time (Col. G) + Return Travel Time (Col. H) + Load Time (Col. I)
= 0.70 + 8.62 + 1.10 + 3.47 + 6.73 = 20.62 min

Work Time (Col. K) = 50 min per hour

Loads/hr (Col. L) = [Work Time (Col. K)]/[Total Time (Col. J)] = 50/20.62 = 2.42 loads/hr

Production Rate, cy/hr (Col. N) = [Heaped Capacity, cy/load (Col. M)] x [Loads/hr (Col. L)]
= (145 cy/load) x (2.42 loads/hr) = 352 cy/hr

Truck + Operator Cost/hr (Col. S) = Equipment Cost (Col. Q) + Operator Cost (Col. R)
= $221.79/hr + $24.27/hr = $246.06/hr

Truck + Operator Cost/cy (Col. T) = [Truck + Operator Cost, $/hr (Col. S)]/[Production Rate, cy/hr (Col. N)] = ($246.06/hr)/(352 cy/hr) = $0.70/cy

Fuel Cost/cy (Col. U) = [Fuel Cost/hr (Col. P)]/[Production Rate, cy/hr (Col. N)]
= ($78.34/hr)/(352 cy/hr) = $0.22/cy

The total unit cost for the hauling riprap and filter = total for equipment + total for fuel = $0.70/ft + $0.22/ft = $0.92/ft

Calculations and Results (continued):

4. Place riprap and filter unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): place riprap and place filter. A Cat 725 is used for these operations. The sequence of calculations for the place riprap and filter unit cost is the same as for haul riprap and filter (from source to site) calculations, above. Inputs to the calculations for placing riprap and filter are generally the same except that Cat 725 operating parameters and costs are used. Delivery and return travel times are calculated based on the haul distance and the Haul Travel Time polynomial equation (see Equipment sheet) that calculates minutes/meter based on effective grade.

   Table 6 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations.

   Table 6

	B	C	D	E	F	G	H	I
19	Placing							
20	Task Description	Equipment	Distance	Grade	Exchange Time (min)	Delivery Travel Time (min)	Unload and Maneuver Time (min)	Return Travel Time (min)
21	Place riprap	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74
22	Place filter	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74

	B	J	K	L	M	N	O	P
19	Placing							
20	Task Description	Load Time (min)	Total Time (min)	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour
21	Place riprap	0.87	6.67	50	7.50	19	141.01	6.02
22	Place filter	0.87	6.67	50	7.50	19	141.01	6.02

	B	Q	R	S	T	U	V	W
19	Placing							
20	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck + Op Cost ($/hr)	Truck+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
21	Place riprap	14.09	73.11	24.27	97.38	0.69	0.10	0.79
22	Place filter	14.09	73.11	24.27	97.38	0.69	0.10	0.79
23								

Calculations and Results (continued):

5. Finish grade unit cost is calculated based on the following separate operations (see "Riprap_Gravel_UC" sheet): finish grade channel and finish grade riprap. A Cat D6T, SU Blade is used for these operations. The sequence of calculations for the finish grade unit cost is the same as for the first operation for bench channel construction – earthwork (excavate and waste) (see those calculations, above, for details). Inputs to the finish grade channel and finish grade riprap calculations are generally the same with the following exceptions:
   - Cat D6T, SU Blade operating parameters and costs are used.
   - Material Factor (Col. E) and Material Weight (Col. G) for riprap are used, which are different than for the excavate and waste, and channel grading, materials.

   Table 7 (split into 3 segments due to many columns) shows the progression of the calculations to estimate the cost for these operations.

   Table 7

	B	C	D	E	F	G	H	I
24								
25	Grading							
26	Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)
27	Finish grade -filter	Cat D6T, SU Blade	304.38	1.0	1.02	3500	1.0	50
28	Finish grade - Riprap	Cat D6T, SU Blade	230.34	0.8	1.02	3700	1.0	50

	B	J	K	L	M	N	O
24							
25	Grading						
26	Task Description	Normal Production (cy/hr)	Operator Factor	Work Time (min)	Visibility Factor[2]	Elevation Factor	Transmission Factor
27	Finish grade -filter	727	1	50	1	1.00	1.00
28	Finish grade - Riprap	727	1	50	1	1.00	1.00

	B	P	Q	R	S	T	U	V
24								
25	Grading							
26	Task Description	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer +Op Cost ($/hr)	Dozer + Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
27	Finish grade -filter	16.8948	63.65	27.41	91.06	0.30	0.06	0.35
28	Finish grade - Riprap	16.8948	63.65	27.41	91.06	0.40	0.07	0.47

TELESTO SOLUTIONS • INCORPORATED

Job No: 200540A | Client: Freeport NM Operations |

Task: Bench Channel Unit Cost (including riprap/filter material) | Computed By: Fred Charles | Date: 4/29/2019

Checked By: Taryn Tigges | Date: 4/30/2019

Calculations and Results (continued):

6. Riprap and filter production costs (where the material source is located) are estimated according to Table 8, with a summary of the calculations provided after Table 8.

Table 8

	B	C	D	E	F	G	H	I
36	Equipment	Equipment Cost	Fuel Cost	# Equipment	Operator	# Operator	Total Equipment Cost	Total Fuel Cost
37		($/hr)	($/hr)		($/hr)		($/hr)	($/hr)
38	Cat 988H	$ 128.76	$ 35.57	1	$ 27.70	1	$ 156.46	$ 35.57
39	Cat 769D	$ 108.01	$ 22.79	3	$ 24.27	3	$ 396.83	$ 68.37
40	1 Deck Screening Plant (5X16, 48X60)	$ 40.59	$ 11.35	1	$ 23.09	1	$ 63.68	$ 11.35
41	3 Deck Screening Plant (5X16, 42X60)	$ 41.16	$ 11.35	1	$ 23.09	1	$ 64.25	$ 11.35
42	Cat 980H	$ 77.56	$ 25.27	2	$ 27.70	2	$ 210.53	$ 50.54
43	Cat 992K	$ 216.23	$ 59.97	0	$ 27.70	0	$ -	$ -
44	Cat 966H	$ 73.11	$ 19.61	1	$ 27.70	1	$ 100.81	$ 19.61
45	Off-Hwy Water Tanker Truck,6,000-gal.	$ 67.69	$ 26.33	1	$ 24.27	1	$ 91.96	$ 26.33
46	Supervisor	$ -	-	0	$ 23.84	1	$ 23.84	$ -
47								
48					Direct Cost	Equipment	Fuel	
49						$ 1,108	$ 223	$/hr
50						8	8	hr/work day
51						$ 8,867	$ 1,785	$/day
52								
53					Production			
54						400	tons input/hr (total)	
55						0.30	% waste	
56						0.70	% rip rap and gravel/filter	
57						280	tons produced/hr (net)	
58						560,000	lb/hr	
59						3,650	lb/cy	
60						153	cy/hr	
61						8	hr/day (net (60 min/hr))	
62						1,227	cy/day net production	
63								
64					Production	$ 7.22	$ 1.45	$/cy
65					Filter Delivery and placement	$ 2.14	$ 0.49	$/cy
66					Rip Rap Delivery and placement	$ 2.24	$ 0.51	$/cy
67								

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

6. Riprap and filter production calculations (continued):

For each type of equipment used, the costs calculated (see Earthwork RCE spreadsheet calculation set) are tabulated in Table 8, including Equipment Cost (Col. C), Fuel Cost (Col. D), and Operator Cost (Col. F).

The number of pieces of equipment (Col. E) and number of operators (Col. G) are assigned based on the logistical requirements for production. Pieces of equipment match the number of operators, except for addition of a Supervisor.

Total equipment cost (Col. H) is calculated as follows, with an example calculation shown for the Cat 988H:

$$Total\ Equipment\ Cost, \$/hr =$$
$$\{(Equip\ Cost\ [Col. C])\ x\ (\#\ Equipment\ [Col. E])\} +$$
$$\{(Operator\ Cost\ [Col. F])\ x\ (\#\ Operator\ [Col. G])\} =$$
$$\{(\$128.76)x(1)\} + \{(\$27.70)x(1)\} = \$156.46/hr$$

Total fuel cost (Col. I) is calculated as follows, with an example calculation shown for the Cat 988H:

$$Total\ Fuel\ Cost, \$/hr = \{(Fuel\ Cost\ [Col. D])\ x\ (\#\ Equipment\ [Col. E])\} =$$
$$\{(\$35.57)x(1)\} = \$35.57/hr$$

The daily cost is calculated for all equipment by summing the total equipment cost (Cell G56) and total fuel cost (Cell H56), as follows:

$$Daily\ Total\ Equipment\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ equipment, \frac{\$}{hr}\right) x \left(8\frac{hr}{day}\right) =$$
$$\left(\frac{\$1{,}108}{hr}\right) x \left(8\frac{hr}{day}\right) = \frac{\$8{,}867}{day}$$

$$Daily\ Total\ Fuel\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ fuel, \frac{\$}{hr}\right) x \left(8\frac{hr}{day}\right) =$$
$$\left(\frac{\$223}{hr}\right) x \left(8\frac{hr}{day}\right) = \frac{\$1{,}785}{day}$$

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

6. Riprap and filter production calculations (continued):

Next, the production calculations are summarized (see Rows 54-62 in Table 8). Daily net production is calculated via the following sequence:

- 400 tons input/hr (total) – see production assumptions
- 30% waste – see production assumptions
- 70 % riprap and gravel/filter = 100 minus % waste
- 280 tons produced/hr (net) = (400 tons input/hr) x (70%)
- 560,000 lb/hr = (280 tons) x (2,000 lb/ton)
- 3,650 lb/cy – see production assumptions
- 153 cy/hr = (560,000 lb/hr)/(3,650 lb/cy)
- 8 hr/day (net [60 min/hr]) – see production assumptions
- 1,227 cy/day net production = (153 cy/hr) x (8 hr/day)

The total cost for production (see Row 64 in Table 8) is calculated separately for equipment and fuel as follows:

- Equipment portion of the cost = ($8,867/day)/(1,227 cy/day) = $7.22/cy
- Fuel portion of the cost = ($1,785/day)/(1,227 cy/day) = $1.45/cy
- This yields a total cost of $8.67/cy

Summary and Conclusions:

These calculations achieve the objective to develop an estimated bench channel unit cost for the earthwork RCE, as summarized below for production of filter and riprap, and delivery and placement of filter and riprap.

The cost for production of filter and riprap $7.22/cy (equipment + operator) + $1.45/cy (fuel) = $8.68/cy (difference due to rounding).

The cost for filter delivery and placement is the sum of the calculations presented above, for loading, hauling, placing, and final grading, for a total of $2.14/cy (equipment + operator) + $0.49/cy (fuel) = $2.63/cy

Similarly, the cost for riprap delivery and placement is the sum of the calculations above, for a total of $2.24/cy (equipment + operator) + $0.51/cy (fuel) = $2.75/cy

The total cost ($/ft) for bench channel construction, including the initial earthwork (excavate and waste) along with riprap placed at 0.44 cy/ft and filter placed at 0.22 cy/ft, for combined equipment/operator and fuel costs, is:

$0.52/ft (excavate and waste) + $2.47/ft (filter) + $5.00/ft (riprap) = $7.99/ft

Downdrain/ Dissipater Unit Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes downdrain/dissipater unit cost information as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). Downdrains are constructed on regraded side slopes of rock stockpiles to convey runoff. Dissipaters are constructed as needed at the bottom end (downslope) of specific downdrains to dissipate the energy of the downdrain runoff flow. The unit cost needs to account for excavation/preparation of the subgrade, material and placement costs to install articulated concrete blocks (ACBs) in the downdrains and dissipaters, and installation of a concrete cutoff wall at the downslope end of each dissipater.

Objective:

1. Develop unit costs for downdrains ($/ft) and dissipaters ($/each) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the downdrain/dissipater unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file.
2. The approach for the calculations is as follows:
   - Identify locations and lengths required for downdrains. Use reclamation design drawings and quantities.
   - Identify excavation equipment and estimate cost to complete the rough grade where the downdrains and dissipaters will be constructed. Use equipment cost information and calculations as also developed for other earthwork operations in the overall earthwork cost estimate.
   - Estimate cost to finish grade and place ACBs in downdrains and dissipaters. Use available unit costs from Contech Engineered Solutions (Contech ES), the manufacturer and installer of ACBs in the area.
   - Estimate cost to install cast-in-place concrete cutoff wall at downslope end of dissipaters. Use online RS Means data.

Data and Assumptions (continued):

1. Attachment A presents the following key quantity data used to develop unit costs (note that Attachment A also includes the calculations and results presented in this calculation set):
   - Downdrain base excavation area = 52 square feet/foot of length (sf/ft)
   - Downdrain ACB area coverage = 31 sf/ft
   - Dissipater area (middle [Area 2]) = 320 sf
   - Dissipater area (each side [Area 1 = Area 3]) = 253 sf
   - Cutoff wall concrete volume (each dissipater) = 14 cubic yards
2. Unit cost data from Contech ES (February 2019, see Attachment A) include the following:
   - Material costs for ACBs (includes non-woven geotextile and microgrid/geogrid) are as follows:
     - $7.42/sf (Block Class 40T, for the channel of each downdrain and both side areas of each dissipater)
     - $10.65/sf (Block Class 70T, for the center area of each dissipater)
   - Installation cost is $4.63/sf, which covers the following installation process for both sizes of ACBs: off-load the truck and place delivered ACBs in temporary storage area, fine grade base/subgrade soils, compact soils to 90% Standard Proctor (D698), place and secure filter fabric (non-woven geotextile), place 4- to 6-inch drainage layer overlaid by geogrid, place ACBs in final configuration, grout seams, and backfill ACBs with crushed stone. The installation cost includes crushed stone.
3. Cost data from RS Means for installation of a concrete cutoff wall at the downslope end of each dissipater are presented in Attachment A. The online RS Means cost is $254.97/cubic yard.

Calculations and Results:

1. The estimated cost to excavate the rough grade (where the downdrains will be constructed) is developed in the same manner as excavation costs prepared for bench channel unit costs. Therefore, see the bench channel unit cost calculation set for details. The downdrain rough grade cost = $0.83/ft.
2. The estimated cost to install ACBs in downdrains includes the finish grade and subsequent placement of ACBs. This estimated cost is developed from the Contech ES quotes (as listed above in Data and Assumptions), as follows:
   - Downdrain material cost for 40T ACBs is $7.42/sf
   - Downdrain installation cost for 40T ACBs is $4.63/sf
   - The cost per ft of downdrain ($/ft) = ($7.42/sf + $4.63/sf) x (31 sf/ft) = $12.05/sf x 31 sf/ft = $373.55/ft

$$\boldsymbol{Total\ downdrain\ installation\ cost\ (after\ rough\ grading) = \$373.55/ft}$$

Calculations and Results (continued):

3. Similarly, the estimated cost to install ACBs in dissipaters includes the finish grade and subsequent placement of ACBs. This estimated cost is developed from the Contech ES quotes (as listed above in Data and Assumptions), as follows:

   - Dissipater material cost for 40T ACBs is $7.42/sf
   - Dissipater material cost for 70T ACBs is $10.65/sf
   - Dissipater installation cost for 40T and 70T ACBs is $4.63/sf
   - For each dissipater, 40T ACBs cover 506 sf and 70T ACBs cover 320 sf
   - The cost for the 40T part of each downdrain ($/each) =
     ($7.42/sf + $4.63/sf) x (506 sf) = $12.05/sf x 506 sf = $6,097.30/each
   - The cost for the 70T part of each downdrain ($/each) =
     ($10.65/sf + $4.63/sf) x (320 sf) = $15.28/sf x 320 sf = $4,889.60/each
   - The total cost for ACBs in each dissipater = $6,097.30 + $4,889.60 = $10,986.90

4. The estimated cost for installing a cast-in-place concrete cutoff wall at the downslope end of each dissipater is based on on-line cost data from RS Means and the required concrete volume:

   - Cast-in-place concrete cutoff wall (RS Means) cost = $254.97/cubic yard
   - Each dissipater requires cutoff wall concrete volume of 14 cubic yard
   - The total cost for cutoff wall installation at each dissipater =
     ($254.97/cubic yard) x (14 cubic yard) = $3,569.58

$$\boldsymbol{Total\ dissipater\ installation\ cost\ (after\ rough\ grading) =}$$
$10,986.90 + $3,569.58 = $14,556.48

Summary and Conclusions:

1. Unit costs for installing downdrains ($/ft) and dissipaters ($/each) were developed for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Note that the estimated unit cost developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. Downdrain cost = $0.83/ft (rough grading) + $373.55/ft (after rough grading) = **$374.38/ft**
3. Dissipater cost **=** $10,986.90/each (rough grading is included in downdrain cost) + $3,569.58/each (cutoff wall) = **$14,556.48/each**

For example use only. Values may not match the current spreadsheet.

Downdrain Unit Cost

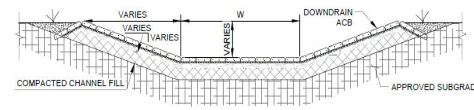
Rough Grade

Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Equipment w/o Fuel Cost ($/ft)	Fuel Cost ($/ft)	Total Excavation Cost ($/ft)
Excavate	Cat D11T CD	1731	1.2	1.6	2900	1.0	175	1851	0.75	50	1.0	1.0	1.0	1.9	0.0011	$69.62	$254.44	$27.41	$281.85	$0.31	$0.08	$0.39
Waste	Cat D11T CD	1542	1.2	1.6	2900	1.0	200	1649	0.75	50	1.0	1.0	1.0	1.9	0.0012	$69.62	$254.44	$27.41	$281.85	$0.35	$0.09	$0.44
								.												$0.67	$0.16	$0.83

Finish Grade & Place ACB

	Area (sf/ft)	Unit Cost ($/sf)	$/ft
Downdrain ACBs			
40T[1]	31	$7.42	$230.02
Installation[1]	31	$4.63	$143.53
		ACB Cost/ft	**$373.55**

Total Downdrain Cost ($/ft)	**$374.38**



N.T.S. AU 022A TYPICAL DOWNDRAIN SECTION

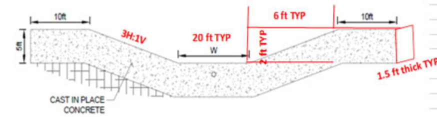
Place ACB

Dissipater ACBs	Area (sf)	Unit Cost ($/sf)	$/sf
70T[1]	320	$10.65	$3,408.00
Installation[1]	320	$4.63	$1,481.60
40T[1]	506	$7.42	$3,754.52
Installation[1]	506	$4.63	$2,342.78
		ACB Cost per Dissipater	**$10,986.90**

Install Cutoff Wall

Cutoff Wall (cast in place concrete)	cubic yard	$/cubic yard	**$/dissipater[2]**
RSMeans (2019)	14	$ 254.97	**$3,569.58**

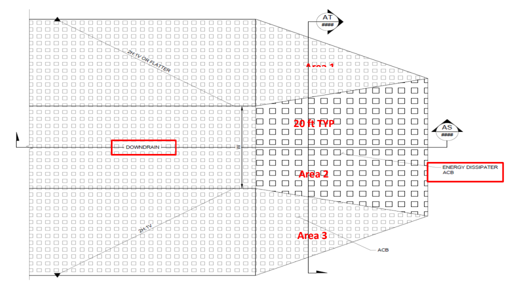
Total Dissipator Cost ($/each)	**$14,556.48**



N.T.S. AX 022A TYPICAL CUTTOFF WALL SECTION

DOWNDRAIN Dimensions:		
Left Side Slope:	3	H:1V
Left Side Slope:	3	H:1V
Depth:	2	ft
Perimeter:	31	ft
Excavation Area:	52	sf
ACB Area:	31	sf

DISSIPATERS	**ACB**				**Cutoff Wall[3]**		
	Surface Area 1	**Surface Area 2**	**Surface Area 3**	**Total**	**Cross-Sectional Area**	**Thickness**	**Volume**
	(sf)	**(sf)**	**(sf)**	**(sf)**	**(sf)**	**(ft)**	**(cy)**
	253	320	253	825	260	1.5	14



N.T.S. 8 022A TYPICAL TOE ENERGY DISSIPATOR PLAN DETAIL

1. Quote from Contech ES 2018; Downdrain ACB installation includes fine grade base/subgrade soils (assuming subgrade at + 0.5 ft); equipment is D6 LGP dozer with Power Angle Tilt Blade (PAT) and GPS Blade Control
2. One cutoff wall per dissipator
3. Typical flow depth is 2'; concrete depth is 5' (diagram is not drawn to scale); concrete thickness is 1.5'

Fred Charles

From: Fawcett, Clayton <CFawcett@conteches.com>
Sent: Tuesday, February 5, 2019 9:25 AM
To: Fred Charles
Subject: RE: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Fred,

Hello and good morning. I hope this message finds you doing well. I made it back in to the office this morning and saw your e-mails.

Material and installation costs we discussed in September are still good. Please feel free to use those to complete your estimate.

Regarding your questions:

1. Yes, installation costs are the same for both downchutes and dissipator basins.
2. Yes, installation cost does include crushed stone infill (purchase and install)

Regarding your follow up e-mail with questions pertaining to cut-off walls.

1. Cut-off walls are not always required, however they are a good idea. The use of cut-off walls has increased in the last five years and as such, they are now recommended for inclusion at dissipator basins.
2. Material and installation costs for the installation of a cut-off wall are not included in the costs previously discussed and should be added.

I hope this information helps. Feel free to contact me directly with any additional questions.

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Fred Charles [mailto:fcharles@telesto-inc.com]
Sent: Sunday, February 3, 2019 3:28 PM
To: Fawcett, Clayton <CFawcett@conteches.com>
Subject: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Hi Clayton. This email is a follow up to our email correspondence in September 2018 regarding material and installation costs for articulated concrete blocks (ACBs) used for downdrains at Chino. We've been using the cost info you passed along to me at that time. Now, I need you to confirm those costs or update them. We will use this information in a reclamation cost estimate (financial assurance for closure bonding) which we are currently finalizing for Chino and other mines in that area.

Costs

As we had discussed, the material costs for ACBs (includes non-woven geotextile and microgrid/geogrid) are as follows:

- $7.42/square foot (Block Class 40T, for the channel of each downdrain)

- $10.65/square foot (Block Class 70T, for the dissipation basin at bottom of each downdrain)

Also, you quoted $4.63/square foot for installation costs, which covers the following installation process: off-load the truck and place delivered ACBs in temporary storage area, fine grade base/subgrade soils, compact soils to 90% Standard Proctor (D698), place and secure filter fabric (non-woven geotextile), place 4-6" drainage layer overlaid by geogrid, place ACBs in final configuration, grout seams, and backfill ACBs with crushed stone.

2 questions
In addition to you confirming or updating the material and installation costs, I have two questions: (1) Is the installation cost ($4.63/square foot) the same for both channel downdrains and dissipation basins? (2) Does the installation or material cost include the crushed stone used to backfill the ACBs?

Please create a new email to me with updated unit costs or reply to this email to confirm what I show is still correct. I will present what you provide for documentation in the cost estimate we submit to the state agencies.

Thanks,

Fred Charles, Ph.D., P.E. Senior Engineer
Office: 970-484-7704, Ext 120 Cell: 720-318-5021
3801 Automation Way, Suite 201, Fort Collins, CO 80525
fcharles@telesto-inc.com

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Truck and Scraper Optimization

Calculation Documentation

Problem Statement:
Freeport-McMoRan's (FMI's) Chino Mines Company utilizes truck optimization information to develop the most efficient proportions of equipment as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). Optimization needs to account for the time required and associated costs for truck loading and hauling operations.

Objectives:

1. Develop optimization calculations to determine the most efficient number of trucks (2 to 9 and a calculated maximum) per loader or shovel for loading cover material at borrow stockpiles.
2. Note that this calculation set presents the approach and calculations and results for optimizing equipment for earthwork. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, calculations, and results for the optimization calculations are presented within the Tyrone earthwork RCE spreadsheet file in sheet (tab) named "18 Truck Optimization".
2. Truck optimization is calculated for each cover material source and destination based on
   - The truck cycle time for 1 roundtrip between a cover material source and destination and the maximum number of trucks per loader/shovel.
   - For X number of trucks (2 to 9 and a calculated maximum), the productivity, task time, cost of using X trucks per loader, the optimum number of trucks per loader/shovel, and the maximum number of trucks per loader/shovel.

For example use only. Values may not match the current spreadsheet.

Calculations and Results:

1. The truck optimization calculations are set up as shown in Table 1, which is a snapshot of a row of data/calculations in the "18 Truck Optimization" sheet. Table 1 is shown in 6 parts due to the many columns in the spreadsheet. Key calculation steps are listed after Table 1, with referencing to the Column identifier in Table 1 (and the spreadsheet).

Table 1

	E	F	G	H	I	J	K	L
13								
14	ID	Task Description	Source Location 1	Destination Location 2	Equipment	Work Hour (min/hr)	Loader/Shovel Cycles per Truck	Loader/Shovel Cycle Time (min)
299	1200-D-b-Tk4	Haul-Cover	Upper South	West Stockpile	Komatsu 730E	50	5	0.45

	M	N	O	P	Q	R	S	T	U
13									
14	Loader/Shovel Time Per Truck (min)	Truck Cycle Time Per Truck (min)	Trucks Per Loader/ Shovel	Loader/ Shovel Type	Loader/ Shovel Cost ($/hr)	Loader Net Bucket Capacity (cy)	Haul Volume (cy)	Max Trucks Round Up	Max Trucks Round Down
299	2.25	22.7	10.1	Sh1	$ 535.68	27.4	3,031,924	3,317	3,016

	V	W	X	Y	Z	AA	AB	AC
13	Productivity for X Trucks (cy/hr)							
14	9	8	7	6	5	4	3	2
299	2,714	2,412	2,111	1,809	1,508	1,206	905	603

	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
13	Task Time for X Trucks (hr)									
14	Max Trucks Round Up	Max Trucks Round Down	9	8	7	6	5	4	3	2
299	914.0	1,005.4	1,117.2	1,256.8	1,436.4	1,675.7	2,010.9	2,513.6	3,351.5	5,027.2

	AN	AO	AP	AQ	AR	AS	AT	AU
13			Cost of Using X Trucks per Loader ($					
14	Loader/ Shovel Task Time (hr)	Truck Cost ($/hr)	Max Trucks Round Up	Max Trucks Round Down	9	8	7	6
299	995.9	$ 246.06	$ 3,229,021	$ 3,012,613	$ 3,072,458	$ 3,147,264	$ 3,243,442	$ 3,371,681

	AV	AW	AX	AY	AZ	BA	BB
13	$)						
14	5	4	3	2	Lowest Cost ($)	Optimum Number of Trucks Per Loader/ Shovel	Optimum Number of Trucks Per Loader/ Shovel Within Max
299	$ 3,551,215	$ 3,820,515	$ 4,269,350	$ 5,167,019	$ 3,012,613	10	10

For example use only. Values may not match the current spreadsheet.

Calculations and Results:

1. Truck optimization (continued)

- Calculate the number of loader/shovel (or referred to as loader) cycles to load a truck and the loading time required per truck (Columns K, L, and M) – this calculation uses data from the “9 Trucks” and “10 Shovel” sheets.

Loader Time Per Truck (Col. M) =
[Loader Cycles per Truck (Col. K)] x [Loader Cycle Time, min (Col. L)]
= (5 cycles/truck) x (0.45 min/cycle) = 2.25 min/truck

- Using the truck cycle time for 1 roundtrip between a cover material source and destination (data from the “9 Trucks” sheet), calculate the maximum number of trucks per loader/shovel.

Max Number Trucks Per Loader (Col. O) = [Truck Cycle Time, min (Col. N)]/[Loader Time, min/truck (Col. M)]
= (22.7 min)/(2.25 loader min/truck) = 10.1 trucks/loader

- Calculate the productivity (cy/hr) for X number of trucks (2 to 9 and a calculated maximum).

For X=6 trucks, Productivity, cy/hr (Col. Y) =
(X) x Work Hour, min/hr (Col. J) x Loader Cycles/Truck (Col. K) x [Loader Net Bucket Capacity, cy (Col. R)]/[Truck Cycle Time Per Truck, min (Col. N)]
= [6 x (50 min/hr) x (5 loader cycles/truck) x (27.4 cy/loader cycle)]/(22.7 min/truck cycle) = 1,809 cy/hr

- Using the productivity and total volume of cover material to be hauled, calculate the task time for X trucks (2 to 9).

For X=6 trucks, Task Time, hr (Col. AI) =
[Haul Volume, cy (Col. S)]/[Productivity, cy/hr (Col. Y)]
= (3,031,924 cy)/(1,809 cy/hr) = 1,676 hr

Calculations and Results (continued):

1. Truck optimization (continued):

   - Calculate the cost of using X trucks per loader (2 to 9 and a calculated maximum) using data for loader/shovel task time in "9 Trucks" (for each cover material source and destination), loader/shovel cost ($/hr), truck cost ($/hr), and task time for the number of trucks.

   For X=6 trucks, Cost of Using X Trucks per Loader, $ (Col. AU) =
   [Max of Task Time for Trucks (Col AI) or Loader/Shovel Task Time (Col. AN)] x
   {(Loader Cost, $/hr (Col. Q) + [(X) x (Truck Cost, $/hr (Col. AO)]}
   = (1,675.7 hr) x {($535.68/hr + [6 x $246.06/hr]} = $3,371,681

   - The optimum number of trucks per loader is the lowest cost number of trucks per loader/shovel. This optimum number is compared with the maximum number of trucks per loader/shovel, to ensure the optimum number is within the maximum.

   For this row of data, the optimum number of trucks per loader = 10, which is the same within the max.

For example use only. Values may not match the current spreadsheet.

Revegetation Unit Cost

Calculation Documentation

Problem Statement:
Freeport-McMoRan (FMI) utilizes revegetation unit cost information as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). The unit cost for revegetation needs to account for equipment rental rates and associated maintenance, fuel costs, and labor rates.

Objectives:

1. Develop a revegetation unit cost ($/acre) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.
2. Note that this calculation set presents the approach, data and assumptions, and calculations and results for developing the unit cost. It is intended to serve as a guide/example even if the actual quantities and/or cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Approach:

1. The data, assumptions, calculations, and results for the revegetation unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet file.
2. The approach for the calculations is as follows:
   - Identify equipment types for scarifying, discing, drill seeding, mulching, crimping.
   - Obtain equipment information from EquipmentWatch (EQW) and RS Means, labor rates from NMDOL; revegetation material costs (seed, mulch) from FMI and/or their supplier; and the current fuel price from fuel cost calculations.
   - Determine the equipment traveling distance and time to cover 1 acre.
   - For each of the key operations, estimate the operating cost ($/hour).
   - Combine all operations and material costs, calculate the total unit cost.

Data and Assumptions:

1. Rental and operating cost information is accessed online from EQW for tractor (Deere 7340), ripper, and mulcher, and from RS Means for disc harrow (see Attachment A). Monthly rental rates are converted to hourly rates assuming 176 hours/month.
2. Equipment information is not available in EQW nor RS Means for drill seeding and crimping. Therefore, the drill seeder cost is assumed to be an average of the mulcher and disc (complexity is between the two, thus an average is assumed), and the crimper rental cost is assumed to be equal to the disc harrow (similar type of equipment).
3. Costs are included in the ripper and disc harrow (and drill seeder and crimper) to account for the ground engaging component (GEC) of these implements. The GEC cost for the ripper is applied to each of these other implements.
4. Local fuel price is developed from fuel cost calculations also prepared for earthwork closure cost estimates – the estimated 2019 fuel price is $2.34/gallon.
5. Revegetation material costs are from a quote by Rocky Mountain Reclamation, based on typical sources for seed and mulch (see Attachment A). The cost for seed is $210/acre and for mulch is $245/ton which, at 2 tons/acre, is $490/acre.

For example use only. Values may not match the current spreadsheet.

Data and Assumptions (continued):

6. Labor rates are from NMDOL (see Attachment A).
7. Equipment typical net coverage (width) is set at 12 feet, and equipment travel speed is set at 3 miles/hour (mph) for a 60-minute hour.

Calculations and Results:

1. The Deere 7340 tractor data, along with labor and fuel costs, are tabulated in the following table:

	B	C	D	E
5	**Tractor used for each operation is Deere 7430**	**Cost**	**Unit**	**Information or Calculation**
6	EQW base rate for tractor rental	$ 5,210.05	$ per month	EQW for Deere 7430
7	EQW base rate for tractor rental	$ 29.60	$ per hour	= ($/month)/176
8	EQW field labor rate per hour of operation	$ 2.53	$ per hour	EQW for Deere 7430, which includes mechanic's wage of $23.09 (NMDOL, 2019)
9	EQW lube material cost	$ 2.84	$ per hour	EQW for Deere 7430
10	EQW field parts cost	$ 0.61	$ per hour	EQW for Deere 7430
11	EQW tire material cost	$ 2.42	$ per hour	EQW for Deere 7430
12	EQW fuel burn rate	5.98	gallons per hour	EQW for Deere 7430
13	Local fuel cost	$ 2.34	$ per gallon	Local quote
14	Fuel cost	$ 13.99	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
15	NM Department of labor equipment operator rate	$ 24.27	$ per hour	NM Department of Labor (NMDOL)
16	**Total tractor cost**	**$ 76.27**	**$ per hour**	**Sum of $ per hour costs shown in boxes**

Data in Rows 6 and 8-12 are from EQW, data in Row 8 also incorporates an NMDOL labor rate in the EQW cost, Row 13 is the estimated local fuel cost of $2.34/gallon, and Row 15 shows an NMDOL labor rate. Costs in other rows (7, 14, and 16) are calculated as follows:

$$EQW\ base\ rate\ for\ tractor\ rental = (\$5{,}210.05/\text{month})/(176\ \text{hours/month}) = \$29.60/\text{hour}$$

$$Fuel\ cost = (\text{EQW burn rate})\ \text{x}\ (\text{local fuel cost}) = (5.98\ \text{gallons/hour})\ \text{x}\ (\$2.34/\text{gallon}) = \$13.99/\text{hour}$$

$$Total\ tractor\ cost = \text{sum of rows } 7, 8, 9, 10, 11, 14, 15 = 29.60 + 2.53 + 2.84 + 0.61 + 2.42 + 13.99 + 24.27 = \$76.27/\text{hour}$$

2. Based on an equipment typical net width of 12 feet, and equipment net travel speed of 2.5 mph (3 mph x 50/60 to adjust for a 50-minute hour), each operation will travel a distance of 3,630 feet to cover 1 acre, and will require 0.275 hour to travel this distance (see calc steps in the table below). The resulting fuel cost is $3.85/acre.

	B	C	D	E
18	**Tractor coverage/rate of operation, fuel cost per acre**			
19	Tractor/equipment net width	12	feet	Assigned as a typical net width of coverage for each pass
20	Tractor/equipment travel speed	2.5	miles per hour	Assigned as approximate average speed of equipment (3 mph for 50 min/hr)
21	For 1 acre, total traveling distance	3630	feet per acre	= (43560 sf/ac)/(net width)
22	Time of travel over 1 acre	0.275	hour per acre	= [(traveling distance feet/acre)/(5280 ft/mile)]/(travel speed)
23	**Fuel cost per acre**	**$ 3.85**	**$ per acre**	**Already included in total tractor cost... Fuel cost/acre = (fuel cost/hour) x (travel time hour/acre)**

For example use only. Values may not match the current spreadsheet.

TELESTO SOLUTIONS INCORPORATED	Job No: 200540A	Client: Freeport NM Operations	Page 3 of 4
	Task: Revegetation Unit Cost	Computed By: Fred Charles	Date: 2/21/2019
		Checked By: Taryn Tigges	Date: 3/14/2019

Calculations and Results (continued):

3. Operating costs for each of the 5 revegetation operations are calculated as shown in the following table. Calculation equations are also noted in the table. Note the total cost for each operation includes fuel.

	B	C		D	E
25	Operation				
26	*Scarifying*				
27	Base rate for ripper rental	$	898.90	per month	EQW Ripper, Miscellaneous MSR-189H, to 260 HP
28	Base rate for ripper rental	$	5.11	$ per hour	= ($/month)/176
29	Lube labor rate per hour of operation	$	0.57	$ per hour	EQW for ripper, incl mechanic's wage $23.09 (NMDOL, 2019)
30	Lube material cost	$	0.15	$ per hour	EQW for ripper
31	Field parts cost	$	0.16	$ per hour	EQW for ripper
32	Ground Engaging Component cost	$	0.78	$ per hour	EQW for ripper
33	**Total cost with tractor+operator included**	**$**	**83.03**	**per hour**	
35	*Discing*				
36	Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
37	Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
38	Ground Engaging Component (GEC) cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
39	**Total cost with tractor+operator included**	**$**	**80.55**	**per hour**	
41	*Drill seeding (assume similar to discing)*				
42	Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
43	Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
44	Ground Engaging Component cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
45	**Total cost with tractor+operator included**	**$**	**80.55**	**per hour**	
47	*Mulching*				
48	Mulcher, diesel powered, trailer mounted	$	2,167.95	per month	EQW for trailer mounted mulcher (Finn B260)
49	Mulcher, diesel powered, trailer mounted	$	12.32	per hour	= ($/month)/176
50	Lube labor rate per hour of operation	$	1.25	$ per hour	EQW for trailer mounted mulcher (Finn B260), incl mechanic's wage $23.09 (NMDOL, 2019)
51	Lube material cost	$	1.60	$ per hour	EQW for trailer mounted mulcher (Finn B260)
52	Field parts cost	$	0.15	$ per hour	EQW for trailer mounted mulcher (Finn B260)
53	Tire material cost	$	0.60	$ per hour	EQW for trailer mounted mulcher (Finn B260)
54	Fuel burn rate		4.13	gallons per hour	EQW for trailer mounted mulcher (Finn B260)
55	Local fuel cost	$	2.34	$ per gallon	Local quote
56	Fuel cost	$	9.66	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
57	NM Department of labor equipment operator rate	$	24.27	$ per hour	NM Department of Labor (NMDOL)
58	**Total cost with tractor+operator included**	**$**	**126.12**	**per hour**	
60	*Crimping (assume similar to discing)*				
61	Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
62	Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
63	Ground Engaging Component cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
64	**Total cost with tractor+operator included**	**$**	**80.55**	**per hour**	

For example use only. Values may not match the current spreadsheet.

Calculations and Results (continued):

5. The hourly operating cost for each operation (includes fuel) is summed for a total cost of \$450.79/hour. The cost for each operations is as follows:
   - Scarifying = \$83.03/hour
   - Discing = \$80.55/hour
   - Drill seeding = \$80.55/hour
   - Mulching = \$126.12/hour
   - Crimping = \$80.55/hour

6. The total combined equipment operating cost with fuel (\$/acre) is then calculated based on the operating cost per hour and the time of travel over 1 acre, as follows:

$$Total\ combined\ operating\ cost = \left(\frac{\$450.79}{hour}\right) x \left(0.275\frac{hour}{acre}\right) = \$123.97/acre$$

7. Seed and mulch costs are added to the total combined operating cost (\$/acre) to calculate the total revegetation unit cost as follows:
   - Total combined operating cost = \$123.97/acre
   - Seed = \$210/acre
   - Mulch = \$490/acre

Total revegetation unit cost = Total combined operating cost + Seed + Mulch = \$123.97/acre + \$210/acre + \$490/acre = \$823.97/acre (\$824/acre)

Summary and Conclusions:

1. A revegetation unit cost was developed for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM. Note that the estimated unit cost developed in this analysis applies only to FMI operations in the Silver City (Grant County), NM area.
2. The total revegetation unit cost is \$824/acre.

For example use only. Values may not match the current spreadsheet.

www.equipmentwatch.com

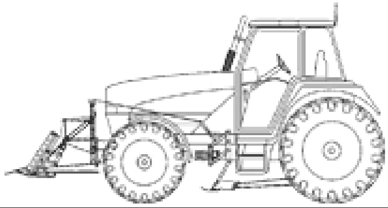
All prices shown in US$

Adjustments for MANDYLILLA27 in All Saved Models

January 17, 2019

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

Power Mode **Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$12.48/hr	$11.70/hr	-6.3%
Cost of Facilities Capital (CFC)	$3.12/hr	$2.43/hr	-22.1%
Overhead	$4.42/hr	$3.35/hr	-24.2%
Overhaul Labor	$6.46/hr	$1.92/hr	-70.3%
Overhaul Parts	$5.55/hr	$4.20/hr	-24.3%
Total Hourly Ownership Cost:	**$32.03/hr**	**$23.60/hr**	**-26.3%**

User Defined Adjustments: Annual Use Hours (1,030hrs -> 1,359hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$8.51/hr	$2.53/hr	-70.3%
Field Parts	$4.86/hr	$0.61/hr	-87.4%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$2.42/hr	-	-
Electrical/Fuel	$19.54/hr	$5.98/hr	-69.4%
Lube	$2.84/hr	-	-
Total Operating Ownership Cost:	**$38.17/hr**	**$14.38/hr**	**-62.3%**

User Defined Adjustments: Annual Field Repair Parts Cost ($4,174.20 -> $0.20) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$32.03/hr	$23.60/hr	-26.3%
Hourly Operating Costs	$38.17/hr	$14.38/hr	-62.3%
Total Hourly Cost	**$70.20**	**$37.98/hr**	**-45.9%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$20.02/hr	$17.48/hr	-12.7%
Idle	$51.57/hr	$29.58/hr	-42.6%

Revised Date: 1st Half 2019

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

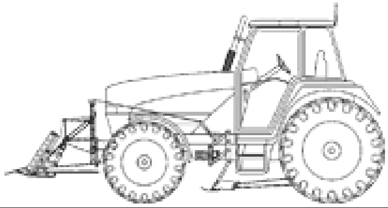
All prices shown in US$

Adjustments for MANDYLILLA27 in All Saved Models

January 17, 2019

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	$3,891.00	$1,303.00	$463.00
Adjustments			
Region (New Mexico: 134%)	$1,319.05	$441.72	$156.96
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$5,210.05**	**$1,744.72**	**$619.96**

Date Last Updated: Oct 01, 2018

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

All prices shown in US$

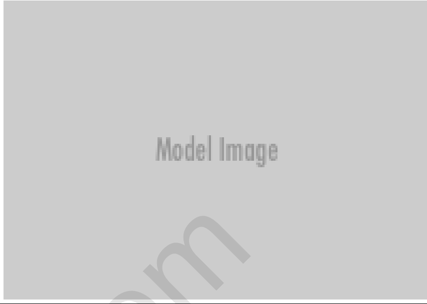
Custom Cost Evaluator

February 21, 2019

Miscellaneous MSR-189H

Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3,557 lbs.



Configuration for MSR-189H

Engine Horsepower	**130 - 189**	Number of Shanks	**3**
Ripper Type	**Parallelogram**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$2.64/hr	$2.50/hr	-5.3%
Cost of Facilities Capital (CFC)	$0.38/hr	$0.31/hr	-18.4%
Overhead	$0.66/hr	$0.52/hr	-21.2%
Overhaul Labor	$1.10/hr	$0.34/hr	-69.1%
Overhaul Parts	$0.95/hr	$0.75/hr	-21.1%
Total Hourly Ownership Cost:	**$5.73/hr**	**$4.42/hr**	**-22.9%**

User Defined Adjustments: Annual Use Hours (1,285hrs -> 1,629hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$1.83/hr	$0.57/hr	-68.9%
Field Parts	$1.18/hr	$0.16/hr	-86.4%
Ground Engaging Component (GEC)	$0.99/hr	$0.78/hr	-21.2%
Tire	$0.00/hr	-	-
Electrical/Fuel	$0.00/hr	-	-
Lube	$0.15/hr	-	-
Total Operating Ownership Cost:	**$4.15/hr**	**$1.66/hr**	**-60%**

User Defined Adjustments: Annual Field Repair Parts Cost ($1,268.18 -> $0.18) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$5.73/hr	$4.42/hr	-22.9%
Hourly Operating Costs	$4.15/hr	$1.66/hr	-60%
Total Hourly Cost	**$9.88**	**$6.08/hr**	**-38.5%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$3.68/hr	$3.33/hr	-9.5%
Idle	$5.73/hr	$4.42/hr	-22.9%

Revised Date: 1st Half 2019

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

All prices shown in US$

Rental Rate Blue Book®

February 21, 2019

Miscellaneous MSR-189H
Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3,557 lbs.

Model Image

Configuration for MSR-189H

Engine Horsepower	**130 - 189**	Number of Shanks	**3**
Ripper Type	**Parallelogram**		

Blue Book Rates

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	$1,010.00	$285.00	$71.00	$11.00	$4.15	$9.89
Adjustments						
Region (Las Cruces, New Mexico: 89%)	($111.10)	($31.35)	($7.81)	($1.21)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$898.90**	**$253.65**	**$63.19**	**$9.79**	**$4.15**	**$9.26**

Non-Active Use Rates	**Hourly**
Standby Rate	$3.52
Idling Rate	$5.11

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	50%	$505.00/mo
Overhaul (ownership)	31%	$313.10/mo
CFC (ownership)	7%	$70.70/mo
Indirect (ownership)	12%	$121.20/mo

Fuel cost data is not available for these rates.

Revised Date: 1st Half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

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www.equipmentwatch.com

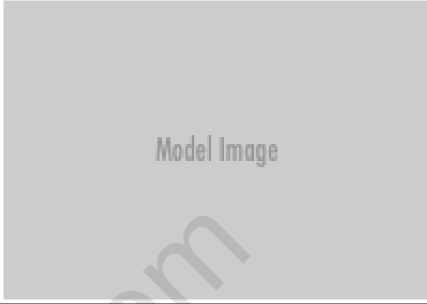
All prices shown in US$

Custom Cost Evaluator

February 21, 2019

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4,880 lbs.



Configuration for B260

Power Mode	**Diesel**	Horsepower	**115**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$5.80/hr	$5.45/hr	-6%
Cost of Facilities Capital (CFC)	$0.88/hr	$0.69/hr	-21.6%
Overhead	$1.18/hr	$0.90/hr	-23.7%
Overhaul Labor	$3.36/hr	$1.00/hr	-70.2%
Overhaul Parts	$2.54/hr	$1.92/hr	-24.4%
Total Hourly Ownership Cost:	**$13.76/hr**	**$9.96/hr**	**-27.6%**

User Defined Adjustments: Annual Use Hours (1,050hrs -> 1,388hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$4.20/hr	$1.25/hr	-70.2%
Field Parts	$1.47/hr	$0.15/hr	-89.8%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$0.60/hr	-	-
Electrical/Fuel	$13.50/hr	$4.13/hr	-69.4%
Lube	$1.60/hr	-	-
Total Operating Ownership Cost:	**$21.37/hr**	**$7.73/hr**	**-63.8%**

User Defined Adjustments: Annual Field Repair Parts Cost ($1,342.66 -> $0.66) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$13.76/hr	$9.96/hr	-27.6%
Hourly Operating Costs	$21.37/hr	$7.73/hr	-63.8%
Total Hourly Cost	**$35.13**	**$17.69/hr**	**-49.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$7.86/hr	$7.04/hr	-10.4%
Idle	$27.26/hr	$14.09/hr	-48.3%

Revised Date: 1st Half 2019

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

All prices shown in US$

Rental Rate Blue Book®

February 21, 2019

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4,880 lbs.

Model Image

Configuration for B260

Power Mode	**Diesel**	Horsepower	**115**

Blue Book Rates

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	$2,425.00	$680.00	$170.00	$26.00	$21.35	$35.13
Adjustments						
Region (Las Cruces, New Mexico: 89.4%)	($257.05)	($72.08)	($18.02)	($2.76)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$2,167.95**	**$607.92**	**$151.98**	**$23.24**	**$21.35**	**$33.67**

Non-Active Use Rates

	Hourly
Standby Rate	$6.16
Idling Rate	$25.82

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	37%	$897.25/mo
Overhaul (ownership)	50%	$1,212.50/mo
CFC (ownership)	6%	$145.50/mo
Indirect (ownership)	7%	$169.75/mo
Fuel (operating) @ 3.27	63%	$13.50/hr

Revised Date: 1st Half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

RS Means Online Data
Accessed February 13, 2019

Revegetation

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
015433201500	Rent disc harrow attchment for tractor, Excl. Hourly Oper. Cost.	Month	$ -	$ -	$ 616.33	$ 616.33	Year 2019	NEW MEXICO / LAS CRUCES (880)

Labor Rates

NMDOL Type A Operator Group	Base rate	Fringe rate	Apprenticeship	Total 2019 Rate ($/hr)
Equipment Operator IV	20.87	5.94	0.6	$ 27.41
Equipment Operator V	20.98	5.94	0.6	$ 27.52
Equipment Operator VI	21.16	5.94	0.6	$ 27.70
Laborer I	16.86	5.63	0.6	$ 23.09
Laborer II	17.61	5.63	0.6	$ 23.84
Truck Driver III	16.15	7.52	0.60	$ 24.27

Labor rates based on NM Department of Labor Type H (Heavy Engineering) 2019 labor rates. Rates include base hourly wage, fringe benefit, and apprenticeship contribution rates.

https://www.dws.state.nm.us/Portals/0/DM/LaborRelations/Prevailing_Wage_Poster_H_2019_final.pdf

Revegetation/Reclamation
Rangeland Rehabilitation
Landscaping / Fencing
Hydroseeding
Environmental Consulting

ROCKY MOUNTAIN RECLAMATION

Phone (307) 745-5235
(307) 745-5230

ron@reveg.us
www.reveg.us

P.O. Box 1695
Laramie, WY 82073

FREEPORT MCMORAN – NEW MEXICO MINING OPERATIONS

PRICE ESTIMATES FOR REVEGETATION SERVICES FOR BUDGETING ESTIMATES

Table 1 –Freeport McMoRan, New Mexico Mining Operations – Price Estimates for Revegetation Services for Budgeting Estimates, prepared April, 2018.

	REVEGETATION OPERATION	ESTIMATED QUANTITY	UNITS	COST/UNIT ($)	TOTAL COST
I.	**OPERATIONS:**				
1	**SCARIFYING**	500	Acres	$30.00	$15,000.00
2	**DISCING**	500	Acres	$20.00	$10,000.00
3	**DRILL SEEDING (special Rangeland Drill)**	500	Acres	$80.00	$40,000.00
4	**MULCHING**	500	Acres	$148.00	$74,000.00
5	**CRIMPING**	500	Acres	$55.00	$27,500.00
6	**DAILY PER DIEM, ETC.**	50	Days	$385.00	$19,250.00
7	**MOBILIZATION**	1	Each	$13,500.00	$13,500.00
	Subtotal				**$199,250.00**
II.	**MATERIALS:**				
1	**SEED** at 8.9 PLS/acre	500	Acres	$210.00	$105,000.00
2	**HAY MULCH** - nox. weed free, native	1000	Tons	$245.00	$245,000.00
	Subtotal				**$350,000.00**
	TOTAL ESTIMATED REVEGETATION COST BEFORE TAX				**$549,250.00**
	Add New Mexico Gross Receipts Tax	5.9375	%		**$32,611.72**
	ESTIMATED REVEGETATION COST PER ACRE:			**$1,163.72**	
	TOTAL ESTIMATED REVEGETATION COST				**$581,861.72**

Estimate prepared by Ron Schreibeis, Rocky Mountain Reclamation, for use for Budgeting Estimates.

O&M Costs

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes cost information for operations and maintenance (O&M) as part of earthwork closure cost estimation associated with the Emma Closure/Closeout Plan (CCP). The O&M costs need to account for vegetation maintenance costs for a 12-year period after completion of initial revegetation activities in each area, along with ongoing erosion control, road maintenance, and groundwater monitoring for a 100-year period.

This calculation set presents a summary of the approach and results for estimating O&M costs. Detailed information is presented in the earthwork reclamation cost estimate (RCE) spreadsheet file.

This calculation set is intended to serve as a guide/example even if the assumptions or actual cost data used in these calculations change due to updates or application to a different Freeport NM Operations mine.

Objective:

1. Develop the estimated O&M costs for vegetation maintenance for a 12-year period after completion of initial revegetation activities in each area, along with ongoing erosion control, road maintenance, and groundwater monitoring activities for a 100-year period. Also, develop tailing cover maintenance costs for previously reclaimed areas for the first 7 years of closure reclamation. The O&M costs are used as part of the earthwork RCE for FMI's mining operations in Grant County, NM.

Approach:

1. The data, assumptions, calculations, and results for the O&M cost estimate are presented within the Tyrone earthwork RCE spreadsheet file. Also, a summary of results is presented in the spreadsheet file.
2. The approach for estimating vegetation maintenance O&M costs is as follows:
    - For each facility (stockpile, tailing pond, reservoirs, etc), the total area is listed, along with approximate year of reclamation start, vegetation maintenance start, and vegetation maintenance complete. A 2% loss per year (i.e., 2% of vegetation fails each year) for 12 years is assumed to estimate the acreage requiring vegetation maintenance for each year.
    - Revegetation unit costs (equipment and fuel) are applied to the loss of acreage for each year to calculate the vegetation maintenance cost for each facility.

For example use only. Values may not match the current spreadsheet.

Approach (continued):

3. The approach for estimating erosion control, road maintenance, tailings cover maintenance, and groundwater monitoring ("Other") O&M costs is as follows:
    - For erosion control and road maintenance
        - Determine base costs ($/day) for equipment and fuel base. Also, estimate the number of days/yr for erosion control and road maintenance for three periods: Years 0-19, 20-39, and 40-99.
        - Calculate the annual equipment and fuel costs, based on days/yr, for the same three periods.
    - For tailing cover maintenance
        - Use erosion control equipment with reduced truck requirement and, therefore, reduced base cost. Assume 10 days/yr for Years 0-6, after which tailing cover maintenance is not required.
    - For groundwater monitoring
        - Determine base costs ($/day) for equipment and aqueous chemistry (lab analytical), and days/yr for groundwater monitoring for three periods: Years 0-19, 20-39, and 40-99.
        - Calculate the annual equipment and annual aqueous chemistry costs, based on days/yr, for the same three periods.
    - For these "Other" O&M activities
        - While reclamation is ongoing, adjust the O&M costs accordingly based on the proportion of reclamation completed as of each year. The full annual cost applies when reclamation is complete.
        - For years after reclamation is complete, assign the O&M costs for each year based on the annual costs calculated for Years 0-19, 20-39, and 40-99.

Results:

1. The vegetation maintenance and "Other" O&M costs are summed for all years, as shown in the summary table below (some of the final results may vary from what is shown). These results are used in the overall earthwork RCE.
2. The indirect costs are set at 17.5% of direct costs, based on an agreement between FMI and the agencies in January 2019. Indirect costs include but are not limited to mobilization and demobilization, contingencies, engineering redesign fees, contractor profit and overhead, project management, administrative expenses, etc.

DRAFT Operations and Maintenance Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$0
	Earthmoving		$0
	Vegetation		$1,328,888
	Other		$6,202,825
	Subtotal, Direct Costs		**$7,531,713**
INDIRECT COSTS[1]	**Subtotal, Indirect Costs**	**17.5%**	**$1,318,050**
TOTAL COST			**$8,849,763**

For example use only. Values may not match the current spreadsheet.

Appendix C

Indirect Costs

State of New Mexico
ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT
and the
ENVIRONMENT DEPARTMENT

Michelle Lujan Grisham
Governor

Howie Morales
Lieutenant Governor

Sarah Cottrell Propst
Cabinet Secretary Designate, EMNRD

James Kenney
Cabinet Secretary Designate, NMED

7008 0500 0001 4875 1648

Certified Mail

January 16, 2019

Sherry Burt-Kested, Manager
Environmental Services
Freport-McMoRan Chion Mines Company
P.O. Box 10
Bayard, NM 88023

Re: Approval of Cost Estimate Resolutions (Agreement) and Request for Schedule

Dear Ms. Burt-Kested,

The New Mexico Mining and Minerals Division of the Energy, Minerals and Natural Resources Department (MMD-EMNRD), and the Mining Environmental Compliance Section (MECS) of the New Mexico Environment Department (MECS-NMED) (collectively, the Agencies) received a letter with tabulated cost estimate resolutions (Agreement) dated January 11, 2019, from Freeport McMoRan New Mexico Operations (FMNO). As noted in your letter, the Financial Assurance (FA) work group included representatives of the Agencies, FMNO, and the Gila Resources Information Project (GRIP). Over the course of multiple meetings and teleconferences, the FA work group developed the Agreement in 2018. The Agencies hereby approve the Agreement for the formulation of cost estimates for closure/closeout plans at the Continental, Little Rock, Tyrone and Chino Mines.

Since the FA work group reached agreement, the Agencies concur this precludes the need for a third party review of cost estimates that had been conditionally required by condition 8.N.7 of MMD Permit No. GR002RE Revision 15-2, and C113.E of NMED Draft DP-1403. FMNO must submit an updated cost estimate by April 3, 2019, in order to fulfill Continental permit condition 8.N.6 of MMD Permit No. GR002RE Revision 15-2, which is similar to condition C113.D of NMED Draft DP-1403.

In your letter, FMNO proposed a timeline for the Continental, Chino, and Tyrone mines for the submittal of updated cost estimates. To ensure efficient use of limited resources, the Agencies request FMNO submit a more detailed schedule that provides greater specificity of when the cost estimates and any other major milestones will be completed. The schedule should provide managers and permit leads a best estimate of key FMNO submittals. With FMNO cooperation, the Agencies anticipate completion of reviews and approvals of cost estimates and associated changes to FA instruments before the end of 2019.

The Agencies acknowledge the successful resolution of multiple cost estimate issues. We appreciate that the FA work group reached agreement through extra effort by FMNO, GRIP, and the Agencies. This Agreement reduces much of the uncertainty associated with FMNO cost estimation and the Agencies' review process. Going forward, the Agencies believe the Agreement ensures timely updates of closure/closeout cost estimates that maintain adequate FA to the mutual benefit of all parties.

If you have any questions, please do not hesitate to contact us or the respective permit leads at MMD and NMED for Continental, Tyrone, Little Rock, and Chino Mines.

Sincerely,

Holland Shepherd
Program Manager
Mining Act Reclamation Program
Mining and Minerals Division-EMNRD
505-476-3437

Kurt Vollbrecht
Program Manager
Mining Environmental Compliance Section
New Mexico Environment Department
505-827-0195

cc: Allyson Siwik, Executive Director, GRIP
MMD mine permit files GR002RE, GR007RE, GR009RE and GR010RE.
NMED discharge permit files DP-1236, 1340, DP-1341 and DP-1403.

Table 1 Summary of Cost Estimate Resolutions

Issue Item	Resolution
Equipment Unit Cost Source and Removal of Indirect Cost Items from EquipmentWatch Ownership Values	Equipment costs determined in the following order sourced from EquipmentWatch: • Unmodified EquipmentWatch Average Rental Rate for Southern New Mexico • Unmodified EquipmentWatch Average Rental Rate for New Mexico • Unmodified Blue Book Rental Rate • If equipment is not listed in EquipmentWatch, then another piece of equipment must be used • Minimum listed rates will not be used • EquipmentWatch Average Rental Rates will be used without adjustment for duplicative indirect cost components
Revegetation	Revegetation steps costed in similar manner to other earthworks
Demolition Costs	Freeport will add 20% for buildings with large equipment (e.g., mills, SX, crusher)
Direct "Commodity" Costs / Quotes	It is fine to use quotes, but the quotes must be for the specifications and scope/scale of Freeport's default scenario (e.g., fuel to complete all Freeport New Mexico mine closures over a series of years). The following are specific examples discussed. • FNMO will compile a database of vendor quotes as they are developed for submittal to the agencies • Quotes will be used directly with no consideration to vendor's profit/overhead or other indirect costing items • Quotes will be used directly with no adjustment for duplicated indirect components
Fuel	Use historical quotes and correlate to public data for future cost estimates
Seed	Freeport quotes, specs and scope
Lime	Freeport quotes, specs and scope
Mulch	Freeport quotes, specs and scope
Articulated Concrete Blocks	Freeport quotes, specs and scope
Well Plugging/replacement	Freeport quotes, specs and scope
Geomembranes (e.g., stormwater pond replacement)	Use RS Means published data
Power	Published rates for area, scope considered
State Labor Rates	Use prevailing wage as published by NMDOLA, which includes fringe benefits
Indirect Rates	Negotiated total values (includes: mobilization and demobilization, contingencies, engineering redesign fees, contractor profit and overhead, project management, administrative expenses, bonding, state procurement costs, construction management, insurance, QA/QC, etc.)
All capital cost items	30%
All Operations and Maintenance cost items	17.5%

Items in black are reformatted from workgroup spreadsheet sent 11/19/2019 and subsequent negotiations

Items in red are from subsequent communications and added for clarity

Appendix D

Supporting Data for Cost Estimation

Appendix D.1

2021 Labor Rates (NMDOL)

Labor Rates

NMDOL Type A Operator Group	Base rate	Fringe rate	Apprenticeship	Total 2021 Rate ($/hr)
Equipment Operator IV	21.51	6.54	0.6	$ 28.65
Equipment Operator V	21.63	6.54	0.6	$ 28.77
Equipment Operator VI	21.81	6.54	0.6	$ 28.95
Equipment Operator VII	21.83	6.54	0.6	$ 28.97
Equipment Operator VIII	23.79	6.54	0.6	$ 30.93
Laborer I	17.06	6.22	0.6	$ 23.88
Laborer II	17.81	6.22	0.6	$ 24.63
Truck Driver III	17.72	6.25	0.60	$ 24.57
Truck Driver V	17.80	6.25	0.60	$ 24.65
Truck Driver VIII	18.31	6.25	0.60	$ 25.16

Labor rates based on NM Department of Labor Type H (Heavy Engineering) 2021 labor rates. Rates include
https://www.dws.state.nm.us/Portals/0/DM/LaborRelations/Prevailing_Wage_Poster_H_2021.pdf

Appendix D.2

Equipment Watch Data

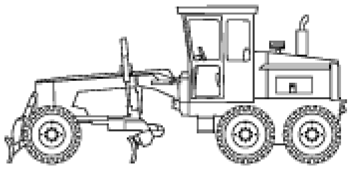
www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 14M (disc. 2015)
Articulated Frame Graders



Size Class:
250 HP & Over
Weight:
46796 lbs

Configuration for 14M (disc. 2015)

Moldboard Size	**14.0 ft**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $15,082.00	USD $5,050.00	USD $1,701.00
Adjustments			
Region (New Mexico: 81%)	(USD $2,848.54)	(USD $953.80)	(USD $321.27)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $12,233.46**	**USD $4,096.20**	**USD $1,379.73**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

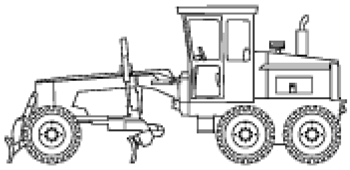
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 14M (disc. 2015)
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
46796 lbs



Configuration for 14M (disc. 2015)

Moldboard Size	**14.0 ft**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $43.90/hr	USD $41.10/hr	-6.4%
Cost of Facilities Capital (CFC)	USD $3.53/hr	USD $2.02/hr	-42.7%
Overhead	USD $19.93/hr	USD $10.93/hr	-45.2%
Overhaul Labor	USD $12.06/hr	USD $2.49/hr	-79.3%
Overhaul Parts	USD $24.44/hr	USD $13.40/hr	-45.2%
Total Hourly Ownership Cost:	**USD $103.86/hr**	**USD $69.94/hr**	**-32.7%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (942hrs -> 1,718hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $10.05/hr	USD $2.08/hr	-79.3%
Field Parts	USD $23.70/hr	USD $3.25/hr	-86.3%
Ground Engaging Component (GEC)	USD $1.97/hr	USD $0.00/hr	-100%
Tire	USD $7.26/hr	-	-
Electrical/Fuel	USD $27.95/hr	USD $8.29/hr	-70.3%
Lube	USD $6.50/hr	-	-
Total Operating Ownership Cost:	**USD $77.44/hr**	**USD $27.38/hr**	**-64.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $1,860.38 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.80) Annual Misc Supply Parts (USD $3,720.75 -> USD $0.00) Annual Field Repair Parts Cost (USD $18,603.77 -> USD $5,581.14)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $103.86/hr	USD $69.94/hr	-32.7%
Hourly Operating Costs	USD $77.44/hr	USD $27.38/hr	-64.6%
Total Hourly Cost	**USD $181.29**	**USD $97.32/hr**	**-46.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $67.36/hr	USD $54.05/hr	-19.8%
Idle	USD $131.81/hr	USD $78.23/hr	-40.6%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

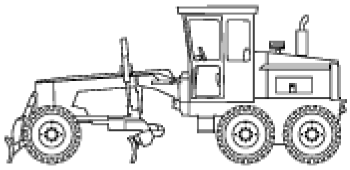
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 16M (disc. 2015)
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
59435 lbs



Configuration for 16M (disc. 2015)

Moldboard Size	**16.0 ft**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $15,082.00	USD $5,050.00	USD $1,701.00
Adjustments			
Region (New Mexico: 81%)	(USD $2,848.54)	(USD $953.80)	(USD $321.27)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $12,233.46**	**USD $4,096.20**	**USD $1,379.73**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

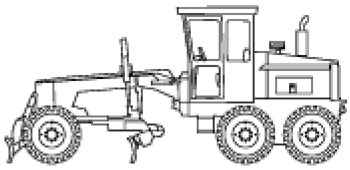
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 16M (disc. 2015)
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
59435 lbs



Configuration for 16M (disc. 2015)

Moldboard Size	**16.0 ft**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $33.17/hr	USD $31.05/hr	-6.4%
Cost of Facilities Capital (CFC)	USD $2.67/hr	USD $1.53/hr	-42.7%
Overhead	USD $15.07/hr	USD $8.26/hr	-45.2%
Overhaul Labor	USD $12.06/hr	USD $2.50/hr	-79.3%
Overhaul Parts	USD $18.46/hr	USD $10.12/hr	-45.2%
Total Hourly Ownership Cost:	**USD $81.43/hr**	**USD $53.47/hr**	**-34.3%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (942hrs -> 1,718hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $10.05/hr	USD $2.08/hr	-79.3%
Field Parts	USD $17.90/hr	USD $2.45/hr	-86.3%
Ground Engaging Component (GEC)	USD $1.49/hr	USD $0.00/hr	-100%
Tire	USD $5.49/hr	-	-
Electrical/Fuel	USD $32.05/hr	USD $9.50/hr	-70.3%
Lube	USD $6.01/hr	-	-
Total Operating Ownership Cost:	**USD $72.99/hr**	**USD $25.54/hr**	**-65%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $1,405.54 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $2,811.07 -> USD $0.00) Annual Field Repair Parts Cost (USD $14,055.36 -> USD $4,216.61)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $81.43/hr	USD $53.47/hr	-34.3%
Hourly Operating Costs	USD $72.99/hr	USD $25.54/hr	-65%
Total Hourly Cost	**USD $154.41**	**USD $79.00/hr**	**-48.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $50.91/hr	USD $40.84/hr	-19.8%
Idle	USD $113.48/hr	USD $62.97/hr	-44.5%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

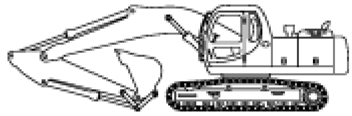
www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators



Size Class:
19.1 - 21.0 MTons
Weight:
43872 lbs

Configuration for 319D L (disc. 2012)

Operating Weight	**19.9 mt**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $6,704.00	USD $2,768.00	USD $985.00
Adjustments			
Region (New Mexico: 101%)	USD $83.00	USD $34.27	USD $12.20
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $6,787.00**	**USD $2,802.27**	**USD $997.20**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

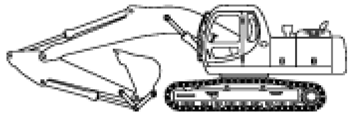
www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators



Size Class:
19.1 - 21.0 MTons
Weight:
43872 lbs

Configuration for 319D L (disc. 2012)

Operating Weight	**19.9 mt**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $23.69/hr	USD $22.17/hr	-6.4%
Cost of Facilities Capital (CFC)	USD $1.65/hr	USD $0.83/hr	-49.7%
Overhead	USD $5.87/hr	USD $2.73/hr	-53.4%
Overhaul Labor	USD $22.02/hr	USD $3.88/hr	-82.4%
Overhaul Parts	USD $11.76/hr	USD $5.48/hr	-53.4%
Total Hourly Ownership Cost:	**USD $64.99/hr**	**USD $35.09/hr**	**-46%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (745hrs -> 1,599hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $26.68/hr	USD $4.70/hr	-82.4%
Field Parts	USD $12.01/hr	USD $2.01/hr	-83.2%
Ground Engaging Component (GEC)	USD $1.92/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $8.20/hr	USD $2.43/hr	-70.3%
Lube	USD $2.50/hr	-	-
Total Operating Ownership Cost:	**USD $51.33/hr**	**USD $11.66/hr**	**-77.3%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $1,431.86 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,789.83 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,159.31 -> USD $3,221.69)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $64.99/hr	USD $35.09/hr	-46%
Hourly Operating Costs	USD $51.33/hr	USD $11.66/hr	-77.3%
Total Hourly Cost	**USD $116.32**	**USD $46.75/hr**	**-59.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $31.21/hr	USD $25.73/hr	-17.6%
Idle	USD $73.20/hr	USD $37.53/hr	-48.7%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

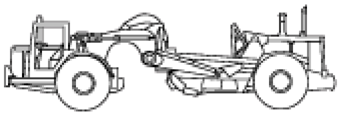
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 637G (disc. 2010)
Dual Engine Conventional Scrapers

Size Class:
18CY & Over
Weight:
114744 lbs



Configuration for 637G (disc. 2010)

Operator Protection	**EROPS**	Power Mode	**Diesel**
Scraper Capacity	**24.0 - 34.0 cu yd**	Scraper Horsepower	**283.0**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $27,250.00	USD $6,812.00	USD $1,362.00
Adjustments			
Region (New Mexico: 101%)	USD $346.56	USD $86.63	USD $17.32
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $27,596.56**	**USD $6,898.63**	**USD $1,379.32**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

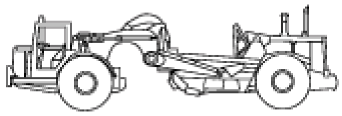
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 637G (disc. 2010)
Dual Engine Conventional Scrapers

Size Class:
18CY & Over
Weight:
114744 lbs



Configuration for 637G (disc. 2010)

Operator Protection	**EROPS**	Power Mode	**Diesel**
Scraper Capacity	**24.0 - 34.0 cu yd**	Scraper Horsepower	**283.0**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $105.74/hr	USD $99.56/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $7.99/hr	USD $5.11/hr	-36.1%
Overhead	USD $28.87/hr	USD $17.76/hr	-38.5%
Overhaul Labor	USD $37.94/hr	USD $8.83/hr	-76.7%
Overhaul Parts	USD $74.87/hr	USD $46.04/hr	-38.5%
Total Hourly Ownership Cost:	**USD $255.42/hr**	**USD $177.30/hr**	**-30.6%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (998hrs -> 1,623hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $56.91/hr	USD $13.24/hr	-76.7%
Field Parts	USD $75.46/hr	USD $8.89/hr	-88.2%
Ground Engaging Component (GEC)	USD $3.21/hr	USD $0.00/hr	-100%
Tire	USD $8.35/hr	-	-
Electrical/Fuel	USD $134.23/hr	USD $39.81/hr	-70.3%
Lube	USD $25.40/hr	-	-
Total Operating Ownership Cost:	**USD $303.57/hr**	**USD $95.69/hr**	**-68.5%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $3,204.63 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $11,216.20 -> USD $0.00) Annual Field Repair Parts Cost (USD $64,092.57 -> USD $14,420.83)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $255.42/hr	USD $177.30/hr	-30.6%
Hourly Operating Costs	USD $303.57/hr	USD $95.69/hr	-68.5%
Total Hourly Cost	**USD $558.99**	**USD $272.98/hr**	**-51.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $142.60/hr	USD $122.43/hr	-14.1%
Idle	USD $389.65/hr	USD $217.10/hr	-44.3%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

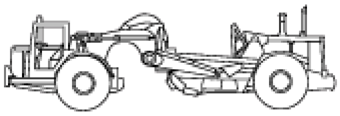
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 657G
Dual Engine Conventional Scrapers

Size Class:
18CY & Over
Weight:
149417 lbs



Configuration for 657G

Operator Protection	**EROPS**	Power Mode	**Diesel**
Scraper Capacity	**32.0 - 44.0 cu yd**	Scraper Horsepower	**410.0**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $27,250.00	USD $6,812.00	USD $1,362.00
Adjustments			
Region (New Mexico: 101%)	USD $346.56	USD $86.63	USD $17.32
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $27,596.56**	**USD $6,898.63**	**USD $1,379.32**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

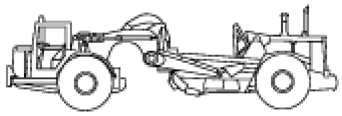
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 657G
Dual Engine Conventional Scrapers

Size Class:
18CY & Over
Weight:
149417 lbs



Configuration for 657G

Operator Protection	**EROPS**	Power Mode	**Diesel**
Scraper Capacity	**32.0 - 44.0 cu yd**	Scraper Horsepower	**410.0**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $166.92/hr	USD $157.18/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $12.61/hr	USD $8.06/hr	-36.1%
Overhead	USD $101.36/hr	USD $62.33/hr	-38.5%
Overhaul Labor	USD $37.94/hr	USD $8.83/hr	-76.7%
Overhaul Parts	USD $118.20/hr	USD $72.68/hr	-38.5%
Total Hourly Ownership Cost:	**USD $437.04/hr**	**USD $309.08/hr**	**-29.3%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (998hrs -> 1,623hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $56.91/hr	USD $13.24/hr	-76.7%
Field Parts	USD $119.12/hr	USD $14.03/hr	-88.2%
Ground Engaging Component (GEC)	USD $5.07/hr	USD $0.00/hr	-100%
Tire	USD $13.18/hr	-	-
Electrical/Fuel	USD $163.05/hr	USD $48.35/hr	-70.3%
Lube	USD $35.22/hr	-	-
Total Operating Ownership Cost:	**USD $392.55/hr**	**USD $124.02/hr**	**-68.4%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $5,059.00 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $17,706.51 -> USD $0.00) Annual Field Repair Parts Cost (USD $101,180.05 -> USD $22,765.51)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $437.04/hr	USD $309.08/hr	-29.3%
Hourly Operating Costs	USD $392.55/hr	USD $124.02/hr	-68.4%
Total Hourly Cost	**USD $829.59**	**USD $433.10/hr**	**-47.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $280.89/hr	USD $227.56/hr	-19%
Idle	USD $600.08/hr	USD $357.43/hr	-40.4%

Revised Date: 4th quarter 2021

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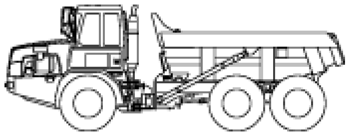
www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps



Size Class:
20 - 25 MTons
Weight:
49075 lbs

Configuration for 725 (disc. 2014)

Axle Configuration	**6 X 6**	Power Mode	**Diesel**
Rated Payload	**23.6 mt**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $9,023.00	USD $3,197.00	USD $1,122.00
Adjustments			
Region (New Mexico: 109%)	USD $798.52	USD $282.93	USD $99.30
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $9,821.52**	**USD $3,479.93**	**USD $1,221.30**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

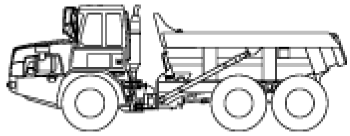
www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps



Size Class:
20 - 25 MTons
Weight:
49075 lbs

Configuration for 725 (disc. 2014)

Axle Configuration	**6 X 6**	Power Mode	**Diesel**
Rated Payload	**23.6 mt**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $37.88/hr	USD $35.62/hr	-6%
Cost of Facilities Capital (CFC)	USD $2.33/hr	USD $1.23/hr	-47.3%
Overhead	USD $9.10/hr	USD $4.39/hr	-51.7%
Overhaul Labor	USD $24.53/hr	USD $4.48/hr	-81.7%
Overhaul Parts	USD $16.38/hr	USD $7.91/hr	-51.7%
Total Hourly Ownership Cost:	**USD $90.22/hr**	**USD $53.63/hr**	**-40.6%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,029hrs -> 2,131hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $19.01/hr	USD $3.47/hr	-81.7%
Field Parts	USD $10.27/hr	USD $0.83/hr	-92%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $8.60/hr	-	-
Electrical/Fuel	USD $20.29/hr	USD $6.02/hr	-70.3%
Lube	USD $5.59/hr	-	-
Total Operating Ownership Cost:	**USD $63.75/hr**	**USD $24.50/hr**	**-61.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,761.21 -> USD $0.00) Annual Field Repair Parts Cost (USD $8,806.07 -> USD $1,761.21)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $90.22/hr	USD $53.63/hr	-40.6%
Hourly Operating Costs	USD $63.75/hr	USD $24.50/hr	-61.6%
Total Hourly Cost	**USD $153.97**	**USD $78.13/hr**	**-49.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $49.31/hr	USD $41.24/hr	-16.4%
Idle	USD $110.51/hr	USD $59.64/hr	-46%

Revised Date: 4th quarter 2021

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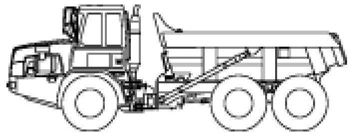
www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 740 (disc. 2014)
Articulated Rear Dumps



Size Class:
35 MTons & Over
Weight:
72973 lbs

Configuration for 740 (disc. 2014)

Axle Configuration	**6 X 6**	Power Mode	**Diesel**
Rated Payload	**39.5 mt**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $16,177.00	USD $5,535.00	USD $1,867.00
Adjustments			
Region (New Mexico: 109%)	USD $1,431.64	USD $489.84	USD $165.23
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $17,608.63**	**USD $6,024.84**	**USD $2,032.23**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

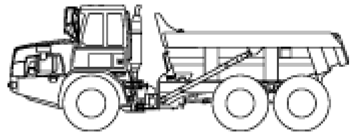
www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 740 (disc. 2014)
Articulated Rear Dumps



Size Class:
35 MTons & Over
Weight:
72973 lbs

Configuration for 740 (disc. 2014)

Axle Configuration	**6 X 6**	Power Mode	**Diesel**
Rated Payload	**39.5 mt**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $42.84/hr	USD $40.30/hr	-5.9%
Cost of Facilities Capital (CFC)	USD $3.04/hr	USD $1.66/hr	-45.5%
Overhead	USD $11.38/hr	USD $5.79/hr	-49.1%
Overhaul Labor	USD $32.38/hr	USD $6.24/hr	-80.7%
Overhaul Parts	USD $18.04/hr	USD $9.18/hr	-49.1%
Total Hourly Ownership Cost:	**USD $107.68/hr**	**USD $63.17/hr**	**-41.3%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,072hrs -> 2,106hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $23.25/hr	USD $4.48/hr	-80.7%
Field Parts	USD $11.13/hr	USD $0.94/hr	-91.5%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $10.64/hr	-	-
Electrical/Fuel	USD $27.23/hr	USD $8.07/hr	-70.3%
Lube	USD $7.63/hr	-	-
Total Operating Ownership Cost:	**USD $79.89/hr**	**USD $31.78/hr**	**-60.2%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,989.41 -> USD $0.00) Annual Field Repair Parts Cost (USD $9,947.04 -> USD $1,989.41)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $107.68/hr	USD $63.17/hr	-41.3%
Hourly Operating Costs	USD $79.89/hr	USD $31.78/hr	-60.2%
Total Hourly Cost	**USD $187.58**	**USD $94.95/hr**	**-49.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $57.26/hr	USD $47.75/hr	-16.6%
Idle	USD $134.91/hr	USD $71.25/hr	-47.2%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

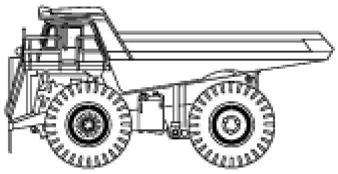
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 769D (disc. 2007)
Mechanical Drive Rear Dumps

Size Class:
30 - 39 MTons
Weight:
66800 lbs



Configuration for 769D (disc. 2007)

Power Mode	**Diesel**	Rated Payload	**36.4 mt**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $13,700.00	USD $4,600.00	USD $1,150.00
Adjustments			
Region (New Mexico: 98%)	(USD $241.84)	(USD $81.20)	(USD $20.30)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $13,458.16**	**USD $4,518.80**	**USD $1,129.70**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

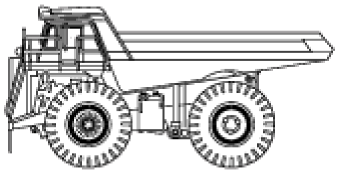
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 769D (disc. 2007)
Mechanical Drive Rear Dumps

Size Class:
30 - 39 MTons
Weight:
66800 lbs



Configuration for 769D (disc. 2007)

Power Mode	**Diesel**	Rated Payload	**36.4 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $34.20/hr	USD $32.21/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $2.61/hr	USD $1.80/hr	-30.9%
Overhead	USD $5.86/hr	USD $3.92/hr	-33.1%
Overhaul Labor	USD $22.32/hr	USD $5.65/hr	-74.7%
Overhaul Parts	USD $15.55/hr	USD $10.40/hr	-33.1%
Total Hourly Ownership Cost:	**USD $80.54/hr**	**USD $53.98/hr**	**-33%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,414hrs -> 2,114hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $17.63/hr	USD $4.46/hr	-74.7%
Field Parts	USD $9.48/hr	USD $1.06/hr	-88.9%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $9.80/hr	-	-
Electrical/Fuel	USD $28.03/hr	USD $8.31/hr	-70.3%
Lube	USD $8.39/hr	-	-
Total Operating Ownership Cost:	**USD $73.32/hr**	**USD $32.01/hr**	**-56.3%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $2,233.68 -> USD $0.00) Annual Field Repair Parts Cost (USD $11,168.40 -> USD $2,233.68)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $80.54/hr	USD $53.98/hr	-33%
Hourly Operating Costs	USD $73.32/hr	USD $32.01/hr	-56.3%
Total Hourly Cost	**USD $153.86**	**USD $86.00/hr**	**-44.1%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $42.67/hr	USD $37.93/hr	-11.1%
Idle	USD $108.57/hr	USD $62.29/hr	-42.6%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

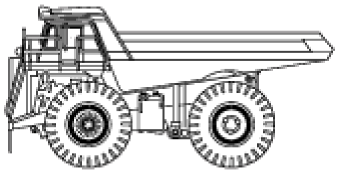
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 777F (disc. 2012)
Mechanical Drive Rear Dumps

Size Class:
90 - 104 MTons
Weight:
154753 lbs



Configuration for 777F (disc. 2012)

Power Mode	**Diesel**	Rated Payload	**90.7 mt**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $54,000.00	USD $18,000.00	USD $6,000.00
Adjustments			
Region (New Mexico: 100%)	-	-	-
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $54,000.00**	**USD $18,000.00**	**USD $6,000.00**

Date Last Updated: Mar 01, 2018

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

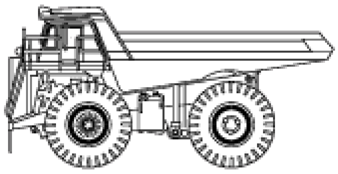
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 777F (disc. 2012)
Mechanical Drive Rear Dumps

Size Class:
90 - 104 MTons
Weight:
154753 lbs



Configuration for 777F (disc. 2012)

Power Mode	**Diesel**	Rated Payload	**90.7 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $64.79/hr	USD $61.01/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $4.51/hr	USD $4.59/hr	+1.9%
Overhead	USD $17.97/hr	USD $18.34/hr	+2.1%
Overhaul Labor	USD $27.83/hr	USD $10.75/hr	-61.4%
Overhaul Parts	USD $26.71/hr	USD $27.26/hr	+2.1%
Total Hourly Ownership Cost:	**USD $141.81/hr**	**USD $121.95/hr**	**-14%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (2,086hrs -> 2,044hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $17.09/hr	USD $6.60/hr	-61.4%
Field Parts	USD $16.48/hr	USD $2.80/hr	-83%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $24.83/hr	-	-
Electrical/Fuel	USD $47.01/hr	USD $13.94/hr	-70.3%
Lube	USD $18.85/hr	-	-
Total Operating Ownership Cost:	**USD $124.26/hr**	**USD $67.02/hr**	**-46.1%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $5,730.98 -> USD $0.00) Annual Field Repair Parts Cost (USD $28,654.88 -> USD $5,730.98)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $141.81/hr	USD $121.95/hr	-14%
Hourly Operating Costs	USD $124.26/hr	USD $67.02/hr	-46.1%
Total Hourly Cost	**USD $266.07**	**USD $188.97/hr**	**-29%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $87.27/hr	USD $83.94/hr	-3.8%
Idle	USD $188.82/hr	USD $135.89/hr	-28%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

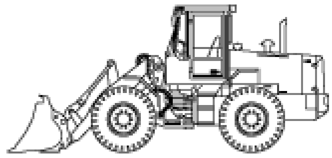
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 966H (disc. 2015)
4-Wd Articulated Wheel Loaders

Size Class:
250 - 274 HP
Weight:
52254 lbs



Configuration for 966H (disc. 2015)

Operator Protection	**EROPS**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $8,776.00	USD $3,166.00	USD $1,112.00
Adjustments			
Region (New Mexico: 103%)	USD $263.66	USD $95.12	USD $33.41
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $9,039.66**	**USD $3,261.12**	**USD $1,145.41**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

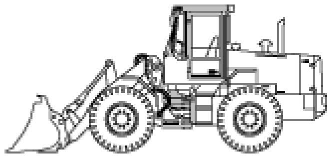
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 966H (disc. 2015)
4-Wd Articulated Wheel Loaders

Size Class:
250 - 274 HP
Weight:
52254 lbs



Configuration for 966H (disc. 2015)

Operator Protection	**EROPS**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $23.94/hr	USD $22.31/hr	-6.8%
Cost of Facilities Capital (CFC)	USD $2.24/hr	USD $1.35/hr	-39.8%
Overhead	USD $6.55/hr	USD $3.78/hr	-42.2%
Overhaul Labor	USD $15.59/hr	USD $3.41/hr	-78.1%
Overhaul Parts	USD $8.31/hr	USD $4.80/hr	-42.2%
Total Hourly Ownership Cost:	**USD $56.63/hr**	**USD $35.65/hr**	**-37%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,012hrs -> 1,751hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $19.02/hr	USD $4.16/hr	-78.1%
Field Parts	USD $9.17/hr	USD $1.51/hr	-83.5%
Ground Engaging Component (GEC)	USD $1.25/hr	USD $0.00/hr	-100%
Tire	USD $5.18/hr	-	-
Electrical/Fuel	USD $13.00/hr	USD $3.86/hr	-70.3%
Lube	USD $3.79/hr	-	-
Total Operating Ownership Cost:	**USD $51.41/hr**	**USD $18.49/hr**	**-64%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $1,263.03 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,381.44 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,893.96 -> USD $2,644.47)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $56.63/hr	USD $35.65/hr	-37%
Hourly Operating Costs	USD $51.41/hr	USD $18.49/hr	-64%
Total Hourly Cost	**USD $108.03**	**USD $54.15/hr**	**-49.9%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $32.73/hr	USD $27.44/hr	-16.2%
Idle	USD $69.63/hr	USD $39.51/hr	-43.3%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

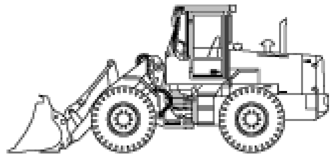
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 980H (disc. 2013)
4-Wd Articulated Wheel Loaders

Size Class:
275 - 349 HP
Weight:
67294 lbs



Configuration for 980H (disc. 2013)

Operator Protection	**EROPS**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $11,282.00	USD $4,119.00	USD $1,456.00
Adjustments			
Region (New Mexico: 103%)	USD $338.94	USD $123.75	USD $43.74
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $11,620.94**	**USD $4,242.75**	**USD $1,499.74**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

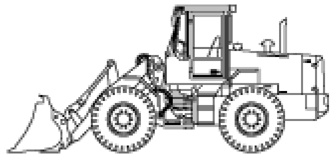
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 980H (disc. 2013)
4-Wd Articulated Wheel Loaders

Size Class:
275 - 349 HP
Weight:
67294 lbs



Configuration for 980H (disc. 2013)

Operator Protection	**EROPS**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $28.31/hr	USD $26.34/hr	-6.9%
Cost of Facilities Capital (CFC)	USD $2.25/hr	USD $1.59/hr	-29.2%
Overhead	USD $4.85/hr	USD $3.33/hr	-31.4%
Overhaul Labor	USD $13.13/hr	USD $3.41/hr	-74%
Overhaul Parts	USD $8.24/hr	USD $5.66/hr	-31.4%
Total Hourly Ownership Cost:	**USD $56.77/hr**	**USD $40.33/hr**	**-29%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,202hrs -> 1,751hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $16.01/hr	USD $4.16/hr	-74%
Field Parts	USD $9.09/hr	USD $1.78/hr	-80.4%
Ground Engaging Component (GEC)	USD $1.24/hr	USD $0.00/hr	-100%
Tire	USD $8.37/hr	-	-
Electrical/Fuel	USD $18.04/hr	USD $5.35/hr	-70.3%
Lube	USD $4.73/hr	-	-
Total Operating Ownership Cost:	**USD $57.49/hr**	**USD $24.39/hr**	**-57.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $1,487.83 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,627.31 -> USD $0.00) Annual Field Repair Parts Cost (USD $9,298.94 -> USD $3,115.15)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $56.77/hr	USD $40.33/hr	-29%
Hourly Operating Costs	USD $57.49/hr	USD $24.39/hr	-57.6%
Total Hourly Cost	**USD $114.26**	**USD $64.72/hr**	**-43.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $35.41/hr	USD $31.26/hr	-11.7%
Idle	USD $74.82/hr	USD $45.68/hr	-38.9%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

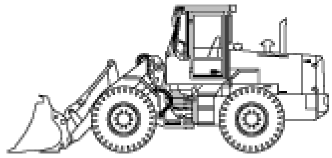
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 988H (disc. 2014)
4-Wd Articulated Wheel Loaders

Size Class:
350 - 499 HP
Weight:
109230 lbs



Configuration for 988H (disc. 2014)

Operator Protection	**EROPS**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $15,457.00	USD $5,361.00	USD $1,864.00
Adjustments			
Region (New Mexico: 103%)	USD $464.37	USD $161.06	USD $56.00
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $15,921.37**	**USD $5,522.06**	**USD $1,920.00**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

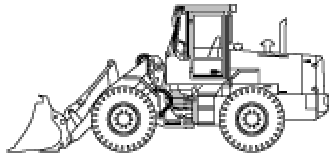
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 988H (disc. 2014)
4-Wd Articulated Wheel Loaders

Size Class:
350 - 499 HP
Weight:
109230 lbs



Configuration for 988H (disc. 2014)

Operator Protection	**EROPS**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $52.48/hr	USD $48.93/hr	-6.8%
Cost of Facilities Capital (CFC)	USD $3.84/hr	USD $3.26/hr	-15.1%
Overhead	USD $6.69/hr	USD $5.60/hr	-16.3%
Overhaul Labor	USD $10.76/hr	USD $3.41/hr	-68.3%
Overhaul Parts	USD $13.98/hr	USD $11.71/hr	-16.3%
Total Hourly Ownership Cost:	**USD $87.75/hr**	**USD $72.90/hr**	**-16.9%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,466hrs -> 1,751hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $13.13/hr	USD $4.16/hr	-68.3%
Field Parts	USD $15.43/hr	USD $3.68/hr	-76.1%
Ground Engaging Component (GEC)	USD $2.10/hr	USD $0.00/hr	-100%
Tire	USD $13.79/hr	-	-
Electrical/Fuel	USD $30.77/hr	USD $9.13/hr	-70.3%
Lube	USD $9.14/hr	-	-
Total Operating Ownership Cost:	**USD $84.36/hr**	**USD $39.90/hr**	**-52.7%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $3,079.29 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $3,367.97 -> USD $0.00) Annual Field Repair Parts Cost (USD $19,245.54 -> USD $6,447.26)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $87.75/hr	USD $72.90/hr	-16.9%
Hourly Operating Costs	USD $84.36/hr	USD $39.90/hr	-52.7%
Total Hourly Cost	**USD $172.11**	**USD $112.80/hr**	**-34.5%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $63.01/hr	USD $57.79/hr	-8.3%
Idle	USD $118.52/hr	USD $82.03/hr	-30.8%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

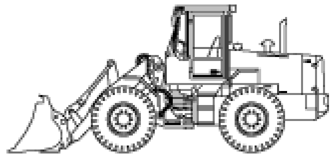
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 992K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
214948 lbs



Configuration for 992K

Operator Protection	**EROPS**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $24,283.00	USD $8,110.00	USD $2,554.00
Adjustments			
Region (New Mexico: 103%)	USD $729.53	USD $243.65	USD $76.73
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $25,012.53**	**USD $8,353.65**	**USD $2,630.73**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

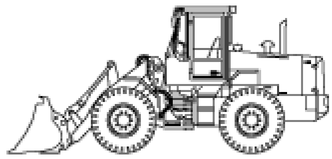
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 992K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
214948 lbs



Configuration for 992K

Operator Protection	**EROPS**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	**User Adjusted Value**	**Variance**
Depreciation	USD $117.34/hr	USD $109.18/hr	-7%
Cost of Facilities Capital (CFC)	USD $6.76/hr	USD $7.71/hr	+13.9%
Overhead	USD $51.43/hr	USD $59.30/hr	+15.3%
Overhaul Labor	USD $7.81/hr	USD $3.41/hr	-56.4%
Overhaul Parts	USD $24.19/hr	USD $27.89/hr	+15.3%
Total Hourly Ownership Cost:	**USD $207.53/hr**	**USD $207.49/hr**	**0%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (2,019hrs -> 1,751hrs)

Hourly Operating Costs

	Standard Value	**User Adjusted Value**	**Variance**
Field Labor	USD $9.53/hr	USD $4.16/hr	-56.4%
Field Parts	USD $26.68/hr	USD $8.77/hr	-67.1%
Ground Engaging Component (GEC)	USD $3.63/hr	USD $0.00/hr	-100%
Tire	USD $55.78/hr	-	-
Electrical/Fuel	USD $65.72/hr	USD $19.49/hr	-70.3%
Lube	USD $21.01/hr	-	-
Total Operating Ownership Cost:	**USD $182.37/hr**	**USD $109.22/hr**	**-40.1%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $7,335.94 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $8,023.68 -> USD $0.00) Annual Field Repair Parts Cost (USD $45,849.60 -> USD $15,359.62)

Total

	Standard Value	**User Adjusted Value**	**Variance**
Hourly Ownership Costs	USD $207.53/hr	USD $207.49/hr	0%
Hourly Operating Costs	USD $182.37/hr	USD $109.22/hr	-40.1%
Total Hourly Cost	**USD $389.90**	**USD $316.70/hr**	**-18.8%**

Non-active use rates

	Standard Value	**User Adjusted Value**	**Variance**
Standby	USD $175.53/hr	USD $176.19/hr	+0.4%
Idle	USD $273.25/hr	USD $226.98/hr	-16.9%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

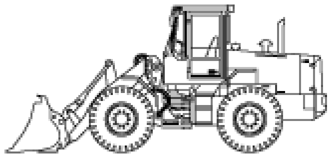
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar 993K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
294800 lbs



Configuration for 993K

Operator Protection	**EROPS**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $24,283.00	USD $8,110.00	USD $2,554.00
Adjustments			
Region (New Mexico: 103%)	USD $729.53	USD $243.65	USD $76.73
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $25,012.53**	**USD $8,353.65**	**USD $2,630.73**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

www.equipmentwatch.com

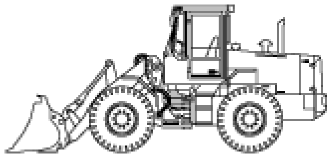
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar 993K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
294800 lbs



Configuration for 993K

Operator Protection	**EROPS**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $140.77/hr	USD $130.98/hr	-7%
Cost of Facilities Capital (CFC)	USD $8.11/hr	USD $9.24/hr	+13.9%
Overhead	USD $57.23/hr	USD $65.98/hr	+15.3%
Overhaul Labor	USD $7.81/hr	USD $3.41/hr	-56.4%
Overhaul Parts	USD $29.01/hr	USD $33.45/hr	+15.3%
Total Hourly Ownership Cost:	**USD $242.93/hr**	**USD $243.07/hr**	**+0.1%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (2,019hrs -> 1,751hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $9.53/hr	USD $4.16/hr	-56.4%
Field Parts	USD $32.01/hr	USD $10.52/hr	-67.1%
Ground Engaging Component (GEC)	USD $4.36/hr	USD $0.00/hr	-100%
Tire	USD $66.92/hr	-	-
Electrical/Fuel	USD $77.94/hr	USD $23.11/hr	-70.3%
Lube	USD $25.12/hr	-	-
Total Operating Ownership Cost:	**USD $215.89/hr**	**USD $129.84/hr**	**-39.9%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $8,800.54 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $9,625.59 -> USD $0.00) Annual Field Repair Parts Cost (USD $55,003.40 -> USD $18,426.14)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $242.93/hr	USD $243.07/hr	+0.1%
Hourly Operating Costs	USD $215.89/hr	USD $129.84/hr	-39.9%
Total Hourly Cost	**USD $458.82**	**USD $372.91/hr**	**-18.7%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $206.10/hr	USD $206.21/hr	+0.1%
Idle	USD $320.87/hr	USD $266.19/hr	-17%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

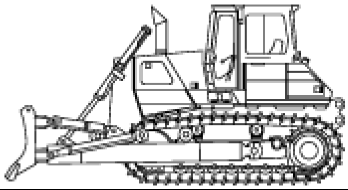
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar D6T (disc. 2019)
Standard Crawler Dozers

Size Class:
160 - 189 HP
Weight:
40550 lbs



Configuration for D6T (disc. 2019)

Dozer Type	**Semi-U**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $7,997.00	USD $2,722.00	USD $882.00
Adjustments			
Region (New Mexico: 110%)	USD $825.13	USD $280.85	USD $91.00
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $8,822.13**	**USD $3,002.85**	**USD $973.00**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

www.equipmentwatch.com

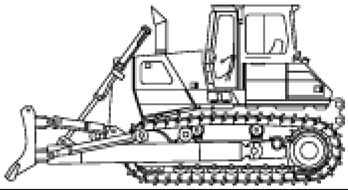
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar D6T (disc. 2019)
Standard Crawler Dozers

Size Class:
160 - 189 HP
Weight:
40550 lbs



Configuration for D6T (disc. 2019)

Dozer Type	**Semi-U**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $40.40/hr	USD $37.61/hr	-6.9%
Cost of Facilities Capital (CFC)	USD $3.52/hr	USD $1.86/hr	-47%
Overhead	USD $21.92/hr	USD $11.07/hr	-49.5%
Overhaul Labor	USD $16.83/hr	USD $3.21/hr	-80.9%
Overhaul Parts	USD $31.07/hr	USD $15.68/hr	-49.5%
Total Hourly Ownership Cost:	**USD $113.75/hr**	**USD $69.43/hr**	**-39%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (806hrs -> 1,597hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $20.75/hr	USD $3.96/hr	-80.9%
Field Parts	USD $30.11/hr	USD $5.06/hr	-83.2%
Ground Engaging Component (GEC)	USD $5.02/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $22.07/hr	USD $6.55/hr	-70.3%
Lube	USD $5.18/hr	-	-
Total Operating Ownership Cost:	**USD $83.13/hr**	**USD $20.76/hr**	**-75%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $4,044.32 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $4,044.32 -> USD $0.00) Annual Field Repair Parts Cost (USD $20,221.59 -> USD $8,088.64)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $113.75/hr	USD $69.43/hr	-39%
Hourly Operating Costs	USD $83.13/hr	USD $20.76/hr	-75%
Total Hourly Cost	**USD $196.88**	**USD $90.19/hr**	**-54.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $65.84/hr	USD $50.54/hr	-23.2%
Idle	USD $135.82/hr	USD $75.98/hr	-44.1%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

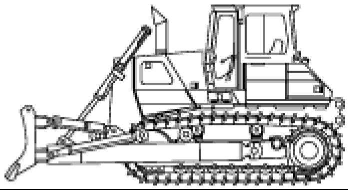
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar D6T XL (disc. 2018)
Standard Crawler Dozers

Size Class:
190 - 259 HP
Weight:
44420 lbs



Configuration for D6T XL (disc. 2018)

Dozer Type	**Semi-U**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $11,442.00	USD $3,990.00	USD $1,403.00
Adjustments			
Region (New Mexico: 110%)	USD $1,180.58	USD $411.69	USD $144.76
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $12,622.58**	**USD $4,401.69**	**USD $1,547.76**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

www.equipmentwatch.com

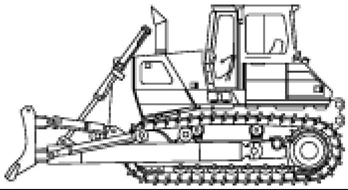
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar D6T XL (disc. 2018)
Standard Crawler Dozers

Size Class:
190 - 259 HP
Weight:
44420 lbs



Configuration for D6T XL (disc. 2018)

Dozer Type	**Semi-U**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $44.12/hr	USD $41.28/hr	-6.4%
Cost of Facilities Capital (CFC)	USD $3.53/hr	USD $1.84/hr	-47.7%
Overhead	USD $19.33/hr	USD $9.56/hr	-50.5%
Overhaul Labor	USD $17.18/hr	USD $3.20/hr	-81.3%
Overhaul Parts	USD $32.24/hr	USD $15.95/hr	-50.5%
Total Hourly Ownership Cost:	**USD $116.40/hr**	**USD $71.84/hr**	**-38.3%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (790hrs -> 1,597hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $21.17/hr	USD $3.95/hr	-81.3%
Field Parts	USD $31.25/hr	USD $5.15/hr	-83.5%
Ground Engaging Component (GEC)	USD $5.21/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $21.72/hr	USD $6.44/hr	-70.3%
Lube	USD $5.20/hr	-	-
Total Operating Ownership Cost:	**USD $84.54/hr**	**USD $20.74/hr**	**-75.5%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $4,114.14 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.80) Annual Misc Supply Parts (USD $4,114.14 -> USD $0.00) Annual Field Repair Parts Cost (USD $20,570.71 -> USD $8,228.28)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $116.40/hr	USD $71.84/hr	-38.3%
Hourly Operating Costs	USD $84.54/hr	USD $20.74/hr	-75.5%
Total Hourly Cost	**USD $200.93**	**USD $92.58/hr**	**-53.9%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $66.98/hr	USD $52.69/hr	-21.3%
Idle	USD $138.11/hr	USD $78.28/hr	-43.3%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

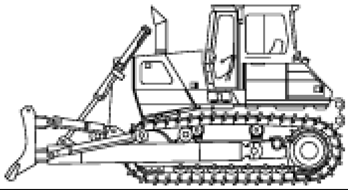
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar D9T
Standard Crawler Dozers

Size Class:
360 - 519 HP
Weight:
105600 lbs



Configuration for D9T

Dozer Type	**Semi-U**	Operator Protection	**ROPS/FOPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $26,926.00	USD $9,306.00	USD $3,273.00
Adjustments			
Region (New Mexico: 110%)	USD $2,778.21	USD $960.19	USD $337.71
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $29,704.21**	**USD $10,266.19**	**USD $3,610.71**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

www.equipmentwatch.com

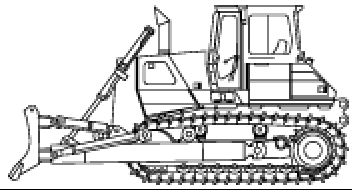
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar D9T
Standard Crawler Dozers

Size Class:
360 - 519 HP
Weight:
105600 lbs



Configuration for D9T

Dozer Type	**Semi-U**	Operator Protection	**ROPS/FOPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $69.45/hr	USD $65.34/hr	-5.9%
Cost of Facilities Capital (CFC)	USD $5.28/hr	USD $4.01/hr	-24.1%
Overhead	USD $40.36/hr	USD $30.05/hr	-25.6%
Overhaul Labor	USD $20.70/hr	USD $5.83/hr	-71.8%
Overhaul Parts	USD $62.12/hr	USD $46.25/hr	-25.6%
Total Hourly Ownership Cost:	**USD $197.90/hr**	**USD $151.47/hr**	**-23.5%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,250hrs -> 1,679hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $24.23/hr	USD $6.83/hr	-71.8%
Field Parts	USD $60.50/hr	USD $15.01/hr	-75.2%
Ground Engaging Component (GEC)	USD $10.08/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $43.93/hr	USD $13.03/hr	-70.3%
Lube	USD $13.31/hr	-	-
Total Operating Ownership Cost:	**USD $152.06/hr**	**USD $48.18/hr**	**-68.3%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $12,604.04 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $12,604.04 -> USD $0.00) Annual Field Repair Parts Cost (USD $63,020.18 -> USD $25,208.08)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $197.90/hr	USD $151.47/hr	-23.5%
Hourly Operating Costs	USD $152.06/hr	USD $48.18/hr	-68.3%
Total Hourly Cost	**USD $349.96**	**USD $199.65/hr**	**-43%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $115.09/hr	USD $99.39/hr	-13.6%
Idle	USD $241.83/hr	USD $164.49/hr	-32%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

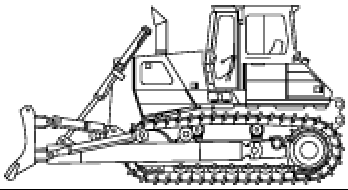
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar D11T CD (disc. 2018)
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
N/A



Configuration for D11T CD (disc. 2018)

Dozer Type	**U Blade**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $30,648.00	USD $10,566.00	USD $3,597.00
Adjustments			
Region (New Mexico: 110%)	USD $3,162.24	USD $1,090.19	USD $371.14
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $33,810.24**	**USD $11,656.19**	**USD $3,968.14**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

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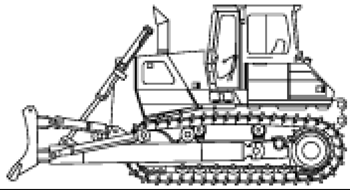
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar D11T CD (disc. 2018)
Standard Crawler Dozers



Size Class:
520 HP & Over
Weight:
N/A

Configuration for D11T CD (disc. 2018)

Dozer Type	**U Blade**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $69.61/hr	USD $65.50/hr	-5.9%
Cost of Facilities Capital (CFC)	USD $4.00/hr	USD $4.29/hr	+7.4%
Overhead	USD $25.98/hr	USD $28.06/hr	+8%
Overhaul Labor	USD $14.27/hr	USD $5.83/hr	-59.1%
Overhaul Parts	USD $46.13/hr	USD $49.82/hr	+8%
Total Hourly Ownership Cost:	**USD $159.99/hr**	**USD $153.49/hr**	**-4.1%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,813hrs -> 1,679hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $16.71/hr	USD $6.83/hr	-59.1%
Field Parts	USD $44.93/hr	USD $16.17/hr	-64%
Ground Engaging Component (GEC)	USD $7.49/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $89.51/hr	USD $26.54/hr	-70.3%
Lube	USD $18.56/hr	-	-
Total Operating Ownership Cost:	**USD $177.20/hr**	**USD $68.10/hr**	**-61.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $13,577.33 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $13,577.33 -> USD $0.00) Annual Field Repair Parts Cost (USD $67,886.64 -> USD $27,154.66)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $159.99/hr	USD $153.49/hr	-4.1%
Hourly Operating Costs	USD $177.20/hr	USD $68.10/hr	-61.6%
Total Hourly Cost	**USD $337.19**	**USD $221.59/hr**	**-34.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $99.59/hr	USD $97.84/hr	-1.8%
Idle	USD $249.50/hr	USD $180.04/hr	-27.8%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

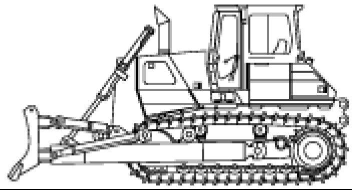
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Caterpillar D11T (disc. 2018)
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
208885 lbs



Configuration for D11T (disc. 2018)

Dozer Type	**U Blade**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $30,648.00	USD $10,566.00	USD $3,597.00
Adjustments			
Region (New Mexico: 110%)	USD $3,162.24	USD $1,090.19	USD $371.14
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $33,810.24**	**USD $11,656.19**	**USD $3,968.14**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

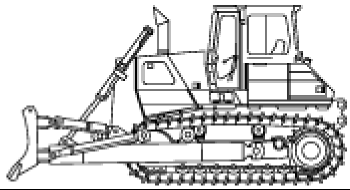
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Caterpillar D11T (disc. 2018)
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
208885 lbs



Configuration for D11T (disc. 2018)

Dozer Type	**U Blade**	Operator Protection	**EROPS**
Power Mode	**Diesel**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $135.34/hr	USD $127.35/hr	-5.9%
Cost of Facilities Capital (CFC)	USD $7.77/hr	USD $8.34/hr	+7.4%
Overhead	USD $42.16/hr	USD $45.52/hr	+8%
Overhaul Labor	USD $14.27/hr	USD $5.83/hr	-59.1%
Overhaul Parts	USD $89.70/hr	USD $96.86/hr	+8%
Total Hourly Ownership Cost:	**USD $289.24/hr**	**USD $283.90/hr**	**-1.8%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,813hrs -> 1,679hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $16.71/hr	USD $6.83/hr	-59.1%
Field Parts	USD $87.37/hr	USD $31.45/hr	-64%
Ground Engaging Component (GEC)	USD $14.56/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $89.51/hr	USD $26.54/hr	-70.3%
Lube	USD $27.63/hr	-	-
Total Operating Ownership Cost:	**USD $235.77/hr**	**USD $92.45/hr**	**-60.8%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $26,399.19 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $26,399.19 -> USD $0.00) Annual Field Repair Parts Cost (USD $131,995.97 -> USD $52,798.38)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $289.24/hr	USD $283.90/hr	-1.8%
Hourly Operating Costs	USD $235.77/hr	USD $92.45/hr	-60.8%
Total Hourly Cost	**USD $525.01**	**USD $376.35/hr**	**-28.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $185.27/hr	USD $181.21/hr	-2.2%
Idle	USD $378.75/hr	USD $310.44/hr	-18%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

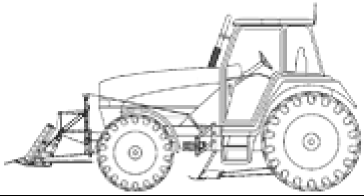
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

Horsepower	**166.0 hp**	Power Mode	**Diesel**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $3,891.00	USD $1,303.00	USD $462.00
Adjustments			
Region (New Mexico: 95%)	(USD $213.18)	(USD $71.39)	(USD $25.31)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $3,677.82**	**USD $1,231.61**	**USD $436.69**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

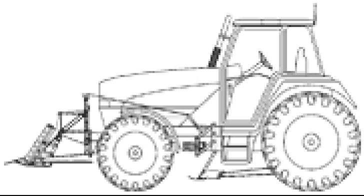
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Deere 7430 (disc. 2011)
Wheel Tractors

Size Class:
125 to 174 hp
Weight:
N/A



Configuration for 7430 (disc. 2011)

Horsepower	**166.0 hp**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $11.78/hr	USD $11.05/hr	-6.2%
Cost of Facilities Capital (CFC)	USD $1.11/hr	USD $0.56/hr	-49.7%
Overhead	USD $6.66/hr	USD $3.17/hr	-52.4%
Overhaul Labor	USD $11.02/hr	USD $1.99/hr	-82%
Overhaul Parts	USD $6.96/hr	USD $3.31/hr	-52.4%
Total Hourly Ownership Cost:	**USD $37.53/hr**	**USD $20.08/hr**	**-46.5%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (647hrs -> 1,359hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $14.53/hr	USD $2.62/hr	-82%
Field Parts	USD $6.10/hr	USD $0.48/hr	-92.1%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.80/hr	-	-
Electrical/Fuel	USD $20.15/hr	USD $5.98/hr	-70.3%
Lube	USD $2.83/hr	-	-
Total Operating Ownership Cost:	**USD $44.42/hr**	**USD $12.71/hr**	**-71.4%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $658.26 -> USD $0.00) Annual Field Repair Parts Cost (USD $3,291.28 -> USD $658.26)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $37.53/hr	USD $20.08/hr	-46.5%
Hourly Operating Costs	USD $44.42/hr	USD $12.71/hr	-71.4%
Total Hourly Cost	**USD $81.95**	**USD $32.78/hr**	**-60%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $19.54/hr	USD $14.77/hr	-24.4%
Idle	USD $57.68/hr	USD $26.05/hr	-54.8%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4880 lbs

Configuration for B260

Horsepower	**115.0**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $5.80/hr	USD $5.45/hr	-6.2%
Cost of Facilities Capital (CFC)	USD $0.26/hr	USD $0.17/hr	-33.5%
Overhead	USD $1.44/hr	USD $0.90/hr	-38%
Overhaul Labor	USD $4.40/hr	USD $1.03/hr	-76.5%
Overhaul Parts	USD $3.10/hr	USD $1.92/hr	-38%
Total Hourly Ownership Cost:	**USD $15.01/hr**	**USD $9.47/hr**	**-36.9%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (861hrs -> 1,388hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $5.50/hr	USD $1.29/hr	-76.5%
Field Parts	USD $1.79/hr	USD $0.15/hr	-91.9%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.60/hr	-	-
Electrical/Fuel	USD $13.92/hr	USD $4.13/hr	-70.3%
Lube	USD $1.64/hr	-	-
Total Operating Ownership Cost:	**USD $23.45/hr**	**USD $7.81/hr**	**-66.7%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $201.40 -> USD $0.00) Annual Field Repair Parts Cost (USD $1,342.66 -> USD $201.40)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $15.01/hr	USD $9.47/hr	-36.9%
Hourly Operating Costs	USD $23.45/hr	USD $7.81/hr	-66.7%
Total Hourly Cost	**USD $38.46**	**USD $17.28/hr**	**-55.1%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $7.51/hr	USD $6.52/hr	-13.2%
Idle	USD $28.93/hr	USD $13.60/hr	-53%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4880 lbs

Configuration for B260

Horsepower	**115.0**	Power Mode	**Diesel**

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019
** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $2,425.00	USD $680.00	USD $170.00	USD $26.00	USD $21.35	USD $35.13
Adjustments						
Region (Las Cruces, New Mexico: 89.4%)	(USD $257.05)	(USD $72.08)	(USD $18.02)	(USD $2.76)		
Model Year (2021: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $2,167.95**	**USD $607.92**	**USD $151.98**	**USD $23.24**	**USD $21.35**	**USD $33.67**

Non-Active Use Rates	**Hourly**
Standby Rate	USD $6.16
Idling Rate	USD $25.82

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	37%	USD $897.25/mo
Overhaul (ownership)	50%	USD $1,212.50/mo
CFC (ownership)	6%	USD $145.50/mo
Indirect (ownership)	7%	USD $169.75/mo
Fuel (operating) @ USD 3.27	63%	USD $13.50/hr

Revised Date: 1st half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

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www.equipmentwatch.com

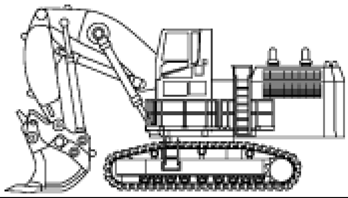
All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
772000 lbs



Configuration for EX3600-5 (disc. 2009)

Operating Weight	**350.0 mt**	Power Mode	**Diesel**

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019
** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $76,625.00	USD $21,455.00	USD $5,365.00	USD $805.00	USD $530.00	USD $965.37
Adjustments						
Region (Las Cruces, New Mexico: 90.4%)	(USD $7,356.00)	(USD $2,059.68)	(USD $515.04)	(USD $77.28)		
Model Year (2009: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $69,269.00**	**USD $19,395.32**	**USD $4,849.96**	**USD $727.72**	**USD $530.00**	**USD $923.57**

Non-Active Use Rates	**Hourly**
Standby Rate	USD $196.79
Idling Rate	USD $664.06

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	32%	USD $24,520.00/mo
Overhaul (ownership)	50%	USD $38,312.50/mo
CFC (ownership)	9%	USD $6,896.25/mo
Indirect (ownership)	9%	USD $6,896.25/mo
Fuel (operating) @ USD 3.27	51%	USD $270.49/hr

Revised Date: 1st half 2019

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EquipmentWatch

www.equipmentwatch.com

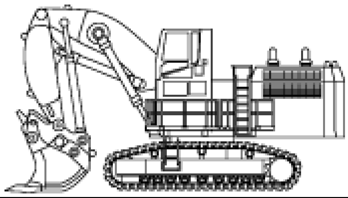
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
772000 lbs



Configuration for EX3600-5 (disc. 2009)

Operating Weight	**350.0 mt**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $157.56/hr	USD $148.69/hr	-5.6%
Cost of Facilities Capital (CFC)	USD $11.66/hr	USD $10.65/hr	-8.6%
Overhead	USD $72.89/hr	USD $66.17/hr	-9.2%
Overhaul Labor	USD $32.75/hr	USD $11.25/hr	-65.7%
Overhaul Parts	USD $113.67/hr	USD $103.19/hr	-9.2%
Total Hourly Ownership Cost:	**USD $388.53/hr**	**USD $339.94/hr**	**-12.5%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,850hrs -> 2,038hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $43.49/hr	USD $14.94/hr	-65.7%
Field Parts	USD $124.46/hr	USD $40.67/hr	-67.3%
Ground Engaging Component (GEC)	USD $19.91/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $278.93/hr	USD $82.72/hr	-70.3%
Lube	USD $60.00/hr	-	-
Total Operating Ownership Cost:	**USD $526.80/hr**	**USD $198.33/hr**	**-62.4%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Annual Ground Engaging Component (USD $36,841.54 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $46,051.93 -> USD $0.00) Annual Field Repair Parts Cost (USD $184,207.72 -> USD $82,893.47)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $388.53/hr	USD $339.94/hr	-12.5%
Hourly Operating Costs	USD $526.80/hr	USD $198.33/hr	-62.4%
Total Hourly Cost	**USD $915.34**	**USD $538.28/hr**	**-41.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $242.11/hr	USD $225.51/hr	-6.9%
Idle	USD $667.46/hr	USD $422.66/hr	-36.7%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

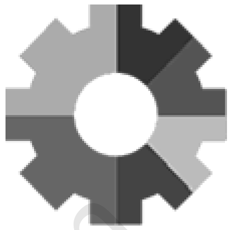
All prices shown in US dollars ($)

Spec Finder

October 5, 2021

Kenworth T800
On-Highway Truck Tractors

Size Class:
45,001 - 60,000 GVW
Weight:
N/A



Specifications

Engine	
Engine	ISM
Engine Manufacturer	Cummins
Horsepower	330.0 hp
Power Mode	Diesel
Transmission	
Number of Speeds	10-Speed
Transmission	FRO-13210C
Transmission Manufacturer	Fuller

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EquipmentWatch

www.equipmentwatch.com

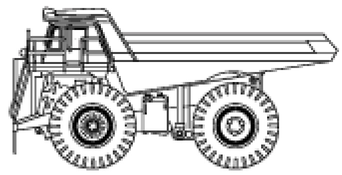
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
309950 lbs



Configuration for 730E

Power Mode	**Diesel**	Rated Payload	**183.7 mt**
Wheel Motor Model	**GE788**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $57.77/hr	USD $54.40/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $4.53/hr	USD $4.39/hr	-3.1%
Overhead	USD $29.49/hr	USD $28.51/hr	-3.3%
Overhaul Labor	USD $57.99/hr	USD $21.21/hr	-63.4%
Overhaul Parts	USD $23.65/hr	USD $22.86/hr	-3.3%
Total Hourly Ownership Cost:	**USD $173.43/hr**	**USD $131.36/hr**	**-24.3%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,850hrs -> 1,914hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $33.77/hr	USD $12.35/hr	-63.4%
Field Parts	USD $11.14/hr	USD $1.80/hr	-83.9%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $21.21/hr	-	-
Electrical/Fuel	USD $96.44/hr	USD $28.60/hr	-70.3%
Lube	USD $19.19/hr	-	-
Total Operating Ownership Cost:	**USD $181.75/hr**	**USD $83.15/hr**	**-54.3%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $3,436.08 -> USD $0.00) Annual Field Repair Parts Cost (USD $17,180.42 -> USD $3,436.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $173.43/hr	USD $131.36/hr	-24.3%
Hourly Operating Costs	USD $181.75/hr	USD $83.15/hr	-54.3%
Total Hourly Cost	**USD $355.18**	**USD $214.50/hr**	**-39.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $91.79/hr	USD $87.29/hr	-4.9%
Idle	USD $269.87/hr	USD $159.96/hr	-40.7%

Revised Date: 4th quarter 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

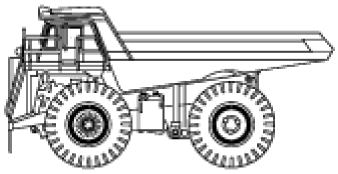
All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
309950 lbs



Configuration for 730E

Power Mode	**Diesel**	Rated Payload	**183.7 mt**
Wheel Motor Model	**GE788**		

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $32,225.00	USD $9,025.00	USD $2,255.00	USD $340.00	USD $193.80	USD $376.90
Adjustments						
Region (Las Cruces, New Mexico: 91.1%)	(USD $2,868.02)	(USD $803.22)	(USD $200.70)	(USD $30.26)		
Model Year (2021: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $29,356.97**	**USD $8,221.78**	**USD $2,054.30**	**USD $309.74**	**USD $193.80**	**USD $360.60**

Non-Active Use Rates	**Hourly**
Standby Rate	USD $88.40
Idling Rate	USD $276.28

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	31%	USD $9,989.75/mo
Overhaul (ownership)	47%	USD $15,145.75/mo
CFC (ownership)	9%	USD $2,900.25/mo
Indirect (ownership)	13%	USD $4,189.25/mo
Fuel (operating) @ USD 3.27	56%	USD $109.48/hr

Revised Date: 1st half 2019

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www.equipmentwatch.com

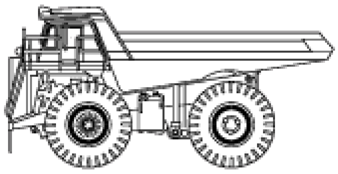
All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Komatsu HD1500-5 (disc. 2008)
Mechanical Drive Rear Dumps

Size Class:
105 - 139 MTons
Weight:
221481 lbs



Configuration for HD1500-5 (disc. 2008)

Power Mode	**Diesel**	Rated Payload	**136.0 mt**

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $27,675.00	USD $7,750.00	USD $1,940.00	USD $290.00	USD $169.35	USD $326.59
Adjustments						
Region (Las Cruces, New Mexico: 91.1%)	(USD $2,463.07)	(USD $689.75)	(USD $172.66)	(USD $25.81)		
Model Year (2008: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $25,211.93**	**USD $7,060.25**	**USD $1,767.34**	**USD $264.19**	**USD $169.35**	**USD $312.60**

Non-Active Use Rates	Hourly
Standby Rate	USD $70.19
Idling Rate	USD $235.20

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	33%	USD $9,132.75/mo
Overhaul (ownership)	51%	USD $14,114.25/mo
CFC (ownership)	8%	USD $2,214.00/mo
Indirect (ownership)	8%	USD $2,214.00/mo
Fuel (operating) @ USD 3.27	54%	USD $91.95/hr

Revised Date: 1st half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

www.equipmentwatch.com

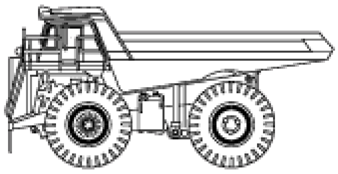
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Komatsu HD1500-5 (disc. 2008)
Mechanical Drive Rear Dumps

Size Class:
105 - 139 MTons
Weight:
221481 lbs



Configuration for HD1500-5 (disc. 2008)

Power Mode	**Diesel**	Rated Payload	**136.0 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $56.76/hr	USD $53.45/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $2.78/hr	USD $3.57/hr	+28.2%
Overhead	USD $17.37/hr	USD $22.84/hr	+31.5%
Overhaul Labor	USD $26.86/hr	USD $13.37/hr	-50.2%
Overhaul Parts	USD $14.33/hr	USD $18.84/hr	+31.5%
Total Hourly Ownership Cost:	**USD $118.10/hr**	**USD $112.06/hr**	**-5.1%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (2,643hrs -> 2,010hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $15.52/hr	USD $7.72/hr	-50.2%
Field Parts	USD $6.08/hr	USD $1.33/hr	-78.1%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $18.78/hr	-	-
Electrical/Fuel	USD $90.56/hr	USD $26.86/hr	-70.3%
Lube	USD $19.76/hr	-	-
Total Operating Ownership Cost:	**USD $150.70/hr**	**USD $74.45/hr**	**-50.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $2,676.50 -> USD $0.00) Annual Field Repair Parts Cost (USD $13,382.50 -> USD $2,676.50)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $118.10/hr	USD $112.06/hr	-5.1%
Hourly Operating Costs	USD $150.70/hr	USD $74.45/hr	-50.6%
Total Hourly Cost	**USD $268.80**	**USD $186.51/hr**	**-30.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $76.91/hr	USD $79.85/hr	+3.8%
Idle	USD $208.66/hr	USD $138.92/hr	-33.4%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

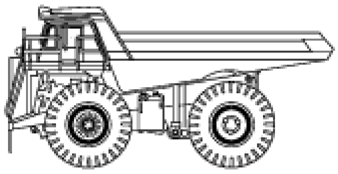
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Komatsu HD1500-5 (disc. 2008)
Mechanical Drive Rear Dumps

Size Class:
105 - 139 MTons
Weight:
221481 lbs



Configuration for HD1500-5 (disc. 2008)

Power Mode	**Diesel**	Rated Payload	**136.0 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $56.76/hr	USD $53.45/hr	-5.8%
Cost of Facilities Capital (CFC)	USD $2.78/hr	USD $3.57/hr	+28.2%
Overhead	USD $17.37/hr	USD $22.84/hr	+31.5%
Overhaul Labor	USD $26.86/hr	USD $13.37/hr	-50.2%
Overhaul Parts	USD $14.33/hr	USD $18.84/hr	+31.5%
Total Hourly Ownership Cost:	**USD $118.10/hr**	**USD $112.06/hr**	**-5.1%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (2,643hrs -> 2,010hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $15.52/hr	USD $7.72/hr	-50.2%
Field Parts	USD $6.08/hr	USD $1.33/hr	-78.1%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $18.78/hr	-	-
Electrical/Fuel	USD $90.56/hr	USD $26.86/hr	-70.3%
Lube	USD $19.76/hr	-	-
Total Operating Ownership Cost:	**USD $150.70/hr**	**USD $74.45/hr**	**-50.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $2,676.50 -> USD $0.00) Annual Field Repair Parts Cost (USD $13,382.50 -> USD $2,676.50)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $118.10/hr	USD $112.06/hr	-5.1%
Hourly Operating Costs	USD $150.70/hr	USD $74.45/hr	-50.6%
Total Hourly Cost	**USD $268.80**	**USD $186.51/hr**	**-30.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $76.91/hr	USD $79.85/hr	+3.8%
Idle	USD $208.66/hr	USD $138.92/hr	-33.4%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 42 X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
26300 lbs

Configuration for 42 X 60' - 516

Conveyor Size	**42' X 60'**	Horsepower	**75.0**
Power Mode	**Electric**	Screen Size	**5' X 16'**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $16,532.00	USD $5,512.00	USD $1,808.00
Adjustments			
Region (New Mexico: 108%)	USD $1,340.04	USD $446.79	USD $146.55
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $17,872.04**	**USD $5,958.79**	**USD $1,954.55**

Date Last Updated: Jun 01, 2021

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www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 42 X 60' - 516
Single Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
22200 lbs

Configuration for 42 X 60' - 516

Conveyor Size	**42' X 60'**	Horsepower	**75.0**
Power Mode	**Electric**	Screen Size	**5' X 16'**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $11,400.00	USD $3,800.00	USD $1,200.00
Adjustments			
Region (New Mexico: 102%)	USD $225.00	USD $75.00	USD $23.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $11,625.00**	**USD $3,875.00**	**USD $1,223.68**

Date Last Updated: Jun 01, 2021

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www.equipmentwatch.com

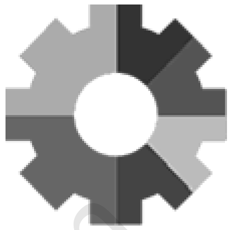
All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous 42 X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
27900 lbs



Configuration for 42 X 60' - 516

Conveyor Size	**42' X 60'**	Horsepower	**110.0**
Power Mode	**Diesel**	Screen Size	**5' X 16'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $10.18/hr	USD $9.62/hr	-5.5%
Cost of Facilities Capital (CFC)	USD $0.53/hr	USD $0.44/hr	-17.6%
Overhead	USD $3.52/hr	USD $2.84/hr	-19.4%
Overhaul Labor	USD $13.99/hr	USD $4.26/hr	-69.5%
Overhaul Parts	USD $7.56/hr	USD $6.09/hr	-19.4%
Total Hourly Ownership Cost:	**USD $35.78/hr**	**USD $23.25/hr**	**-35%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,250hrs -> 1,551hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $15.65/hr	USD $4.77/hr	-69.5%
Field Parts	USD $7.23/hr	USD $1.16/hr	-83.9%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.37/hr	-	-
Electrical/Fuel	USD $16.36/hr	USD $4.85/hr	-70.3%
Lube	USD $2.43/hr	-	-
Total Operating Ownership Cost:	**USD $42.03/hr**	**USD $13.58/hr**	**-67.7%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,806.29 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,225.16 -> USD $1,806.29)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $35.78/hr	USD $23.25/hr	-35%
Hourly Operating Costs	USD $42.03/hr	USD $13.58/hr	-67.7%
Total Hourly Cost	**USD $77.80**	**USD $36.84/hr**	**-52.7%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $14.23/hr	USD $12.90/hr	-9.4%
Idle	USD $52.13/hr	USD $28.10/hr	-46.1%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 48 X 60' - 516
Double Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
24800 lbs

Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**100.0**
Power Mode	**Electric**	Screen Size	**5' X 16'**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $11,594.00	USD $3,865.00	USD $1,247.00
Adjustments			
Region (New Mexico: 110%)	USD $1,103.08	USD $367.72	USD $118.64
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $12,697.08**	**USD $4,232.72**	**USD $1,365.64**

Date Last Updated: Jun 01, 2021

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EquipmentWatch™

www.equipmentwatch.com

All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 48 X 60' - 516
Single Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
23300 lbs

Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**100.0**
Power Mode	**Electric**	Screen Size	**5' X 16'**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $11,400.00	USD $3,800.00	USD $1,200.00
Adjustments			
Region (New Mexico: 102%)	USD $225.00	USD $75.00	USD $23.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $11,625.00**	**USD $3,875.00**	**USD $1,223.68**

Date Last Updated: Jun 01, 2021

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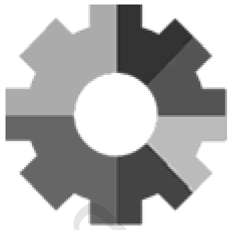
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 48 X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
27400 lbs



Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**100.0**
Power Mode	**Electric**	Screen Size	**5' X 16'**

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	Weekly	Daily
Published Rates	USD $16,532.00	USD $5,512.00	USD $1,808.00
Adjustments			
Region (New Mexico: 108%)	USD $1,340.04	USD $446.79	USD $146.55
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $17,872.04**	**USD $5,958.79**	**USD $1,954.55**

Date Last Updated: Jun 01, 2021

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All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous 48 X 60' - 516
Single Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
24900 lbs

Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**110.0**
Power Mode	**Diesel**	Screen Size	**5' X 16'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $10.30/hr	USD $9.74/hr	-5.5%
Cost of Facilities Capital (CFC)	USD $0.63/hr	USD $0.43/hr	-31.4%
Overhead	USD $4.25/hr	USD $2.80/hr	-34%
Overhaul Labor	USD $16.32/hr	USD $4.07/hr	-75%
Overhaul Parts	USD $9.26/hr	USD $6.11/hr	-34%
Total Hourly Ownership Cost:	**USD $40.76/hr**	**USD $23.16/hr**	**-43.2%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,025hrs -> 1,553hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $18.47/hr	USD $4.61/hr	-75%
Field Parts	USD $8.60/hr	USD $1.14/hr	-86.8%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.39/hr	-	-
Electrical/Fuel	USD $16.36/hr	USD $4.85/hr	-70.3%
Lube	USD $2.42/hr	-	-
Total Operating Ownership Cost:	**USD $46.24/hr**	**USD $13.41/hr**	**-71%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,763.65 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,054.61 -> USD $1,763.65)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $40.76/hr	USD $23.16/hr	-43.2%
Hourly Operating Costs	USD $46.24/hr	USD $13.41/hr	-71%
Total Hourly Cost	**USD $87.00**	**USD $36.57/hr**	**-58%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $15.18/hr	USD $12.97/hr	-14.5%
Idle	USD $57.12/hr	USD $28.01/hr	-51%

Revised Date: 4th quarter 2021

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EquipmentWatch

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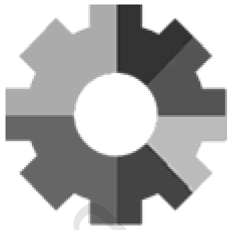
Custom Cost Evaluator

October 5, 2021

Miscellaneous 48 X 60' - 516
Double Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
26400 lbs



Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**110.0**
Power Mode	**Diesel**	Screen Size	**5' X 16'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $12.69/hr	USD $11.99/hr	-5.5%
Cost of Facilities Capital (CFC)	USD $0.80/hr	USD $0.45/hr	-43.3%
Overhead	USD $5.39/hr	USD $2.86/hr	-46.9%
Overhaul Labor	USD $20.65/hr	USD $4.15/hr	-79.9%
Overhaul Parts	USD $11.68/hr	USD $6.21/hr	-46.9%
Total Hourly Ownership Cost:	**USD $51.21/hr**	**USD $25.67/hr**	**-49.9%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (825hrs -> 1,553hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $22.95/hr	USD $4.61/hr	-79.9%
Field Parts	USD $10.79/hr	USD $1.15/hr	-89.4%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.40/hr	-	-
Electrical/Fuel	USD $16.36/hr	USD $4.85/hr	-70.3%
Lube	USD $2.44/hr	-	-
Total Operating Ownership Cost:	**USD $52.93/hr**	**USD $13.44/hr**	**-74.6%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,780.71 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,122.85 -> USD $1,780.71)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $51.21/hr	USD $25.67/hr	-49.9%
Hourly Operating Costs	USD $52.93/hr	USD $13.44/hr	-74.6%
Total Hourly Cost	**USD $104.15**	**USD $39.11/hr**	**-62.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $18.88/hr	USD $15.31/hr	-18.9%
Idle	USD $67.57/hr	USD $30.52/hr	-54.8%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous 48 X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37 & Over
Weight:
29000 lbs

Configuration for 48 X 60' - 516

Conveyor Size	**48' X 60'**	Horsepower	**110.0**
Power Mode	**Diesel**	Screen Size	**5' X 16'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $10.88/hr	USD $10.28/hr	-5.5%
Cost of Facilities Capital (CFC)	USD $0.57/hr	USD $0.47/hr	-17.6%
Overhead	USD $3.76/hr	USD $3.03/hr	-19.4%
Overhaul Labor	USD $13.99/hr	USD $4.26/hr	-69.5%
Overhaul Parts	USD $8.08/hr	USD $6.51/hr	-19.4%
Total Hourly Ownership Cost:	**USD $37.27/hr**	**USD $24.55/hr**	**-34.1%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,250hrs -> 1,551hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $15.65/hr	USD $4.77/hr	-69.5%
Field Parts	USD $7.72/hr	USD $1.24/hr	-83.9%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $0.39/hr	-	-
Electrical/Fuel	USD $16.36/hr	USD $4.85/hr	-70.3%
Lube	USD $2.48/hr	-	-
Total Operating Ownership Cost:	**USD $42.60/hr**	**USD $13.74/hr**	**-67.7%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $1,929.86 -> USD $0.00) Annual Field Repair Parts Cost (USD $7,719.43 -> USD $1,929.86)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $37.27/hr	USD $24.55/hr	-34.1%
Hourly Operating Costs	USD $42.60/hr	USD $13.74/hr	-67.7%
Total Hourly Cost	**USD $79.87**	**USD $38.29/hr**	**-52.1%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $15.21/hr	USD $13.78/hr	-9.4%
Idle	USD $53.62/hr	USD $29.40/hr	-45.2%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

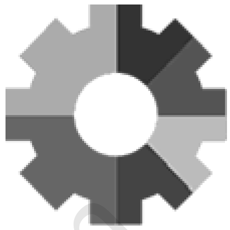
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 6000 330
Off-Highway Water Tanker Trucks

Size Class:
300 - 399 HP
Weight:
54400 lbs



Configuration for 6000 330

Horsepower	**330.0**	Power Mode	**Diesel**
Tank Capacity	**6000.0 gal**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $9,220.00	USD $3,256.00	USD $1,233.00
Adjustments			
Region (New Mexico: 101%)	USD $117.26	USD $41.41	USD $15.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $9,337.26**	**USD $3,297.41**	**USD $1,248.68**

Date Last Updated: Jun 01, 2021

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

EquipmentWatch

www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous 6000 330
Off-Highway Water Tanker Trucks

Size Class:
300 - 399 HP
Weight:
54400 lbs

Configuration for 6000 330

Horsepower	**330.0**	Power Mode	**Diesel**
Tank Capacity	**6000.0 gal**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $22.91/hr	USD $21.43/hr	-6.5%
Cost of Facilities Capital (CFC)	USD $1.71/hr	USD $1.24/hr	-27.4%
Overhead	USD $8.60/hr	USD $6.06/hr	-29.5%
Overhaul Labor	USD $11.38/hr	USD $3.04/hr	-73.3%
Overhaul Parts	USD $6.88/hr	USD $4.85/hr	-29.5%
Total Hourly Ownership Cost:	**USD $51.49/hr**	**USD $36.62/hr**	**-28.9%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,275hrs -> 1,809hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $27.97/hr	USD $7.46/hr	-73.3%
Field Parts	USD $12.57/hr	USD $1.48/hr	-88.3%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $6.42/hr	-	-
Electrical/Fuel	USD $37.95/hr	USD $11.25/hr	-70.3%
Lube	USD $6.26/hr	-	-
Total Operating Ownership Cost:	**USD $91.17/hr**	**USD $32.88/hr**	**-63.9%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $2,671.74 -> USD $0.00) Annual Field Repair Parts Cost (USD $13,358.67 -> USD $2,671.74)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $51.49/hr	USD $36.62/hr	-28.9%
Hourly Operating Costs	USD $91.17/hr	USD $32.88/hr	-63.9%
Total Hourly Cost	**USD $142.66**	**USD $69.49/hr**	**-51.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $33.22/hr	USD $28.73/hr	-13.5%
Idle	USD $89.43/hr	USD $47.87/hr	-46.5%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

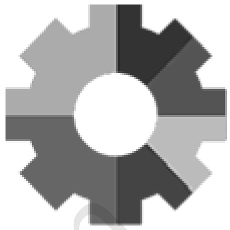
All prices shown in US dollars ($)

AED Green Book®

October 5, 2021

Miscellaneous 10000 450
Off-Highway Water Tanker Trucks

Size Class:
400 - 499 HP
Weight:
82200 lbs



Configuration for 10000 450

Horsepower	**450.0**	Power Mode	**Diesel**
Tank Capacity	**10000.0 gal**		

AED Rental Rates

These rental rates reflect an average for equipment of this type and size. Rates shown for specific brands or models are provided for convenience only. Rates charged by rental companies for specific brands or models will vary depending on many factors

	Monthly	**Weekly**	**Daily**
Published Rates	USD $13,290.00	USD $4,830.00	USD $1,450.00
Adjustments			
Region (New Mexico: 101%)	USD $169.02	USD $61.43	USD $18.44
User Defined			
Rental Rates (100%)	-	-	-
Total:	**USD $13,459.02**	**USD $4,891.43**	**USD $1,468.44**

Date Last Updated: Jun 01, 2021

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EquipmentWatch

www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous 10000 450
Off-Highway Water Tanker Trucks

Size Class:
400 - 499 HP
Weight:
82200 lbs

Configuration for 10000 450

Horsepower	**450.0**	Power Mode	**Diesel**
Tank Capacity	**10000.0 gal**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $37.32/hr	USD $34.91/hr	-6.5%
Cost of Facilities Capital (CFC)	USD $3.05/hr	USD $2.04/hr	-33.3%
Overhead	USD $15.47/hr	USD $9.97/hr	-35.6%
Overhaul Labor	USD $18.03/hr	USD $4.40/hr	-75.6%
Overhaul Parts	USD $11.71/hr	USD $7.55/hr	-35.6%
Total Hourly Ownership Cost:	**USD $85.58/hr**	**USD $58.85/hr**	**-31.2%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,155hrs -> 1,793hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $43.71/hr	USD $10.65/hr	-75.6%
Field Parts	USD $22.61/hr	USD $2.43/hr	-89.3%
Ground Engaging Component (GEC)	USD $0.00/hr	-	-
Tire	USD $10.47/hr	-	-
Electrical/Fuel	USD $51.74/hr	USD $15.35/hr	-70.3%
Lube	USD $9.19/hr	-	-
Total Operating Ownership Cost:	**USD $137.73/hr**	**USD $48.09/hr**	**-65.1%**

User Defined Adjustments: Fuel (USD $3.37 -> USD $1.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $4,352.35 -> USD $0.00) Annual Field Repair Parts Cost (USD $21,761.77 -> USD $4,352.35)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $85.58/hr	USD $58.85/hr	-31.2%
Hourly Operating Costs	USD $137.73/hr	USD $48.09/hr	-65.1%
Total Hourly Cost	**USD $223.31**	**USD $106.94/hr**	**-52.1%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $55.84/hr	USD $46.91/hr	-16%
Idle	USD $137.33/hr	USD $74.19/hr	-46%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous MSR-189H
Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3557 lbs

Configuration for MSR-189H

Number Of Shanks	**3.0**	Ripper Type	**Parallelogram**
Power Mode	**Hydraulic**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $2.64/hr	USD $2.50/hr	-5.1%
Cost of Facilities Capital (CFC)	USD $0.10/hr	USD $0.08/hr	-18.5%
Overhead	USD $0.66/hr	USD $0.52/hr	-21.1%
Overhaul Labor	USD $1.18/hr	USD $0.35/hr	-70.2%
Overhaul Parts	USD $0.95/hr	USD $0.75/hr	-21.1%
Total Hourly Ownership Cost:	**USD $5.52/hr**	**USD $4.20/hr**	**-23.9%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,285hrs -> 1,629hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $1.96/hr	USD $0.59/hr	-70.2%
Field Parts	USD $1.18/hr	USD $0.93/hr	-21.1%
Ground Engaging Component (GEC)	USD $0.99/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $0.00/hr	-	-
Lube	USD $0.15/hr	-	-
Total Operating Ownership Cost:	**USD $4.28/hr**	**USD $1.67/hr**	**-61.1%**

User Defined Adjustments: Annual Ground Engaging Component (USD $1,268.17 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $253.63 -> USD $0.00) Annual Field Repair Parts Cost (USD $1,268.17 -> USD $1,521.81)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $5.52/hr	USD $4.20/hr	-23.9%
Hourly Operating Costs	USD $4.28/hr	USD $1.67/hr	-61.1%
Total Hourly Cost	**USD $9.81**	**USD $5.87/hr**	**-40.1%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $3.40/hr	USD $3.10/hr	-8.6%
Idle	USD $5.52/hr	USD $4.20/hr	-23.9%

Revised Date: 4th quarter 2021

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EquipmentWatch

www.equipmentwatch.com

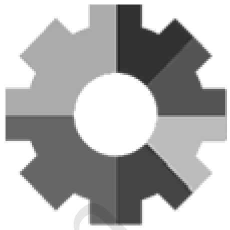
All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Miscellaneous MSR-189H
Crawler Tractor Multi-Shank Rippers

Size Class:
To 260 HP
Weight:
3557 lbs



Configuration for MSR-189H

Number Of Shanks	**3.0**	Ripper Type	**Parallelogram**
Power Mode	**Hydraulic**		

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $1,010.00	USD $285.00	USD $71.00	USD $11.00	USD $4.15	USD $9.89
Adjustments						
Region (Las Cruces, New Mexico: 89%)	(USD $111.10)	(USD $31.35)	(USD $7.81)	(USD $1.21)		
Model Year (2021: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $898.90**	**USD $253.65**	**USD $63.19**	**USD $9.79**	**USD $4.15**	**USD $9.26**

Non-Active Use Rates

	Hourly
Standby Rate	USD $3.52
Idling Rate	USD $5.11

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	50%	USD $505.00/mo
Overhaul (ownership)	31%	USD $313.10/mo
CFC (ownership)	7%	USD $70.70/mo
Indirect (ownership)	12%	USD $121.20/mo

Fuel cost data is not available for these rates.

Revised Date: 1st half 2019

These are the most accurate rates for the selected Revision Date(s). However, due to more frequent online updates, these rates may not match Rental Rate Blue Book Print. Visit the Cost Recovery Product Guide on our Help page for more information.

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EquipmentWatch

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All prices shown in US dollars ($)

Custom Cost Evaluator

October 5, 2021

Miscellaneous MSR-359H
Crawler Tractor Multi-Shank Rippers

Size Class:
260 HP & Over
Weight:
N/A

Configuration for MSR-359H

Number Of Shanks	**3.0**	Ripper Type	**Parallelogram**
Power Mode	**Hydraulic**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	USD $7.23/hr	USD $6.86/hr	-5.1%
Cost of Facilities Capital (CFC)	USD $0.24/hr	USD $0.20/hr	-18.2%
Overhead	USD $1.68/hr	USD $1.33/hr	-20.8%
Overhaul Labor	USD $2.95/hr	USD $0.88/hr	-70%
Overhaul Parts	USD $2.35/hr	USD $1.86/hr	-20.8%
Total Hourly Ownership Cost:	**USD $14.45/hr**	**USD $11.13/hr**	**-23%**

User Defined Adjustments: Sales Tax (5.1% -> 0%) Annual Use Hours (1,285hrs -> 1,623hrs)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	USD $5.40/hr	USD $1.62/hr	-70%
Field Parts	USD $2.37/hr	USD $1.87/hr	-20.8%
Ground Engaging Component (GEC)	USD $1.97/hr	USD $0.00/hr	-100%
Tire	USD $0.00/hr	-	-
Electrical/Fuel	USD $0.00/hr	-	-
Lube	USD $0.37/hr	-	-
Total Operating Ownership Cost:	**USD $10.12/hr**	**USD $3.87/hr**	**-61.8%**

User Defined Adjustments: Annual Ground Engaging Component (USD $2,534.87 -> USD $0.00) Mechanics Wage (USD $63.11 -> USD $23.88) Annual Misc Supply Parts (USD $506.97 -> USD $0.00) Annual Field Repair Parts Cost (USD $2,534.87 -> USD $3,041.85)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	USD $14.45/hr	USD $11.13/hr	-23%
Hourly Operating Costs	USD $10.12/hr	USD $3.87/hr	-61.8%
Total Hourly Cost	**USD $24.56**	**USD $15.00/hr**	**-38.9%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	USD $9.15/hr	USD $8.39/hr	-8.3%
Idle	USD $14.45/hr	USD $11.13/hr	-23%

Revised Date: 4th quarter 2021

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www.equipmentwatch.com

All prices shown in US dollars ($)

Rental Rate Blue Book®

October 5, 2021

Miscellaneous MSR-359H
Crawler Tractor Multi-Shank Rippers

Size Class:
260 HP & Over
Weight:
N/A

Configuration for MSR-359H

Number Of Shanks	**3.0**	Ripper Type	**Parallelogram**
Power Mode	**Hydraulic**		

Blue Book Rates

Non-current (i.e. archived) rates: Jan 1, 2019 - Jun 30, 2019

** FHWA Rate is equal to the monthly ownership cost divided by 176 plus the hourly estimated operating cost.

	Ownership Costs				Estimated Operating Costs	FHWA Rate**
	Monthly	**Weekly**	**Daily**	**Hourly**	**Hourly**	**Hourly**
Published Rates	USD $2,635.00	USD $740.00	USD $185.00	USD $28.00	USD $9.75	USD $24.72
Adjustments						
Region (Las Cruces, New Mexico: 89%)	(USD $289.85)	(USD $81.40)	(USD $20.35)	(USD $3.08)		
Model Year (2021: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**USD $2,345.15**	**USD $658.60**	**USD $164.65**	**USD $24.92**	**USD $9.75**	**USD $23.07**

Non-Active Use Rates	Hourly
Standby Rate	USD $9.19
Idling Rate	USD $13.32

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	50%	USD $1,317.50/mo
Overhaul (ownership)	31%	USD $816.85/mo
CFC (ownership)	7%	USD $184.45/mo
Indirect (ownership)	12%	USD $316.20/mo

Fuel cost data is not available for these rates.

Revised Date: 1st half 2019

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All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators

Size Class:
19.1 - 21.0 MTons
Weight:
19.9 lbs

Specifications

Boom, Bucket, Loader, Platform, and Stick	
Boom Length	209.0 ft
Boom Type	1-Piece
Bucket Capacity	1.0 cu yd
Bucket Capacity Range	0.59 cu yd
Bucket Digging Force-Standard	18142.0 lbf
Bucket Type	Heavy Duty
Bucket Width	36.0 in
Stick Length	126.0 in
Engine	
Displacement	259.0 cid
Engine	C4.2
Engine Manufacturer	Caterpillar
Gross Horsepower	131.0 hp
Horsepower	125.0 hp
Power Mode	Diesel
Fluid Capacities	
Fuel Tank Capacity	79.3 gal
Hydraulic Tank Capacity	28.0 gal
Hydraulics	
Main Pump - Maximum Flow	100.1 gal/min
Standard Relief Pressure	5076.0 psi
Performance	
Front Lift Capy @ 20' G.L.	13000.0 lbs
Maximum Drawbar Pull	46466.0 lbs
Maximum Swing Speed	11.1 rpm
Side Lift Capy @ 20' G.L.	6700.0 lbs
Stick Digging Force - Standard	18142.0 lbs
Travel Speed - High	3.0 mph
Undercarriage	
Ground Pressure	5.1 psi
No. of Lower/Track Rollers	7.0
No. of Upper/Carrier Rollers	2.0
Track Gauge	87.0 in
Track Length	175.0 in
Track Shoe Width	28.0 in
Weights & Dimensions	
Digging Depth (8' Flat Bottom)	265.0 in
Maximum Digging Depth	271.0 in
Maximum Dumping Height	269.0 in
Maximum Reach at Ground Level	380.0 in
Operating Weight	19.9 lbs
Overall Height	139.0 in
Overall Length	345.0 in
Overall Track Width--Retracted	114.0 in
Overall Width	114.0 in
Tail Swing Radius	98.0 in
Undercarriage Ground Clearance	17.0 in

Vertical Straight Wall Depth	225.0 in

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All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps

Size Class:
20 - 25 MTons
Weight:
N/A

Specifications

Axles & Tires

Axle Configuration	6 X 6
Front Tire Size	23.5 R25
Rear Tire Size	23.5 R25

Dump Body

Body Capacity	14.3 cu yd
Body Floor-Plate Thickness	0.55 in
Body Front-Plate Thickness	0.31 in
Body Sidewall Thickness	0.47 in
Dump Angle	70.0 degrees
Dump Cycle (Hoist/Raise)	10.0 sec
Dump Cycle (Power Down)	8.0 sec

Engine

Displacement	680.0 cid
Emissions Tier	Tier 3
Engine	C11 ACERT
Engine Manufacturer	Caterpillar
Horsepower	301.0 hp
Number of Cylinders	6.0
Power Mode	Diesel

Fluid Capacities

Fuel Tank Capacity	94.0 gal
Hydraulic System Capacity	49.0 gal

Steering

Steering Angle	45.0 degrees

Transmission

Maximum Speed	35.0 mph
Number of Speeds	6F/1R
Transmission	Autoshift
Transmission Manufacturer	Caterpillar

Weights & Dimensions

Center Axle Weight (GVW)	34440.0 lbs
Front Axle Weight (GVW)	33135.0 lbs
Gross Weight	101085.0 lbs
Ground Clearance	18.0 in
Inside Turning Radius	146.0 in
Load Over Height	108.0 in
Net Weight	49075.0 lbs
Outside Turning Radius	286.0 in
Overall Machine Height	135.0 in
Overall Machine Length	389.0 in
Overall Machine Width	109.0 in
Rated Payload	23.6 mt
Rear Axle Weight (GVW)	33510.0 lbs
Wheelbase	215.0 in

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All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Caterpillar 777F (disc. 2012)
Mechanical Drive Rear Dumps

Size Class:
90 - 104 MTons
Weight:
N/A

Specifications

Axles & Tires

Front Tire Size	27.00 R49
Rear Tire Size	27.00 R49

Brakes

Parking Brake	SAHR

Dump Body

Body Capacity	54.8 cu yd
Dump Angle	49.4 degrees
Dump Cycle (Hoist/Raise)	15.0 sec
Dump Cycle (Power Down)	13.0 sec

Engine

Displacement	1959.0 cid
Engine	CAT C32 ACERT
Engine Manufacturer	Caterpillar
Engine Torque @ RPM	4716Nm@-- ft-lb
Gross Horsepower	1016.0 hp
Horsepower	938.0 hp
Number of Cylinders	12.0
Power Mode	Diesel
Rated RPM	1750.0 rpm

Fluid Capacities

Fuel Tank Capacity	300.0 gal
Hydraulic System Capacity	50.0 gal

Transmission

Maximum Speed	40.1 mph
Number of Speeds	7F/1R
Transmission	Powershift
Transmission Manufacturer	Caterpillar

Weights & Dimensions

Gross Weight	360000.0 lbs
Ground Clearance	35.0 in
Inside Turning Diameter	996.0 in
Load Over Height	172.0 in
Maximum Payload	90.7 mt
Overall Machine Height	204.0 in
Overall Machine Length	415.0 in
Overall Machine Width	238.0 in
Rated Payload	90.7 mt
Wheelbase	180.0 in

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All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
350.0 lbs

Specifications

Boom, Bucket, Loader, Platform, and Stick

Boom Length	311.0 ft
Bucket Capacity	27.4 cu yd
Bucket Digging Force-Standard	254000.0 lbf
Bucket Type	Bottom Dump
Bucket Width	155.0 in

Engine

Displacement	3990.0 cid
Engine	S16R-TAA
Engine Manufacturer	Hitachi
Gross Horsepower	1880.0 hp
Horsepower	1880.0 hp
Number of Cylinders	16.0
Power Mode	Diesel
Rated RPM	1600.0 rpm

Fluid Capacities

Fuel Tank Capacity	1900.0 gal

Hydraulics

Hydraulic Pumps - Type	Piston
Main Pump - Maximum Flow	1056.0 gal/min
Standard Relief Pressure	4270.0 psi

Performance

Maximum Drawbar Pull	395700.0 lbs
Maximum Swing Speed	3.2 rpm
Stick Digging Force - Standard	269000.0 lbs
Travel Speed - High	1.4 mph

Undercarriage

Ground Pressure	26.3 psi
Track Gauge	217.0 in
Track Shoe Width	50.0 in

Weights & Dimensions

Component Weight-Counterweight	88600.0 lbs
Height to Top of Cab	305.0 in
Length of Track on Ground	262.0 in
Maximum Digging Depth	154.0 in
Maximum Dumping Height	433.0 in
Maximum Reach at Ground Level	599.0 in
Operating Weight	350.0 lbs
Overall Track Width--Retracted	267.0 in
Tail Swing Radius	262.0 in
Track Length	342.0 in
Undercarriage Ground Clearance	36.0 in
Upperstructure Width	355.0 in

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EquipmentWatch

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All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
N/A

Specifications

Axles & Tires

Front Tire Size	37.00R57
Rear Tire Size	37.00R57

Brakes

Elec. Dynamic Retarding (Max.)	3700.0 hp
Parking Brake	SAHR
Service Brakes - Front	Wheel Spd Disc
Service Brakes - Rear	Dual Disc

Dump Body

Body Capacity	101.0 cu yd
Body Floor-Plate Thickness	0.75 in
Body Front-Plate Thickness	0.47 in
Body Sidewall Thickness	0.35 in
Dump Angle	45.0 degrees
Dump Cycle (Hoist/Raise)	21.0 sec
Dump Cycle (Power Down)	15.0 sec

Electric Drive

Alternator/Generator Mfr	General Electric
Alternator/Generator Model	GTA-22
Maximum Travel Speed	34.6 mph
System Current	AC/DC
Wheel Motor Manufacturer	General Electric
Wheel Motor Model	GE788
Wheel Motor Planetary Ratio	26.825:1

Engine

Engine	SSA16V159
Engine Manufacturer	Komatsu
Gross Horsepower	2000.0 hp
Horsepower	1860.0 hp
Number of Cylinders	16.0
Power Mode	Diesel
Rated RPM	1900.0 rpm

Fluid Capacities

Fuel Tank Capacity	850.0 gal
Hydraulic System Capacity	193.0 gal

Weights & Dimensions

Clearance Circle	1104.0 in
Gross Weight	715000.0 lbs
Ground Clearance	45.0 in
Height of Rear Body (Empty)	221.0 in
Height to Cab Guard - Loading	246.0 in
Maximum Payload	186.0 mt
Net Weight	309950.0 lbs
Overall Machine Length	505.0 in
Overall Machine Width	297.0 in
Rated Payload	183.7 mt
Wheelbase	232.0 in

www.equipmentwatch.com

All prices shown in US dollars ($)

Spec Finder

January 8, 2021

Komatsu HD1500-5 (disc. 2008)
Mechanical Drive Rear Dumps

Size Class:
105 - 139 MTons
Weight:
N/A

Specifications

Axles & Tires

Front Tire Size	33.00 R51
Rear Tire Size	33.00 R51 Dual

Dump Body

Body Capacity	71.0 cu yd
Dump Cycle (Hoist/Raise)	15.0 sec
Dump Cycle (Power Down)	15.0 sec

Engine

Displacement	2746.0 cid
Engine	SDA12V160
Engine Manufacturer	Komatsu
Engine Torque @ RPM	4285.0 ft-lb
Gross Horsepower	1486.0 hp
Horsepower	1406.0 hp
Number of Cylinders	12.0
Power Mode	Diesel
Rated RPM	1900.0 rpm

Fluid Capacities

Fuel Tank Capacity	560.0 gal
Hydraulic System Capacity	238.0 gal

Transmission

Maximum Speed	36.0 mph
Number of Speeds	7F/1R
Transmission	Powershift
Transmission Manufacturer	Komatsu

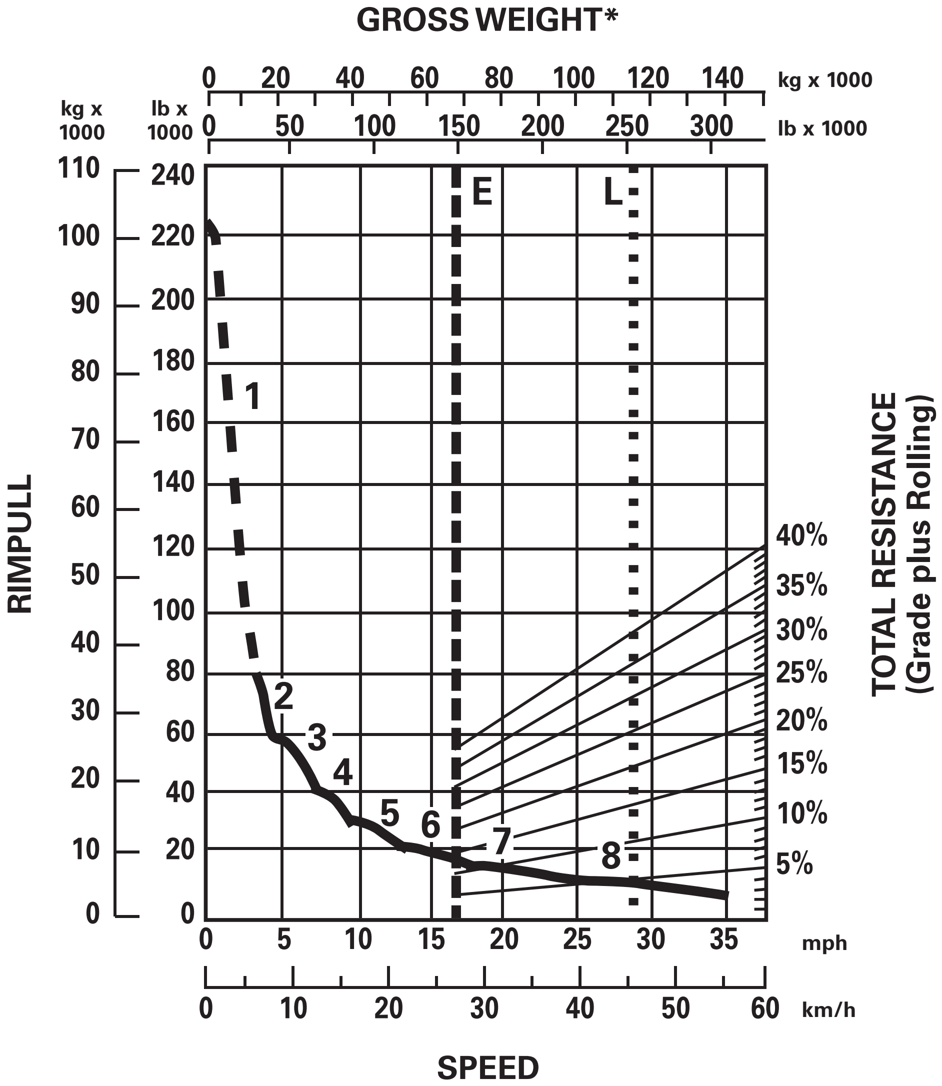
Weights & Dimensions

Clearance Circle	960.0 in
Gross Weight	550000.0 lbs
Ground Clearance	35.0 in
Load Over Height	195.0 in
Maximum Payload	149.0 mt
Net Weight	221481.0 lbs
Overall Machine Height	230.0 in
Overall Machine Length	448.0 in
Overall Machine Width	261.0 in
Rated Payload	136.0 mt
Wheelbase	213.0 in

The equipment represented in this report has been exclusively prepared for MANDY LILLA (mlilla@fmi.com)

Appendix D.3

Equipment Productivity Curve Fits



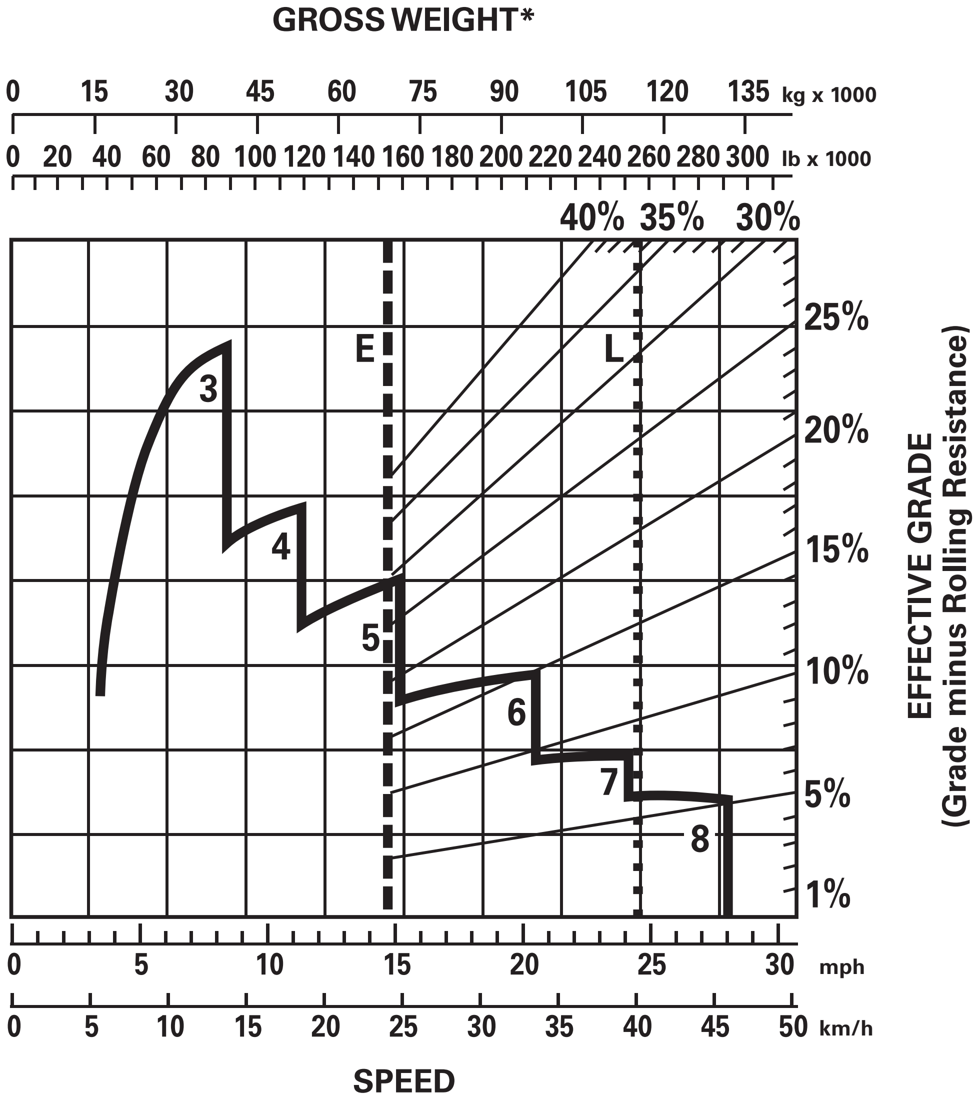
*at sea level

KEY

1 — 1st Gear Torque Converter Drive
2 — 2nd Gear Torque Converter Drive
3 — 3rd Gear Direct Drive
4 — 4th Gear Direct Drive
5 — 5th Gear Direct Drive
6 — 6th Gear Direct Drive
7 — 7th Gear Direct Drive
8 — 8th Gear Direct Drive

KEY

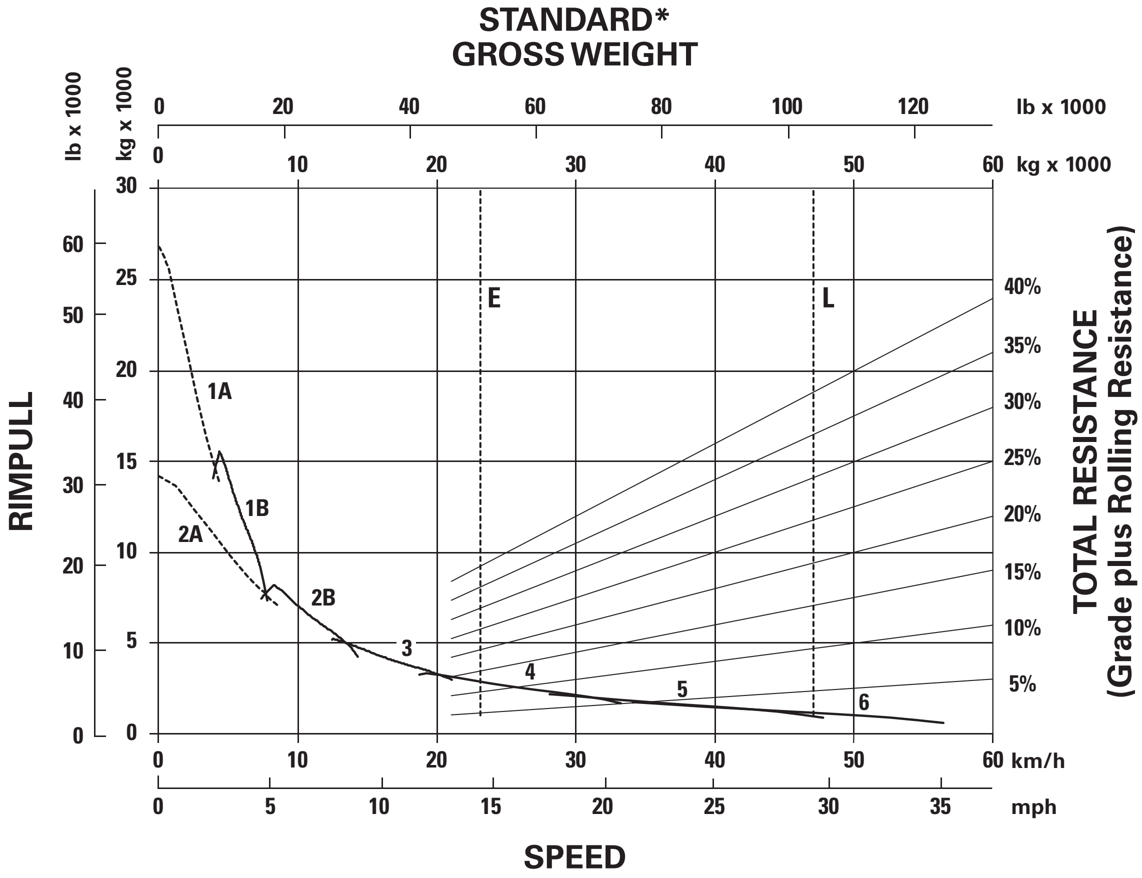
E — Empty 72 804 kg (160,505 lb)
L — Loaded 119 978 kg (264,505 lb)



*at sea level

KEY
3 — 3rd Gear Direct Drive
4 — 4th Gear Direct Drive
5 — 5th Gear Direct Drive
6 — 6th Gear Direct Drive
7 — 7th Gear Direct Drive
8 — 8th Gear Direct Drive

KEY
E — Empty 72 804 kg (160,505 lb)
L — Loaded 119 978 kg (264,505 lb)



KEY

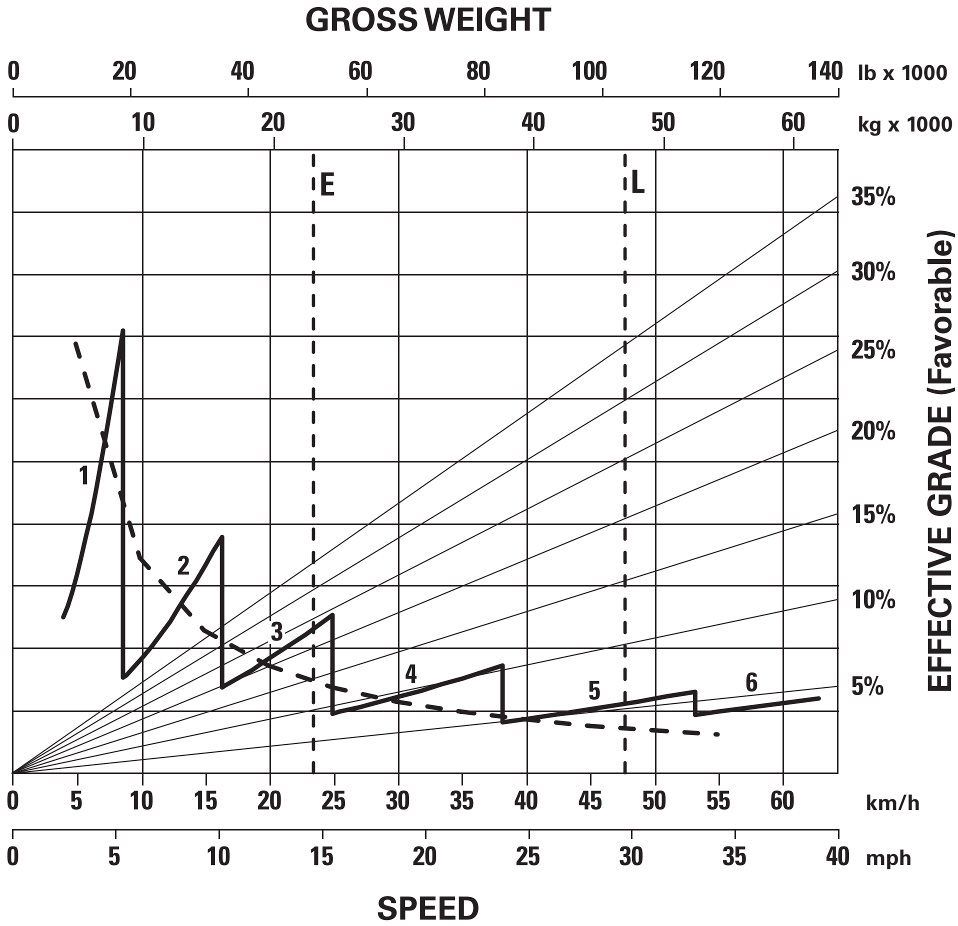
1A — 1st Gear (Converter Drive)
1B — 1st Gear (Direct Drive)
2A — 2nd Gear (Converter Drive
2B — 2nd Gear (Direct Drive)
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear

KEY

E — Empty 23 040 kg (50,795 lb)
L — Loaded 47 040 kg (103,707 lb)

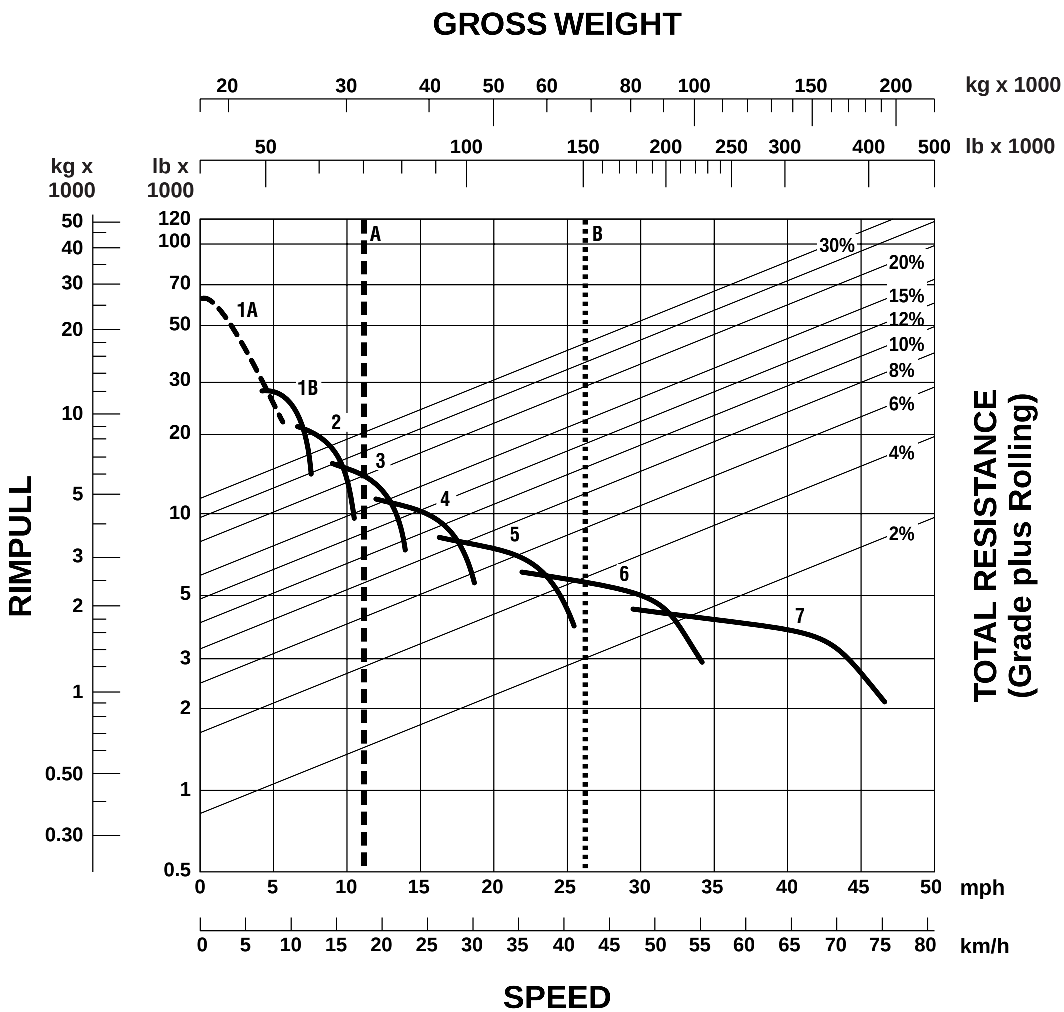
*At sea level.

725C2 Brake/Retarder Performance Curve
- 23.5R25 Tires
- Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final)



KEY
1 — 1st Gear
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear

KEY
E — Empty 23 040 kg (50,795 lb)
L — Loaded 47 040 kg (103,707 lb)

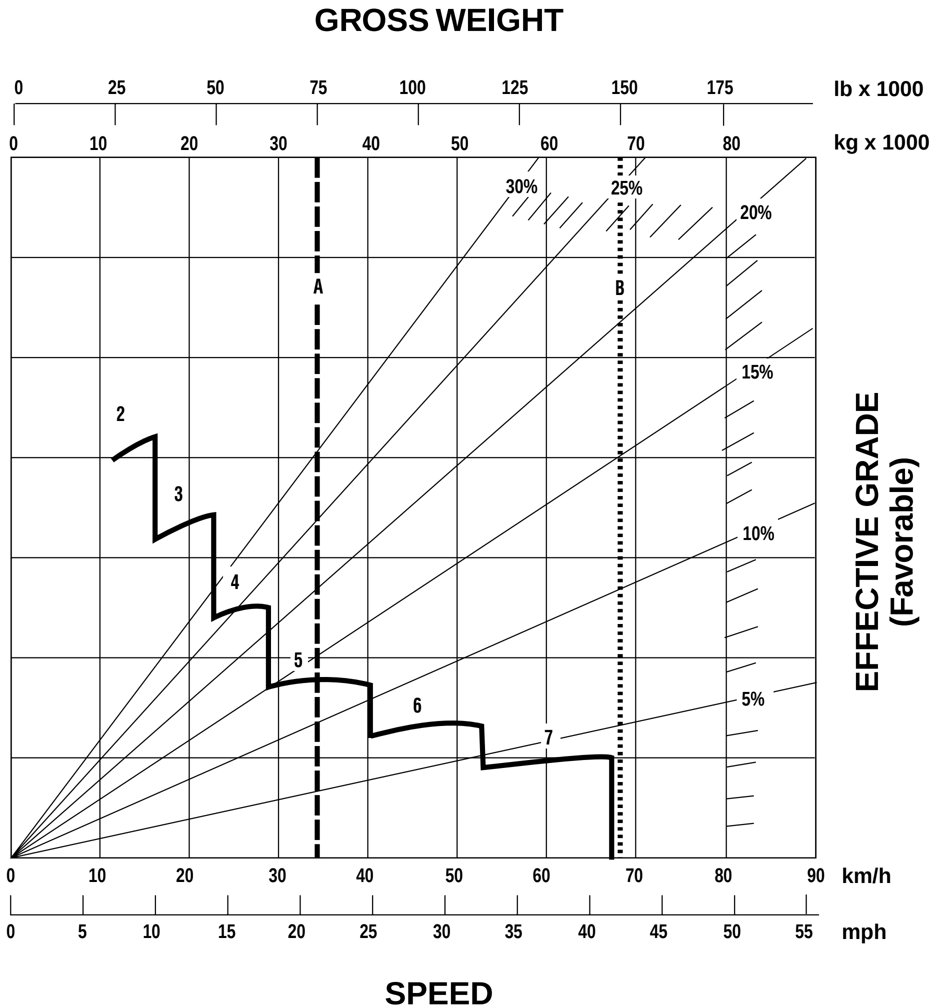


KEY

1A — 1st Gear (Torque Converter)
1B — 1st Gear
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

A — Empty 31 250 kg (68,900 lb)
B — Max GMW 68 182 kg (150,000 lb)



CONTINUOUS GRADE LENGTH

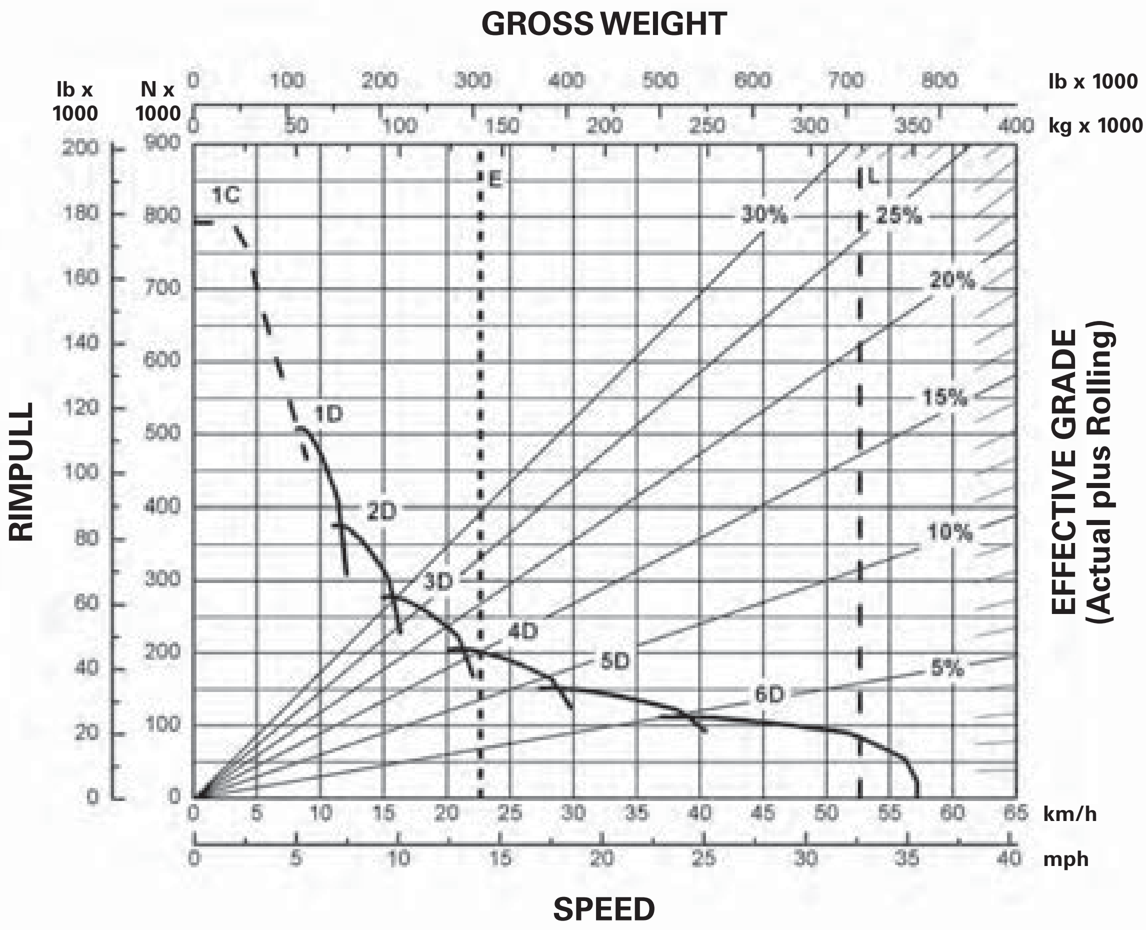
KEY

2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

A — Empty 31 250 kg (68,900 lb)
B — Max GMW 68 182 kg (150,000 lb)

789D 2100 HP Rimpull-Speed-Gradeability
- 37.00R57 Tires**
- 1593 mm **(5'2.7")** Tire Radius



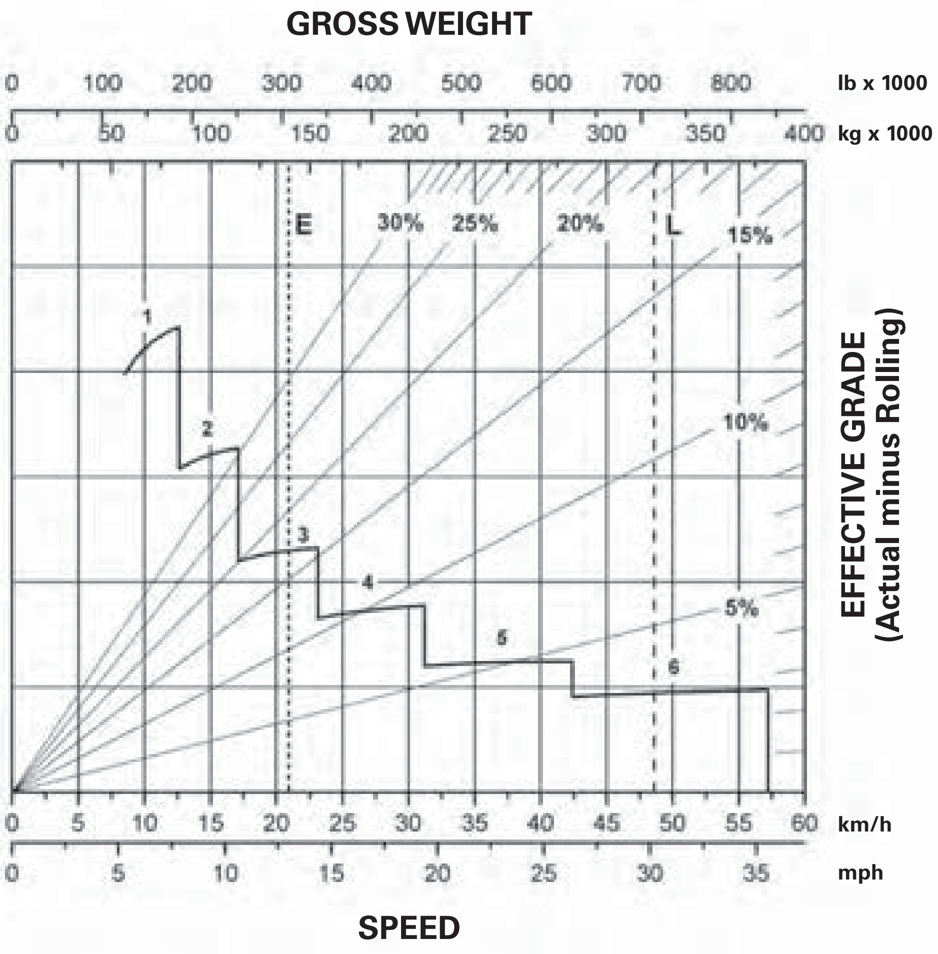
KEY

1C — 1st Gear (Torque Converter)
1D — 1st Gear
2D — 2nd Gear
3D — 3rd Gear
4D — 4th Gear
5D — 5th Gear
6D — 6th Gear

KEY

E — Empty Operating Weight 141 214 kg (311,324 lb)*
L — Target GMW 324 319 kg (715,000 lb)

*Truck equipped with sideboards and liners.
**At Sea Level.

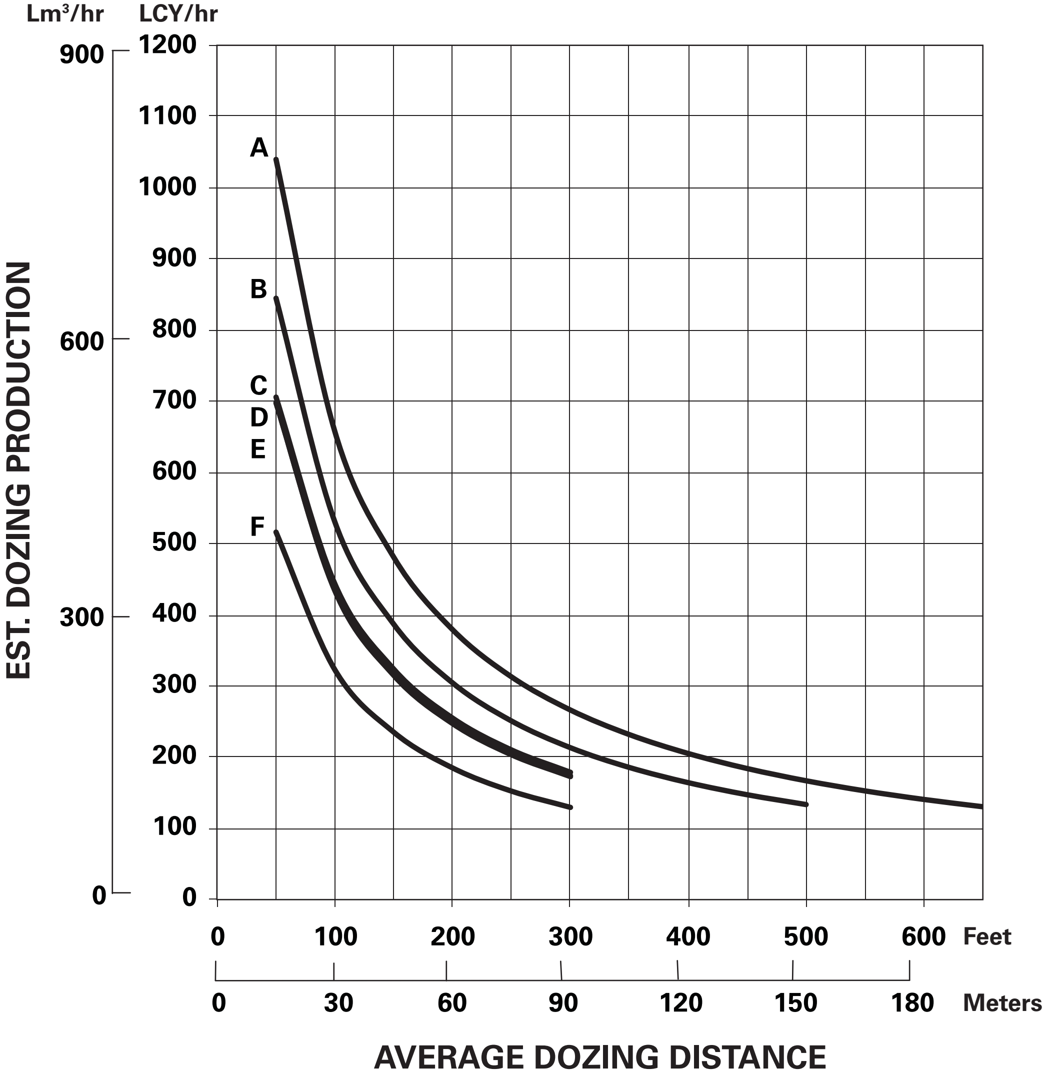


KEY
1 — 1st Gear
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear

KEY
E — Empty Operating Weight 141 214 kg (311,324 lb)*
L — Target GMW 324 319 kg (715,000 lb)

*Truck equipped with sideboards and liners.
**At Sea Level.

ESTIMATED DOZING PRODUCTION ● Semi-Universal Blades ● D6N through D8R

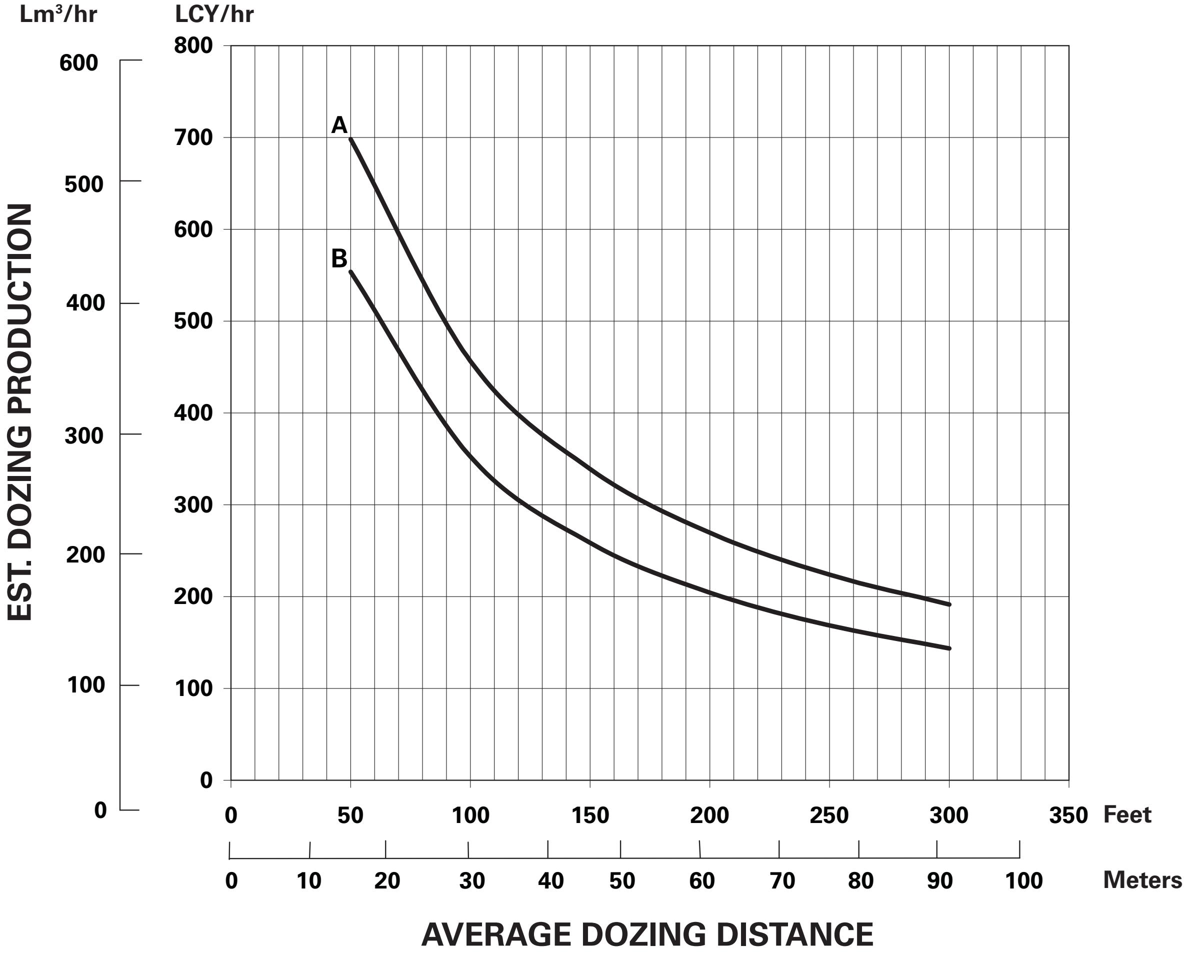


KEY

A — D8R
B — D7R
C — D6T Tier 4 Interim/Stage IIIB/Japan 2011 (Tier 4 Interim)
D — D6T
E — D6R
F — D6N

NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

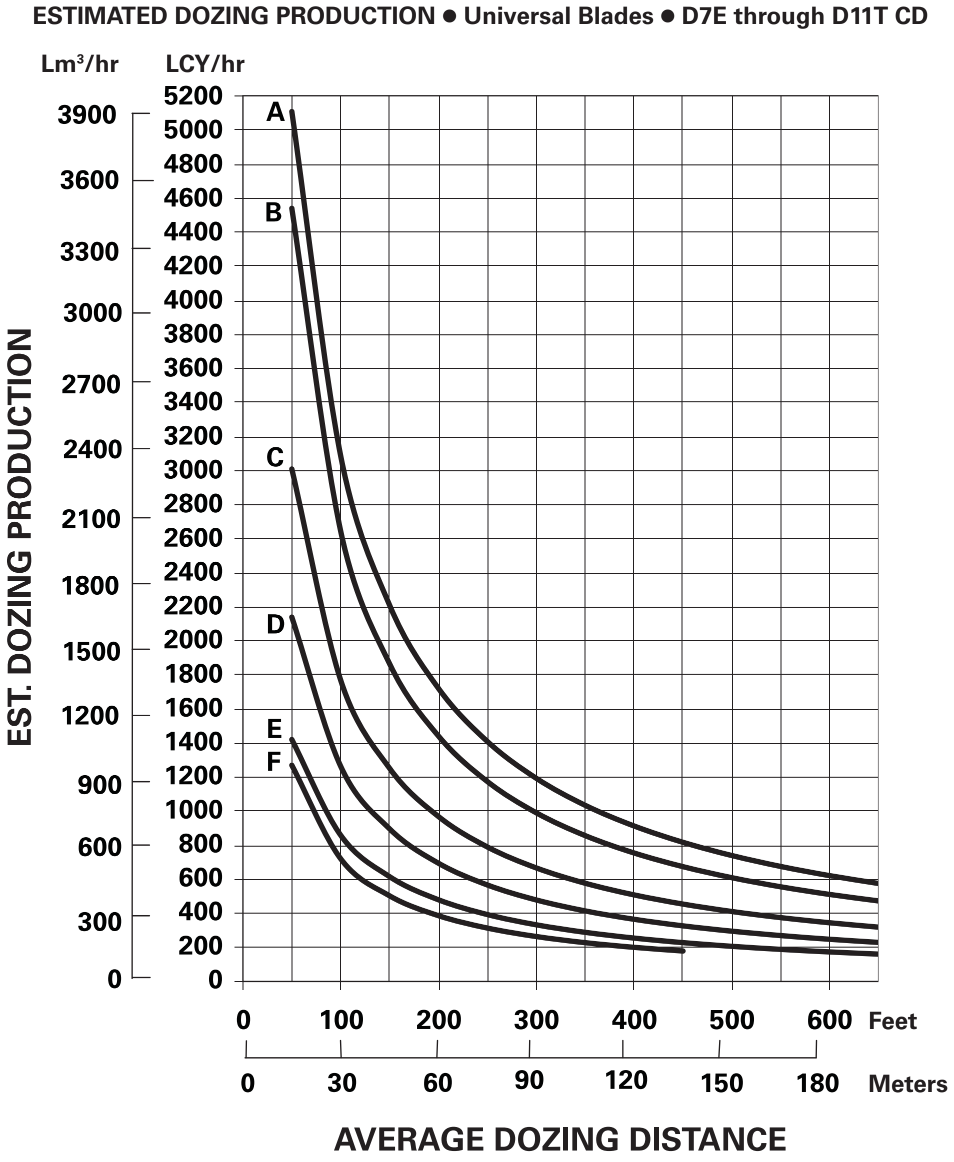
ESTIMATED DOZING PRODUCTION ● Straight Blades ● D6T through D7E



KEY

A — D7E
B — D6T

NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

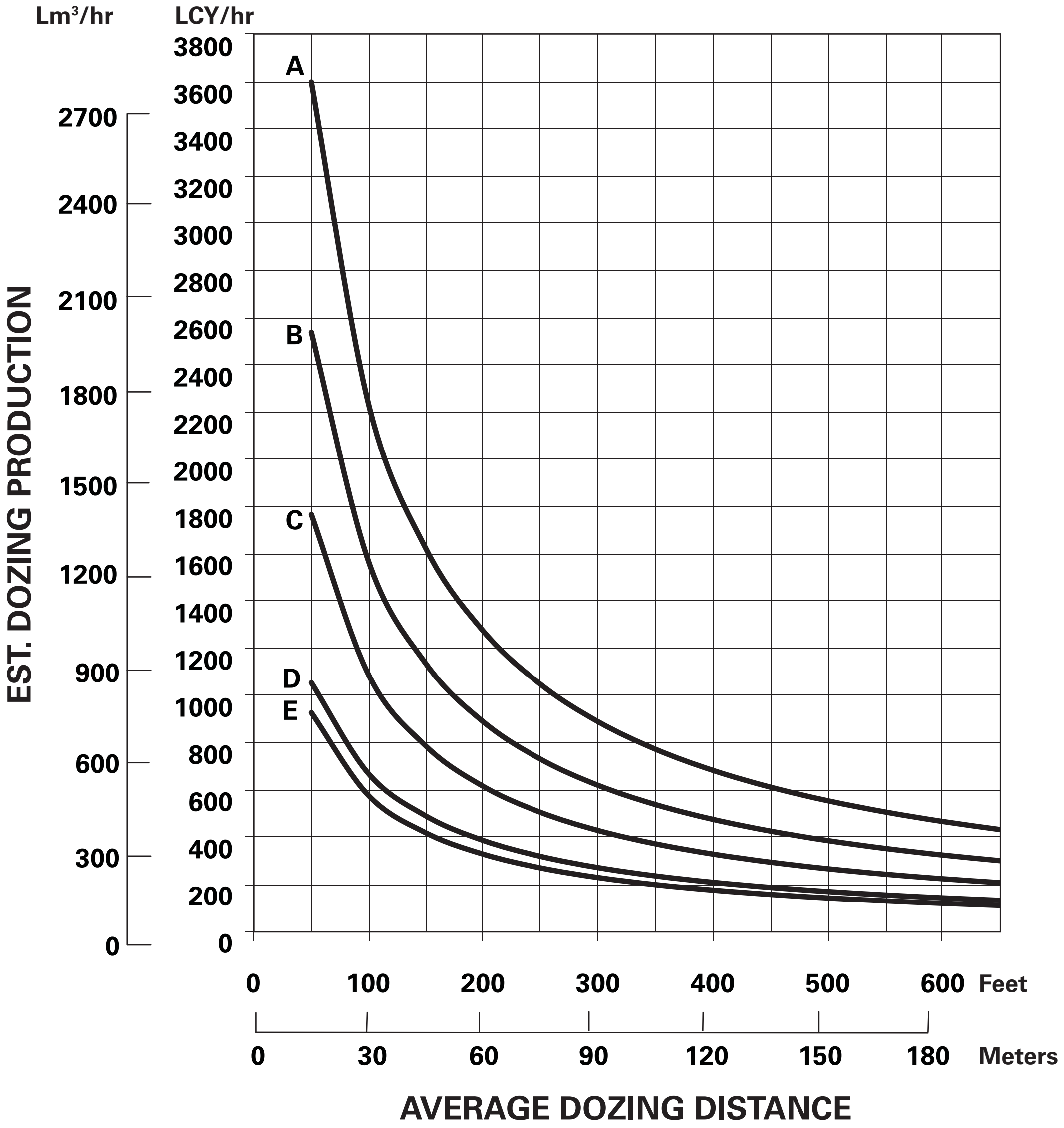


KEY

A — D11T CD
B — D11T
C — D10T2
D — D9T
E — D8T
F — D7E

NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

ESTIMATED DOZING PRODUCTION ● Semi-Universal Blades ● D7E through D11T

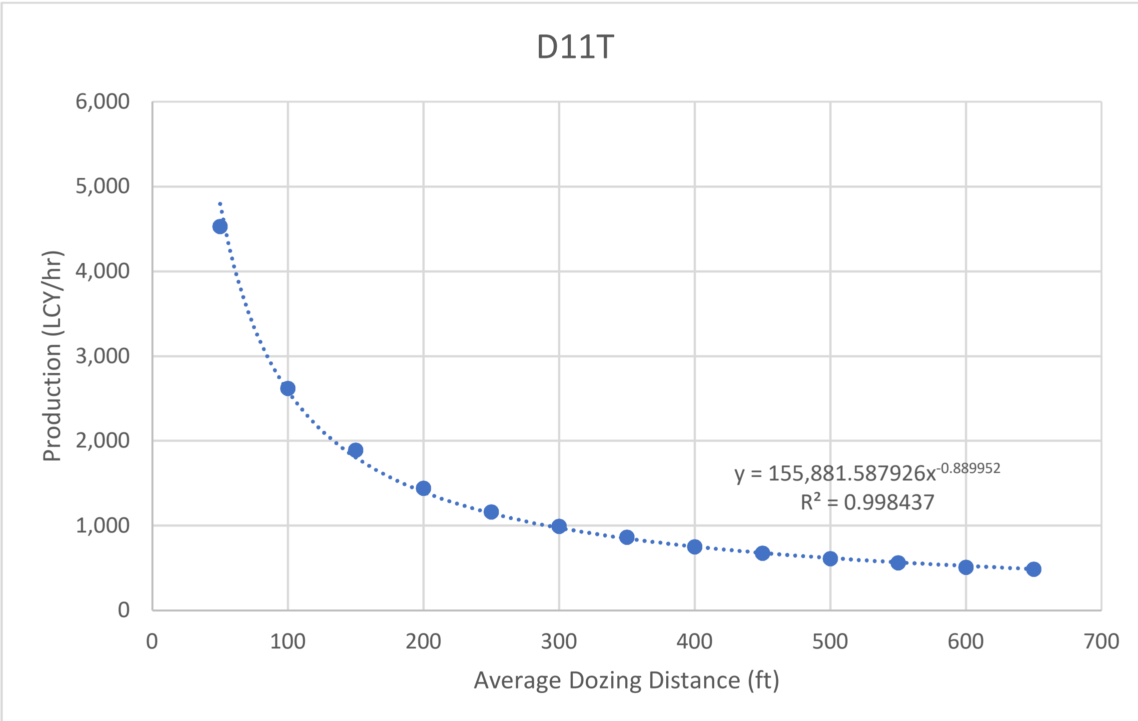


KEY

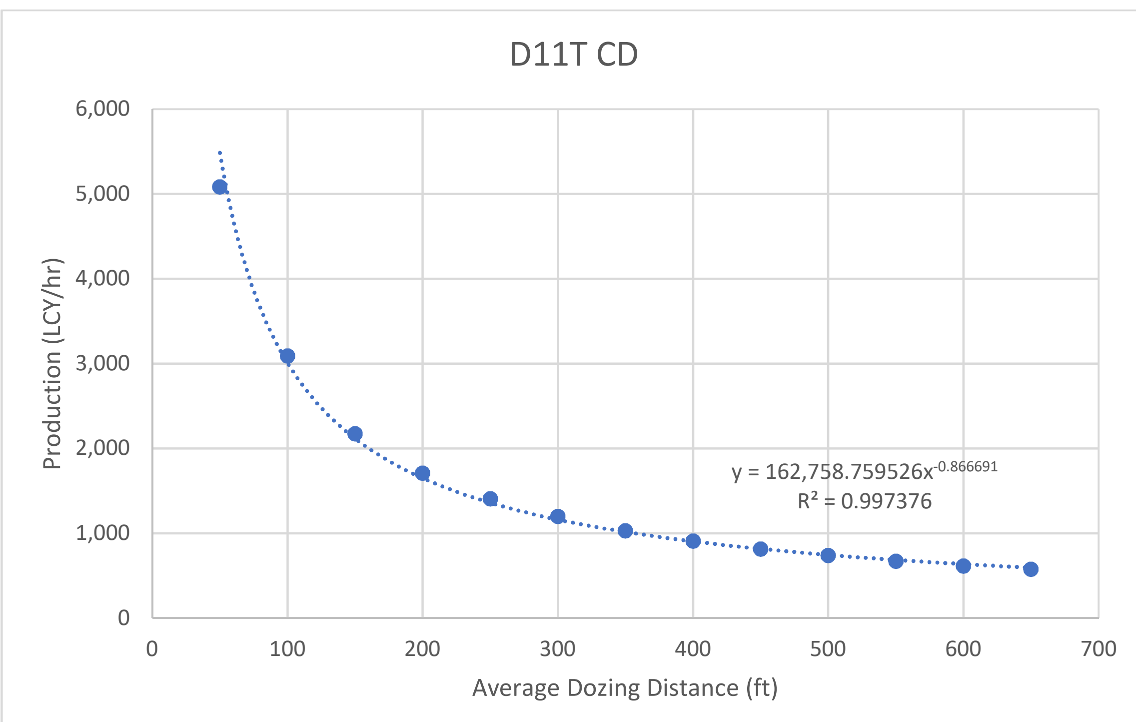
A — D11T
B — D10T2
C — D9T
D — D8T
E — D7E

NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

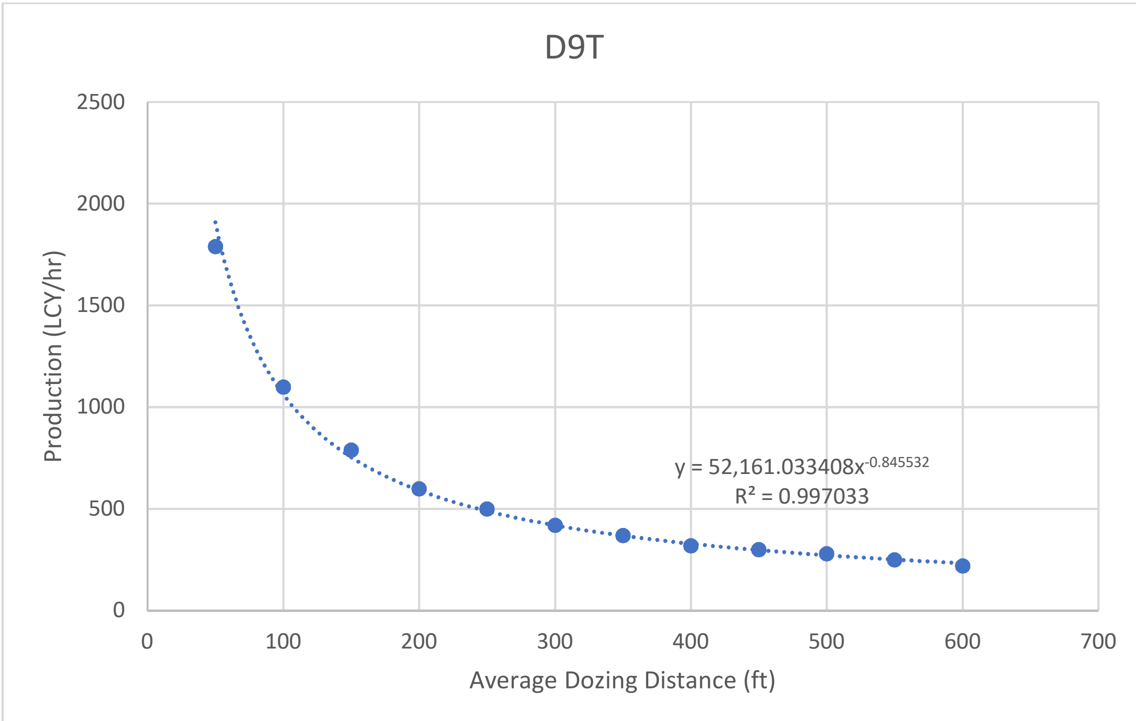
Dozing Production



Caterpillar Performance Handbook Edition 47, 19-51



Caterpillar Performance Handbook Edition 47, 19-51



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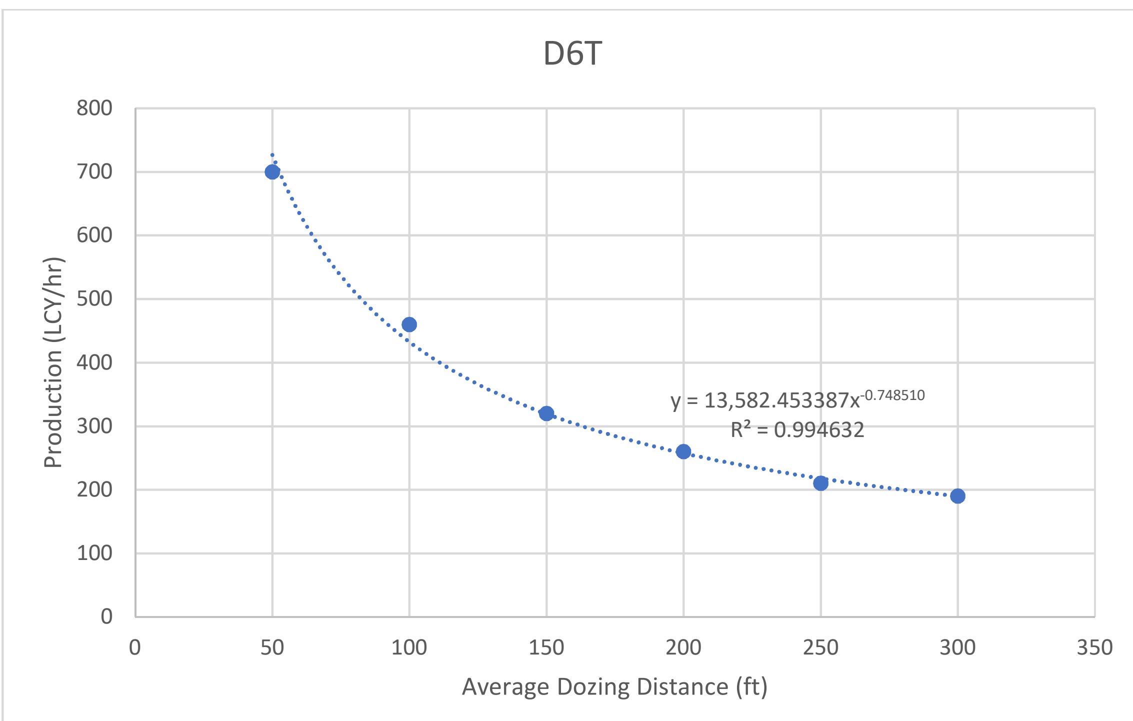
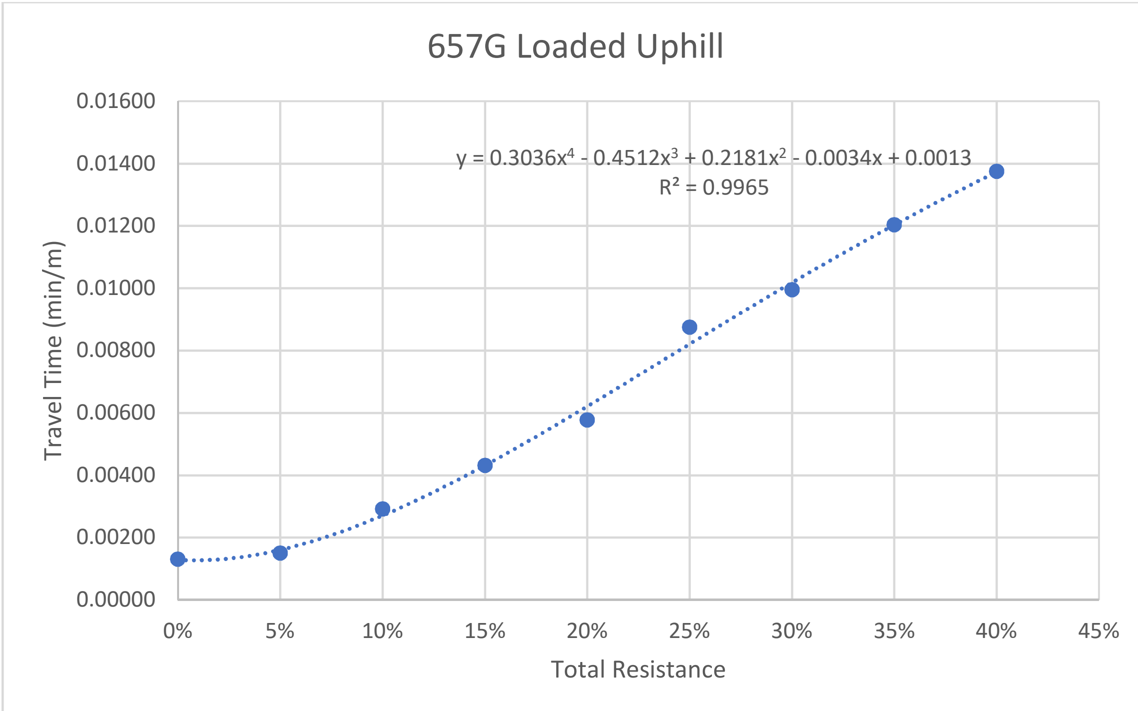
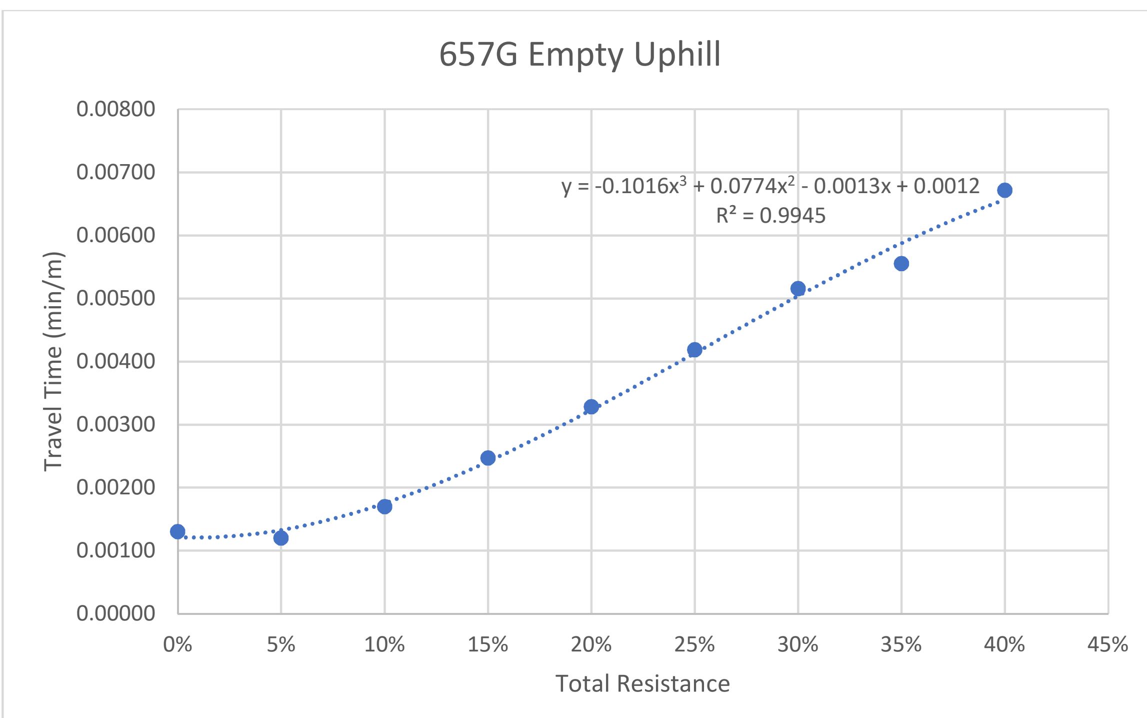


Caterpillar Performance Handbook Edition 47, 19-53

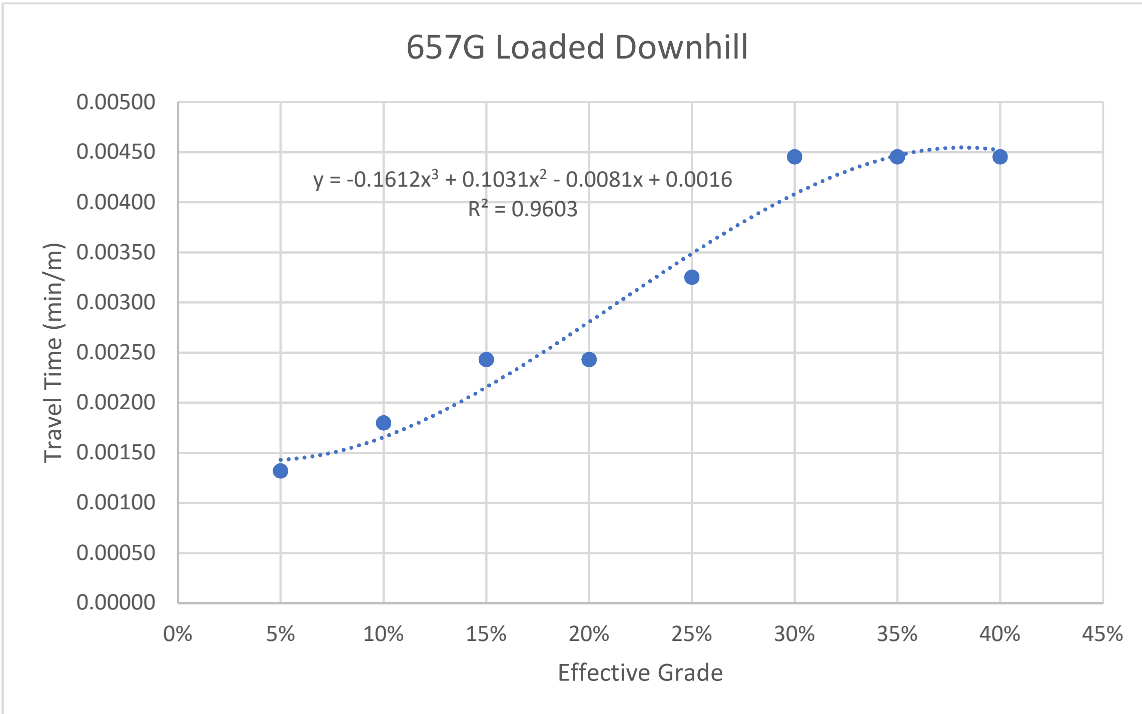
Scraper Haul Travel Time



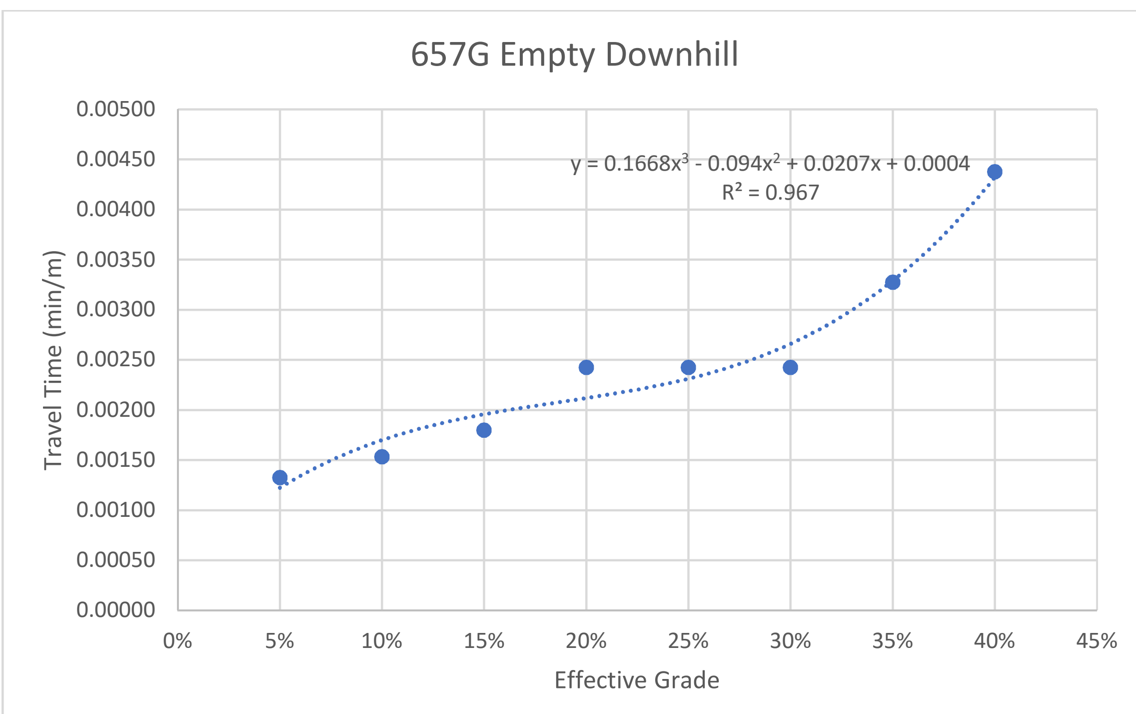
Caterpillar Performance Handbook Edition 47, 24-29



Caterpillar Performance Handbook Edition 47, 24-29

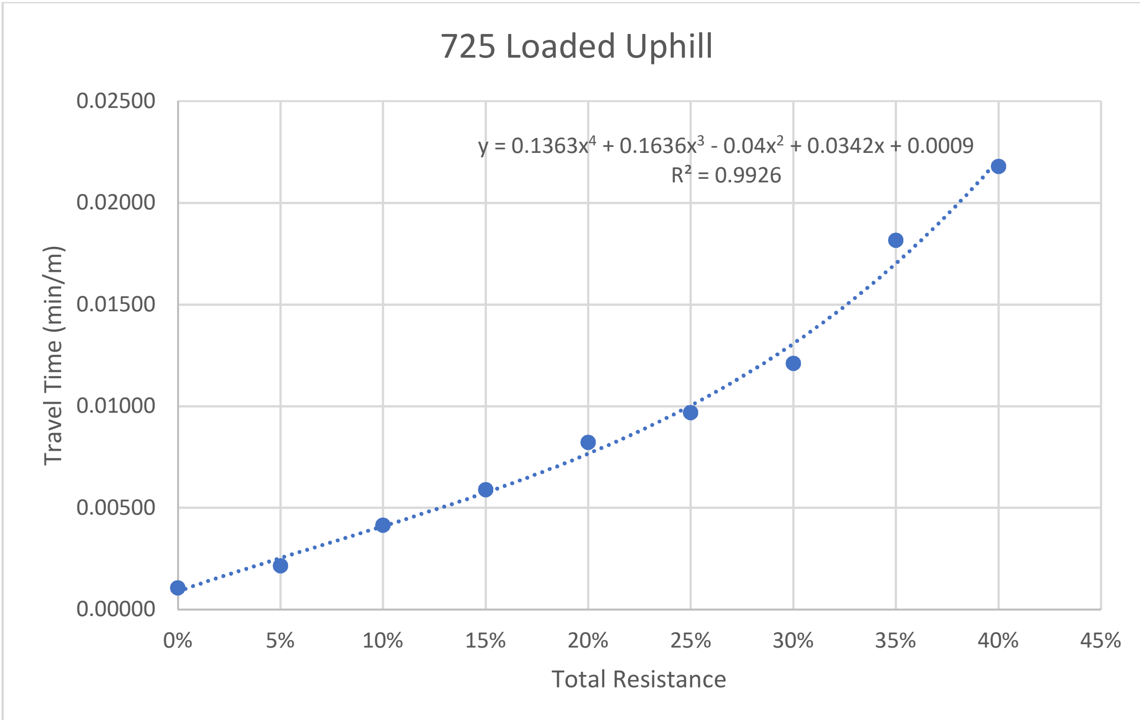


Caterpillar Performance Handbook Edition 47, 24-30

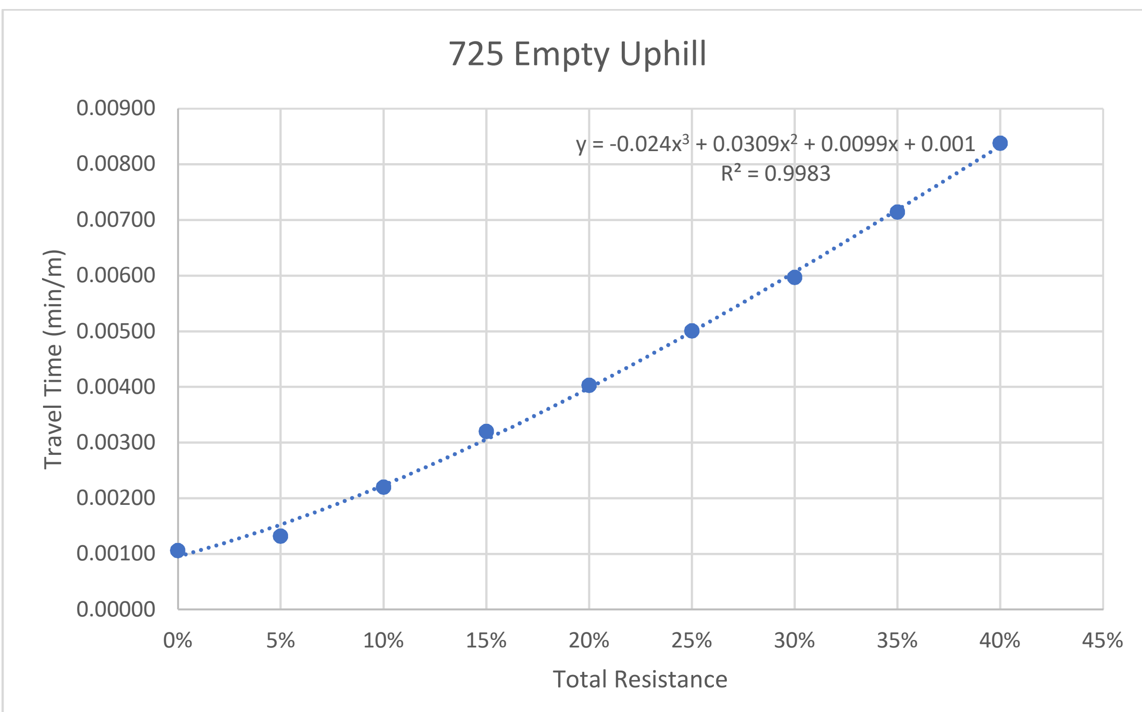


Caterpillar Performance Handbook Edition 47, 24-30

Truck Haul Travel Time



Caterpillar Performance Handbook Edition 47, 1-9



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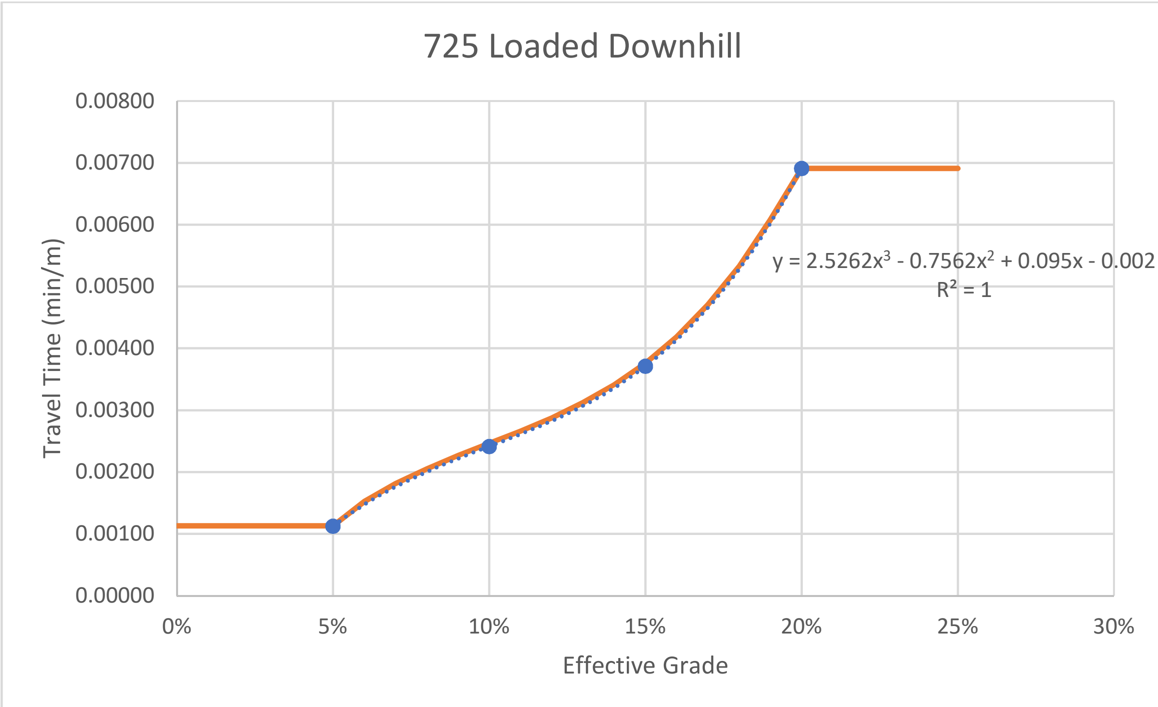

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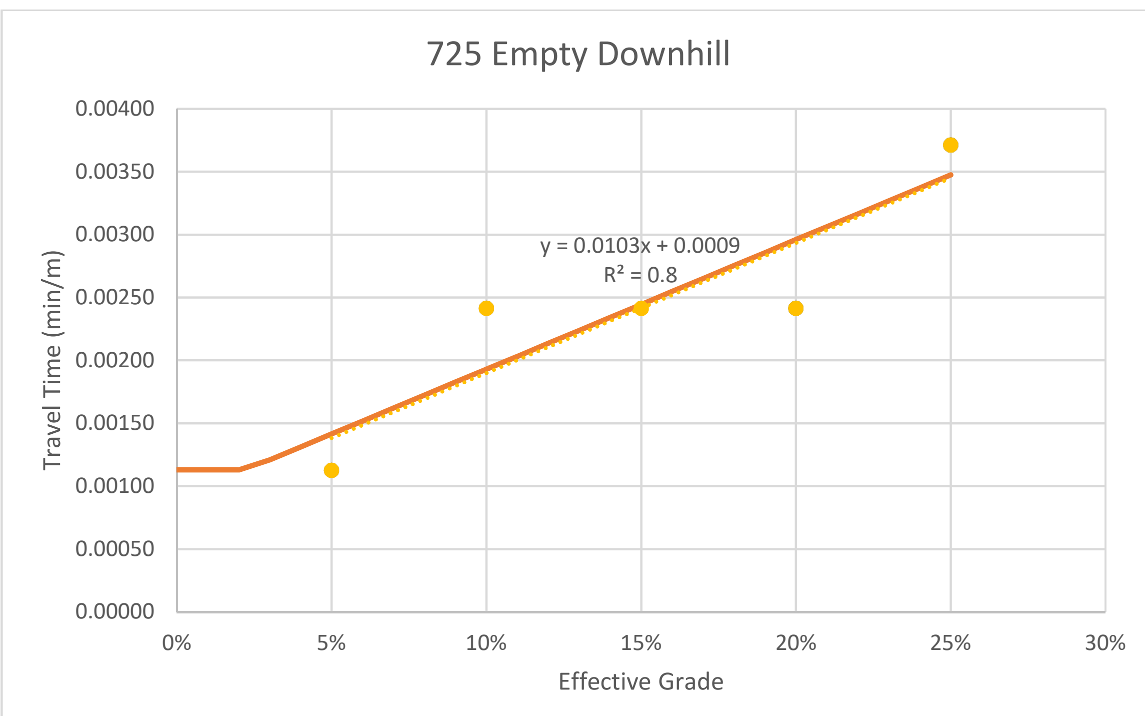

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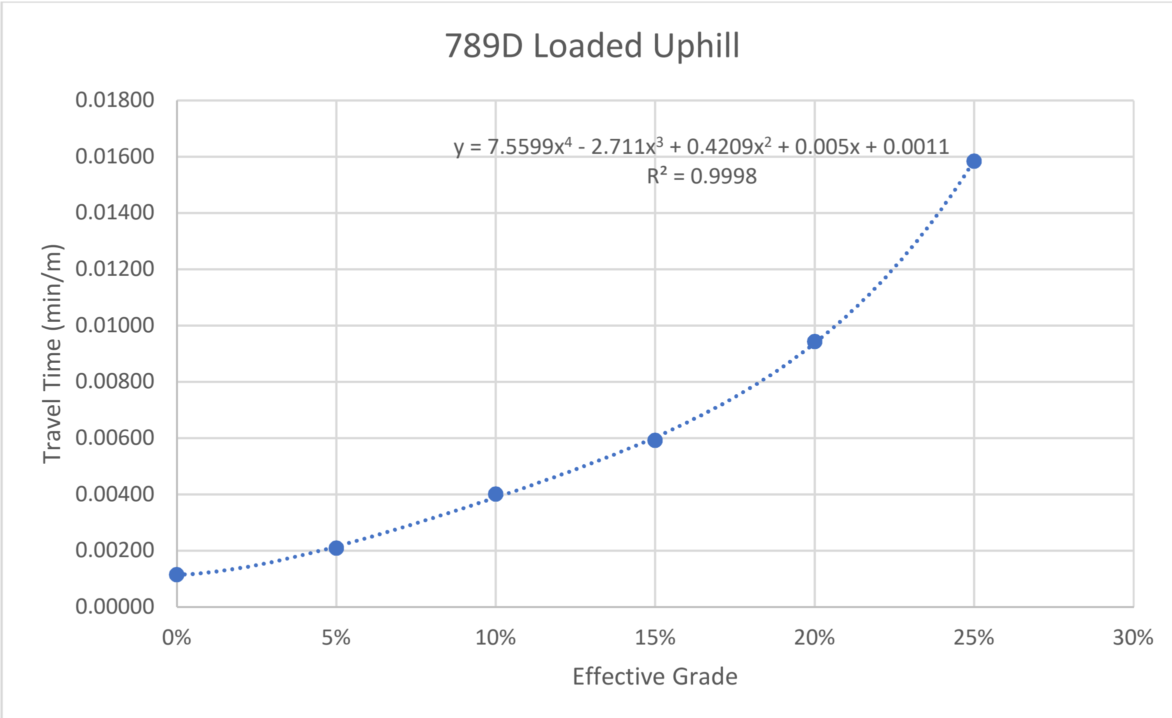
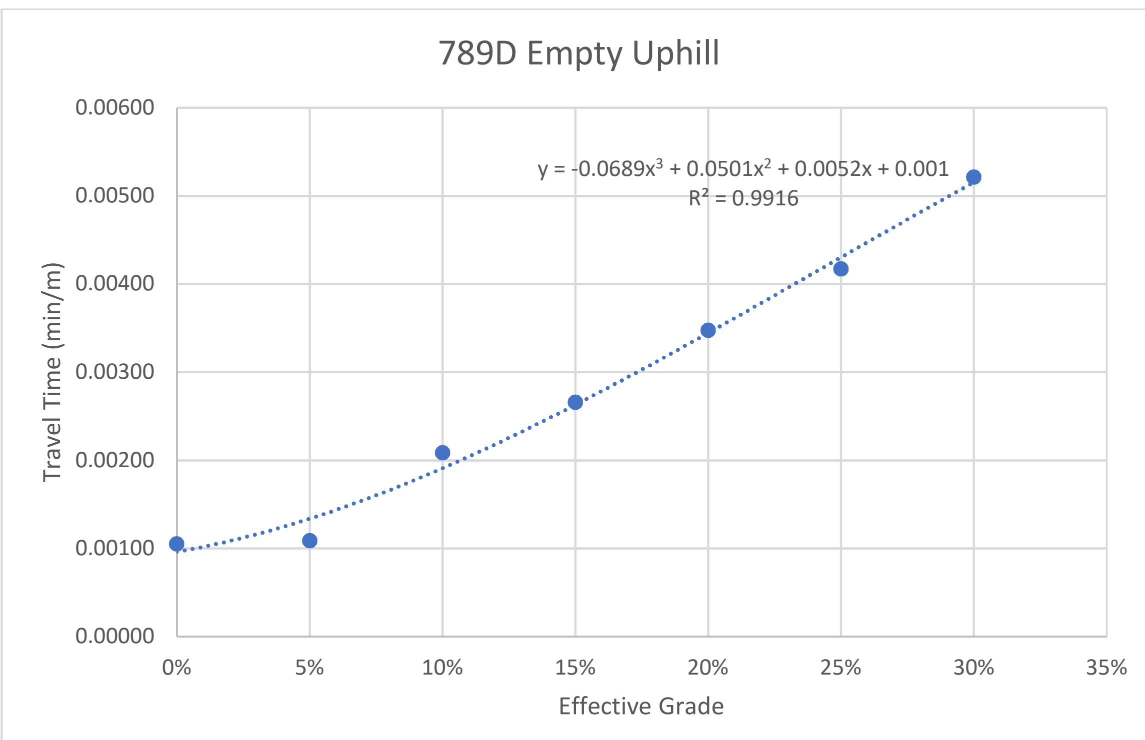


Caterpillar Performance Handbook Edition 47, 10-64



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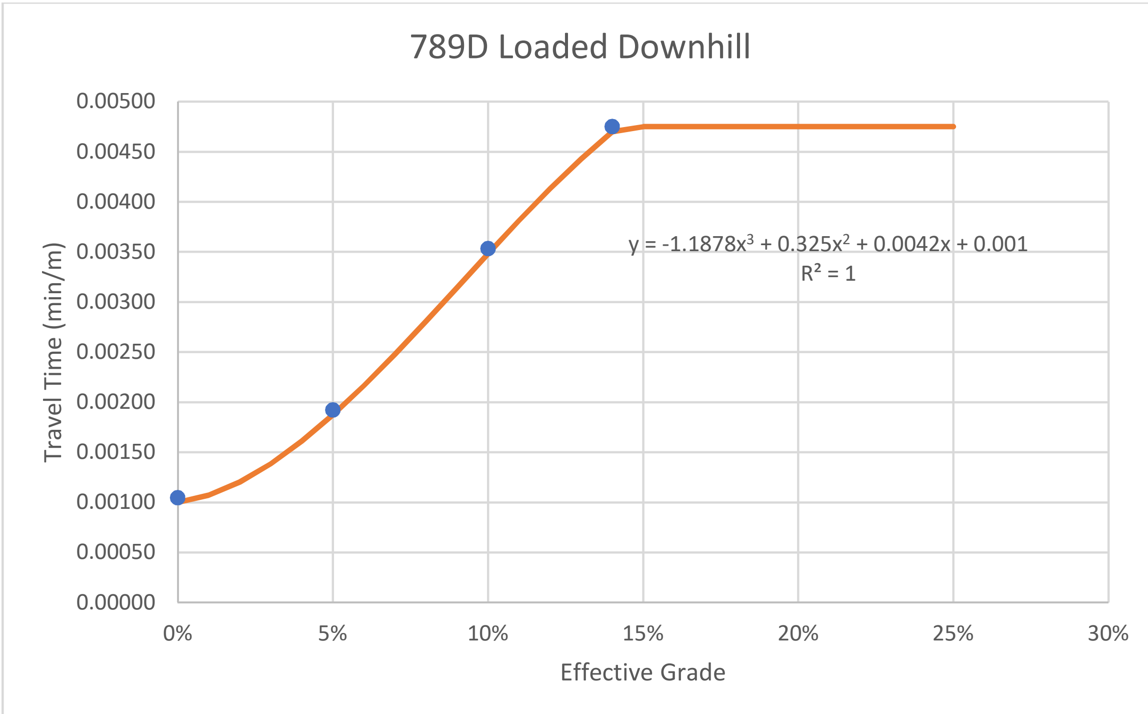

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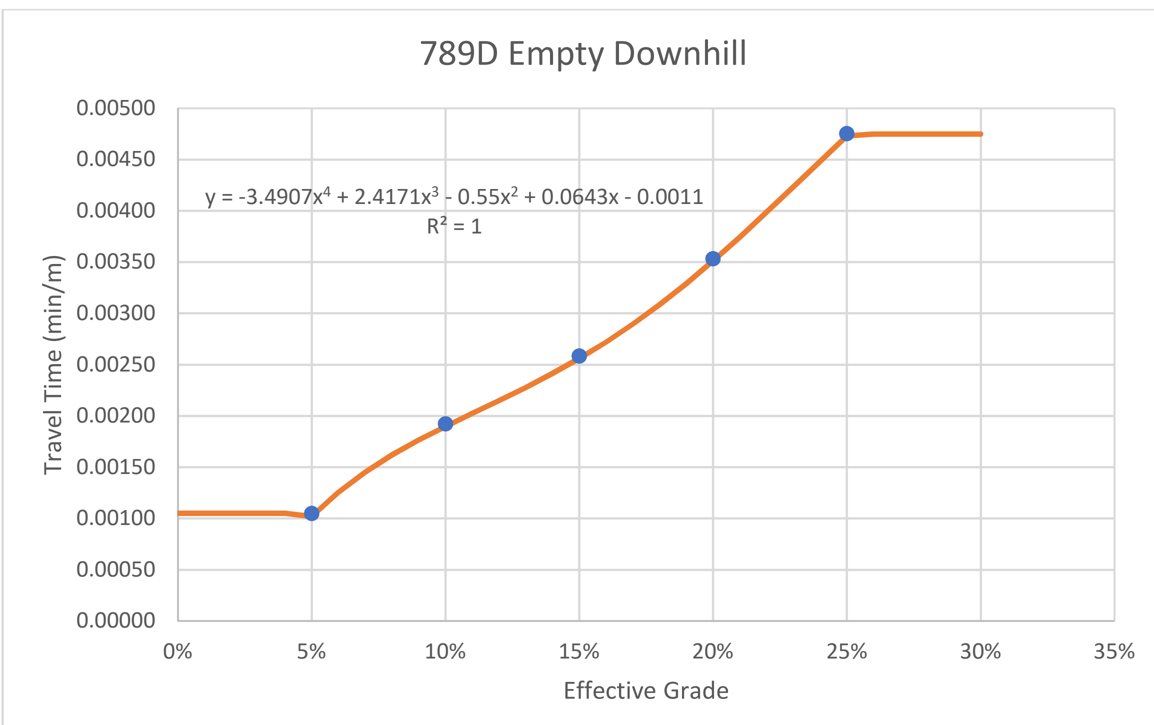

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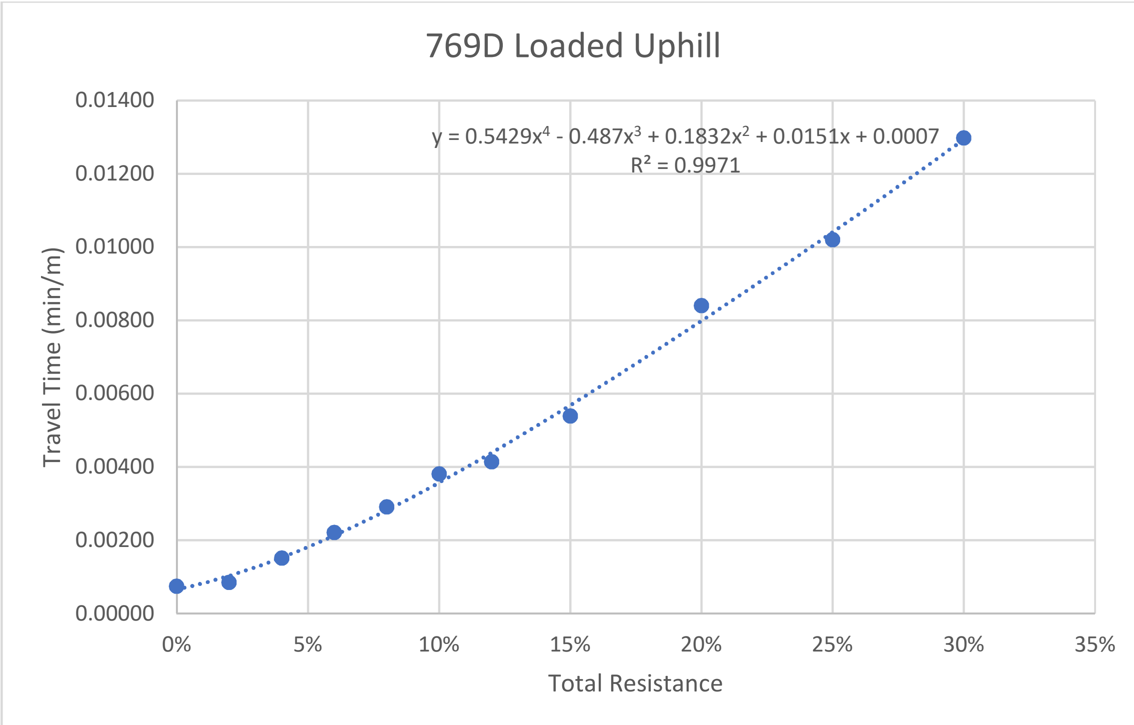
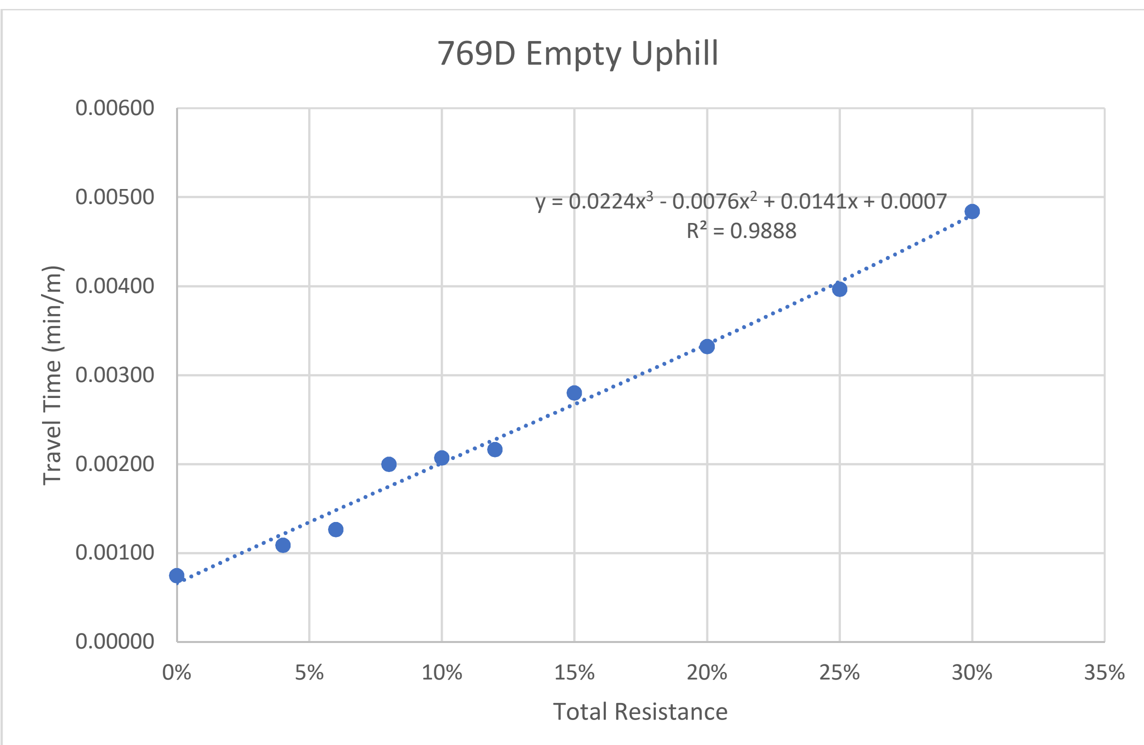
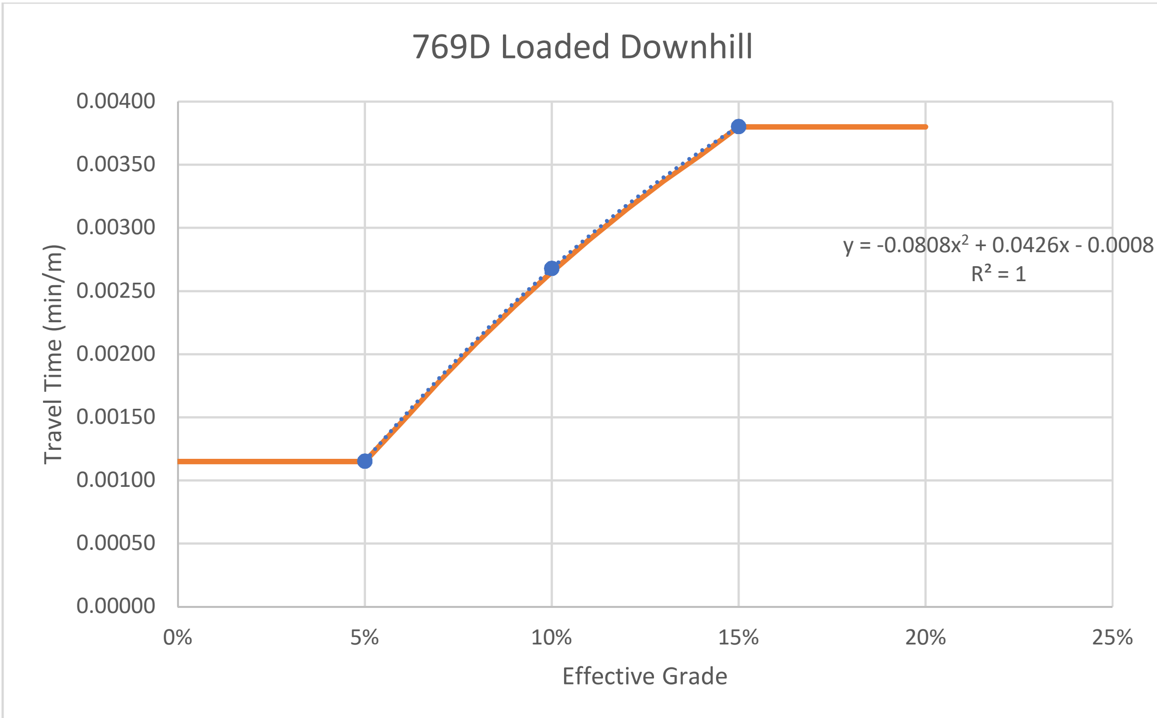


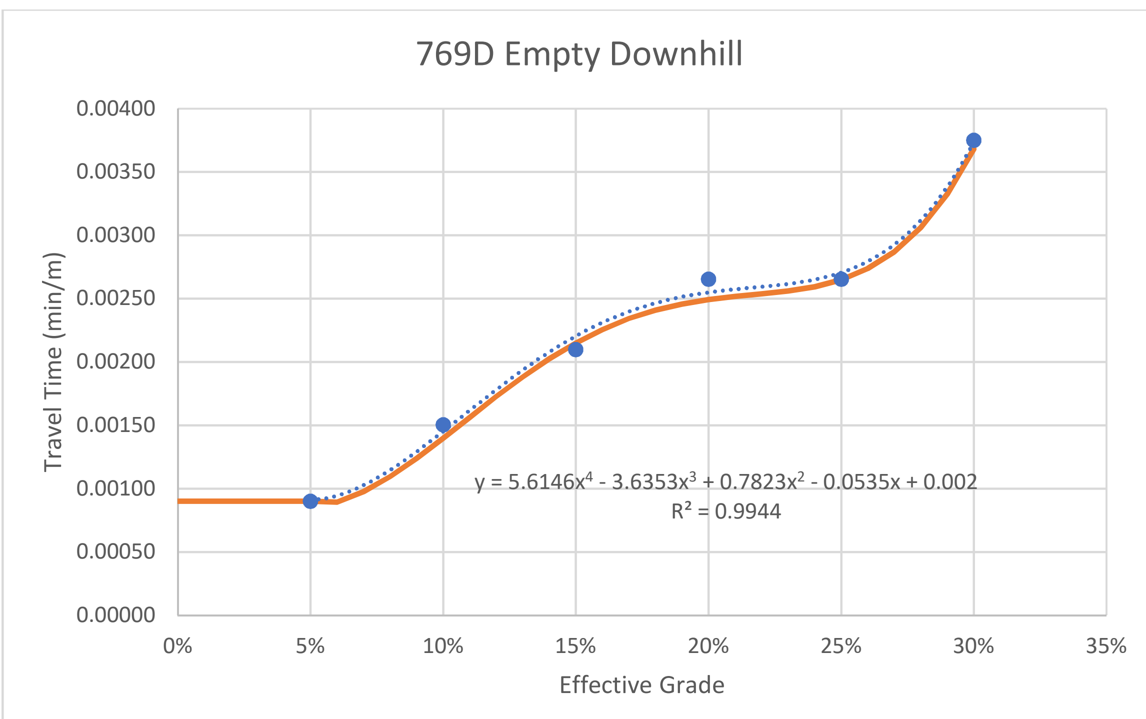
Caterpillar Performance Handbook Edition 29, 9-10



Caterpillar Performance Handbook Edition 29, 9-10



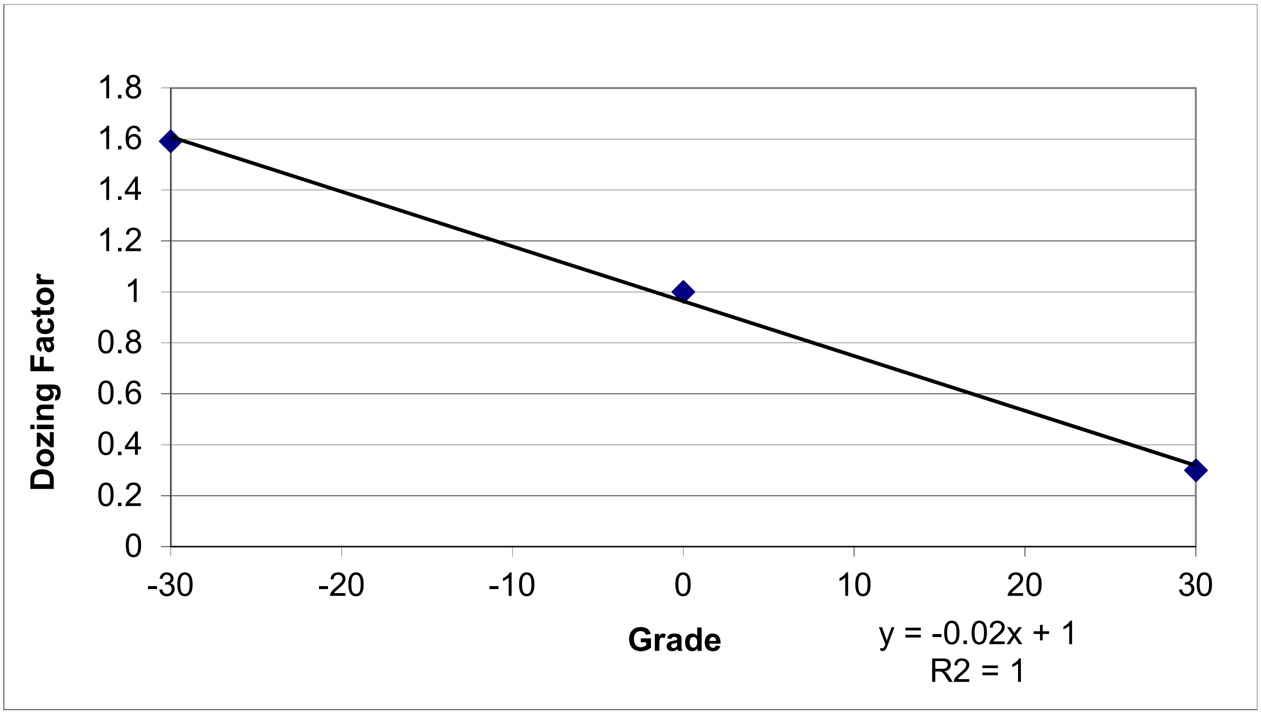
Caterpillar Performance Handbook Edition 29, 9-11



Caterpillar Performance Handbook Edition 29, 9-11

Grade vs. Dozing Factor

Grade %	Dozing Factor
0	1
-30	1.59
30	0.3



Appendix D.4

R.S. Means Data

RS Means Online Data

Demolition - accessed September 21, 2021

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
024113400190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation	L.F.	$ -	$ 10.08	$ 2.38	$ 12.46	Year 2021	NEW MEXICO / LAS CRUCES (880)

Revegetation - accessed September 21, 2021

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
015433201500	Rent disc harrow attchment for tractor, Excl. Hourly Oper. Cost.	Month	$ -	$ -	$ 670.65	$ 670.65	Year 2021	NEW MEXICO / LAS CRUCES (880)
329343100560	Planting, trees, shrubs, and ground cover, medium soil, bare root seedlings, 3" to 5", includes planting only	Clab	$ -	$ 0.37	$ -	$ 0.37	Year 2021	NEW MEXICO / LAS CRUCES (880)

Concrete cutoff wall (dissipater [dissipation basin]) & Grade Control Wall - accessed September 21, 2021

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
033053406200	Structural concrete, in place, gravity retaining wall (3000 psi), 4' high, includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	C.Y.	$ 155.23	$ 101.84	$ 5.51	$ 262.58	Year 2021	NEW MEXICO / LAS CRUCES (880)
033053403945	Structural concrete, in place, continuous strip footing (3000 psi), 36" wide x 12" deep, unreinforced, includes forms(4 uses), concrete (Portland cement Type I), placing and finishing, excludes reinforcing	C.Y.	$ 127.01	$ 43.47	$ 0.31	$ 170.79	Year 2021	NEW MEXICO / LAS CRUCES (880)

Perimeter Items - accessed September 21, 2021

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
323113200800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	L.F.	$ 20.63	$ 3.20	$ 0.82	$ 24.65	Year 2021	NEW MEXICO / LAS CRUCES (880)
323113205070	Fence, chain link industrial, double swing gates, 6' high, 20' opening, includes excavation, posts & hardware in concrete	Opng.	$ 568.54	$ 309.40	$ 79.07	$ 957.01	Year 2021	NEW MEXICO / LAS CRUCES (880)
101453200600	Signs, guide and directional signs, reflectorized, 12" x 18", excludes posts	Ea.	$ 42.50	$ 18.92	$ 12.21	$ 73.63	Year 2021	NEW MEXICO / LAS CRUCES (880)

Excavation- accessed September 21, 2021

Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
312316466070	Excavating, bulk, dozer, open site, bank measure, common earth, 700 HP dozer, 300' haul	B.C.Y.	$ -	$ 0.54	$ 4.66	$ 5.20	Year 2021	NEW MEXICO / LAS CRUCES (880)
312316466010	Excavating, bulk, dozer, open site, bank measure, common earth, 700 HP dozer, 50' haul	B.C.Y.	$ -	$ 0.16	$ 1.39	$ 1.55	Year 2021	NEW MEXICO / LAS CRUCES (880)
312323205040	Cycle hauling (wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 5 MPH, excludes loading equipment	L.C.Y.	$ -	$ 0.82	$ 2.05	$ 2.87	Year 2021	NEW MEXICO / LAS CRUCES (880)

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew A-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Concrete Saw, Gas Manual		113.70		125.07	14.21	15.63
8 L.H., Daily Totals		$468.90		$655.07	$58.61	$81.88

Crew A-1A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Skilled Worker	$57.10	$456.80	$85.90	$687.20	$57.10	$85.90
1 Shot Blaster, 20″		208.70		229.57	26.09	28.70
8 L.H., Daily Totals		$665.50		$916.77	$83.19	$114.60

Crew A-1B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Concrete Saw		112.85		124.14	14.11	15.52
8 L.H., Daily Totals		$468.05		$654.13	$58.51	$81.77

Crew A-1C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Chain Saw, Gas, 18″		52.20		57.42	6.53	7.18
8 L.H., Daily Totals		$407.40		$587.42	$50.92	$73.43

Crew A-1D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Vibrating Plate, Gas, 18″		31.90		35.09	3.99	4.39
8 L.H., Daily Totals		$387.10		$565.09	$48.39	$70.64

Crew A-1E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Vibrating Plate, Gas, 21″		165.60		182.16	20.70	22.77
8 L.H., Daily Totals		$520.80		$712.16	$65.10	$89.02

Crew A-1F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Rammer/Tamper, Gas, 8″		47.00		51.70	5.88	6.46
8 L.H., Daily Totals		$402.20		$581.70	$50.27	$72.71

Crew A-1G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Rammer/Tamper, Gas, 15″		54.65		60.12	6.83	7.51
8 L.H., Daily Totals		$409.85		$590.12	$51.23	$73.76

Crew A-1H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Exterior Steam Cleaner		77.20		84.92	9.65	10.62
8 L.H., Daily Totals		$432.40		$614.92	$54.05	$76.86

Crew A-1J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Cultivator, Walk-Behind, 5 H.P.		53.25		58.58	6.66	7.32
8 L.H., Daily Totals		$408.45		$588.58	$51.06	$73.57

Crew A-1K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Cultivator, Walk-Behind, 8 H.P.		92.20		101.42	11.53	12.68
8 L.H., Daily Totals		$447.40		$631.42	$55.92	$78.93

Crew A-1M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Building Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Snow Blower, Walk-Behind		68.30		75.13	8.54	9.39
8 L.H., Daily Totals		$423.50		$605.13	$52.94	$75.64

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew A-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.87	$68.50
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	8.27	9.10
24 L.H., Daily Totals		$1299.30		$1862.35	$54.14	$77.60

Crew A-2A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.87	$68.50
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Concrete Saw		112.85		124.14	12.97	14.27
24 L.H., Daily Totals		$1412.15		$1986.48	$58.84	$82.77

Crew A-2B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (light)	$48.80	$390.40	$73.00	$584.00	$48.80	$73.00
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	24.81	27.29
8 L.H., Daily Totals		$588.90		$802.35	$73.61	$100.29

Crew A-3A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43	22.09	24.30
8 L.H., Daily Totals		$620.75		$856.02	$77.59	$107.00

Crew A-3B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$55.15	$82.30
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28		
1 F.E. Loader, W.M., 2.5 C.Y.		638.30		702.13	76.10	83.71
16 L.H., Daily Totals		$2100.05		$2656.22	$131.25	$166.01

Crew A-3C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	55.79	61.37
8 L.H., Daily Totals		$890.30		$1152.53	$111.29	$144.07

Crew A-3D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (light)	$48.80	$390.40	$73.00	$584.00	$48.80	$73.00
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Flatbed Trailer, 25 Ton		137.20		150.92	39.24	43.17
8 L.H., Daily Totals		$704.35		$929.35	$88.04	$116.17

Crew A-3E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.38	$84.13
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43	11.05	12.15
16 L.H., Daily Totals		$1078.75		$1540.43	$67.42	$96.28

Crew A-3F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.38	$84.13
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Lowbed Trailer, 75 Ton		258.10		283.91	58.38	64.21
16 L.H., Daily Totals		$1836.00		$2373.40	$114.75	$148.34

Crews - Standard

Crew A-3G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.38	$84.13
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Truck Tractor, 6x4, 450 H.P.		608.95		669.85		
1 Lowbed Trailer, 75 Ton		258.10		283.91	65.24	71.76
16 L.H., Daily Totals		$1945.80		$2494.18	$121.61	$155.89

Crew A-3H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$61.45	$91.55
1 Hyd. Crane, 12 Ton (Daily)		733.15		806.47	91.64	100.81
8 L.H., Daily Totals		$1224.75		$1538.87	$153.09	$192.36

Crew A-3I	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$61.45	$91.55
1 Hyd. Crane, 25 Ton (Daily)		810.50		891.55	101.31	111.44
8 L.H., Daily Totals		$1302.10		$1623.95	$162.76	$202.99

Crew A-3J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$61.45	$91.55
1 Hyd. Crane, 40 Ton (Daily)		1287.00		1415.70	160.88	176.96
8 L.H., Daily Totals		$1778.60		$2148.10	$222.32	$268.51

Crew A-3K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.98	$84.90
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 55 Ton (Daily)		1377.00		1514.70		
1 P/U Truck, 3/4 Ton (Daily)		143.85		158.24	95.05	104.56
16 L.H., Daily Totals		$2432.45		$3031.34	$152.03	$189.46

Crew A-3L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.98	$84.90
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 80 Ton (Daily)		2058.00		2263.80		
1 P/U Truck, 3/4 Ton (Daily)		143.85		158.24	137.62	151.38
16 L.H., Daily Totals		$3113.45		$3780.43	$194.59	$236.28

Crew A-3M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$56.98	$84.90
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 100 Ton (Daily)		2253.00		2478.30		
1 P/U Truck, 3/4 Ton (Daily)		143.85		158.24	149.80	164.78
16 L.H., Daily Totals		$3308.45		$3994.93	$206.78	$249.68

Crew A-3N	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$61.45	$91.55
1 Tower Crane (monthly)		1737.00		1910.70	217.13	238.84
8 L.H., Daily Totals		$2228.60		$2643.10	$278.57	$330.39

Crew A-3P	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 A.T. Forklift, 31' reach, 45' lift		346.45		381.10	43.31	47.64
8 L.H., Daily Totals		$790.45		$1042.69	$98.81	$130.34

Crew A-3Q	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Flatbed Trailer, 3 Ton		71.15		78.27	30.99	34.09
8 L.H., Daily Totals		$691.90		$934.29	$86.49	$116.79

Crew A-3R	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Forklift, Smooth Floor, 8,000 Lb.		283.25		311.57	35.41	38.95
8 L.H., Daily Totals		$727.25		$973.17	$90.91	$121.65

Crew A-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$51.95	$77.40
1 Painter, Ordinary	46.45	371.60	68.90	551.20		
24 L.H., Daily Totals		$1246.80		$1857.60	$51.95	$77.40

Crew A-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$44.89	$67.00
.25 Truck Driver (light)	48.80	97.60	73.00	146.00		
.25 Flatbed Truck, Gas, 1.5 Ton		49.63		54.59	2.76	3.03
18 L.H., Daily Totals		$857.63		$1260.59	$47.65	$70.03

Crew A-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Instrument Man	$57.10	$456.80	$85.90	$687.20	$54.88	$82.15
1 Rodman/Chainman	52.65	421.20	78.40	627.20		
1 Level, Electronic		34.40		37.84	2.15	2.37
16 L.H., Daily Totals		$912.40		$1352.24	$57.02	$84.52

Crew A-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Chief of Party	$68.50	$548.00	$102.35	$818.80	$59.42	$88.88
1 Instrument Man	57.10	456.80	85.90	687.20		
1 Rodman/Chainman	52.65	421.20	78.40	627.20		
1 Level, Electronic		34.40		37.84	1.43	1.58
24 L.H., Daily Totals		$1460.40		$2171.04	$60.85	$90.46

Crew A-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Chief of Party	$68.50	$548.00	$102.35	$818.80	$57.73	$86.26
1 Instrument Man	57.10	456.80	85.90	687.20		
2 Rodmen/Chainmen	52.65	842.40	78.40	1254.40		
1 Level, Electronic		34.40		37.84	1.08	1.18
32 L.H., Daily Totals		$1881.60		$2798.24	$58.80	$87.44

Crew A-9	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Asbestos Foreman	$61.45	$491.60	$94.00	$752.00	$61.01	$93.34
7 Asbestos Workers	60.95	3413.20	93.25	5222.00		
64 L.H., Daily Totals		$3904.80		$5974.00	$61.01	$93.34

Crew A-10A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Asbestos Foreman	$61.45	$491.60	$94.00	$752.00	$61.12	$93.50
2 Asbestos Workers	60.95	975.20	93.25	1492.00		
24 L.H., Daily Totals		$1466.80		$2244.00	$61.12	$93.50

Crew A-10B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Asbestos Foreman	$61.45	$491.60	$94.00	$752.00	$61.08	$93.44
3 Asbestos Workers	60.95	1462.80	93.25	2238.00		
32 L.H., Daily Totals		$1954.40		$2990.00	$61.08	$93.44

Crew A-10C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Asbestos Workers	$60.95	$1462.80	$93.25	$2238.00	$60.95	$93.25
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	8.27	9.10
24 L.H., Daily Totals		$1661.30		$2456.35	$69.22	$102.35

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew A-10D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Asbestos Workers	$60.95	$975.20	$93.25	$1492.00	$58.96	$89.08
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hydraulic Crane, 33 Ton		983.15		1081.46	30.72	33.80
32 L.H., Daily Totals		$2869.95		$3931.86	$89.69	$122.87
Crew A-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$61.45	$491.60	$94.00	$752.00	$61.01	$93.34
7 Asbestos Workers	60.95	3413.20	93.25	5222.00		
2 Chip. Hammers, 12 Lb., Elec.		65.70		72.27	1.03	1.13
64 L.H., Daily Totals		$3970.50		$6046.27	$62.04	$94.47
Crew A-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Asbestos Foreman	$61.45	$491.60	$94.00	$752.00	$61.01	$93.34
7 Asbestos Workers	60.95	3413.20	93.25	5222.00		
1 Trk-Mtd Vac, 14 CY, 1500 Gal.		542.60		596.86		
1 Flatbed Truck, 20,000 GVW		204.05		224.46	11.67	12.83
64 L.H., Daily Totals		$4651.45		$6795.31	$72.68	$106.18
Crew A-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Trk-Mtd Vac, 14 CY, 1500 Gal.		542.60		596.86		
1 Flatbed Truck, 20,000 GVW		204.05		224.46	93.33	102.66
8 L.H., Daily Totals		$1190.65		$1482.92	$148.83	$185.36
Crew B-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Laborers	44.40	710.40	66.25	1060.00		
24 L.H., Daily Totals		$1081.60		$1614.00	$45.07	$67.25
Crew B-1A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Laborers	44.40	710.40	66.25	1060.00		
2 Cutting Torches		25.90		28.49		
2 Sets of Gases		347.20		381.92	15.55	17.10
24 L.H., Daily Totals		$1454.70		$2024.41	$60.61	$84.35
Crew B-1B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.16	$73.33
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
2 Cutting Torches		25.90		28.49		
2 Sets of Gases		347.20		381.92		
1 Hyd. Crane, 12 Ton		475.80		523.38	26.53	29.18
32 L.H., Daily Totals		$2422.10		$3280.19	$75.69	$102.51
Crew B-1C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Laborers	44.40	710.40	66.25	1060.00		
1 Telescoping Boom Lift, to 60'		292.45		321.69	12.19	13.40
24 L.H., Daily Totals		$1374.05		$1935.69	$57.25	$80.65
Crew B-1D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$44.40	$66.25
1 Small Work Boat, Gas, 50 H.P.		120.85		132.94		
1 Pressure Washer, 7 GPM		93.95		103.35	13.43	14.77
16 L.H., Daily Totals		$925.20		$1296.28	$57.83	$81.02

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-1E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.90	$67.00
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Work Boat, Diesel, 200 H.P.		1436.00		1579.60		
2 Pressure Washers, 7 GPM		187.90		206.69	50.75	55.82
32 L.H., Daily Totals		$3060.70		$3930.29	$95.65	$122.82
Crew B-1F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Workers	$57.10	$913.60	$85.90	$1374.40	$52.87	$79.35
1 Laborer	44.40	355.20	66.25	530.00		
1 Small Work Boat, Gas, 50 H.P.		120.85		132.94		
1 Pressure Washer, 7 GPM		93.95		103.35	8.95	9.85
24 L.H., Daily Totals		$1483.60		$2140.68	$61.82	$89.19
Crew B-1G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$44.40	$66.25
1 Small Work Boat, Gas, 50 H.P.		120.85		132.94	7.55	8.31
16 L.H., Daily Totals		$831.25		$1192.93	$51.95	$74.56
Crew B-1H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Skilled Workers	$57.10	$913.60	$85.90	$1374.40	$52.87	$79.35
1 Laborer	44.40	355.20	66.25	530.00		
1 Small Work Boat, Gas, 50 H.P.		120.85		132.94	5.04	5.54
24 L.H., Daily Totals		$1389.65		$2037.34	$57.90	$84.89
Crew B-1J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (inside)	$44.90	$359.20	$67.00	$536.00	$44.65	$66.63
1 Laborer	44.40	355.20	66.25	530.00		
16 L.H., Daily Totals		$714.40		$1066.00	$44.65	$66.63
Crew B-1K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (inside)	$55.20	$441.60	$82.40	$659.20	$54.95	$82.03
1 Carpenter	54.70	437.60	81.65	653.20		
16 L.H., Daily Totals		$879.20		$1312.40	$54.95	$82.03
Crew B-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.80	$66.85
4 Laborers	44.40	1420.80	66.25	2120.00		
40 L.H., Daily Totals		$1792.00		$2674.00	$44.80	$66.85
Crew B-2A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Laborers	44.40	710.40	66.25	1060.00		
1 Telescoping Boom Lift, to 60'		292.45		321.69	12.19	13.40
24 L.H., Daily Totals		$1374.05		$1935.69	$57.25	$80.65
Crew B-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.47	$73.84
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
2 Dump Trucks, 12 C.Y., 400 H.P.		1158.70		1274.57	48.01	52.82
48 L.H., Daily Totals		$4679.10		$6079.57	$97.48	$126.66
Crew B-3A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Laborers	$44.40	$1420.80	$66.25	$2120.00	$47.32	$70.58
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38	17.40	19.13
40 L.H., Daily Totals		$2588.60		$3588.58	$64.72	$89.71

Crew B-3B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$49.77	$74.28
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Backhoe Loader, 80 H.P.		235.05		258.56		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	25.45	28.00
32 L.H., Daily Totals		$2407.20		$3272.64	$75.22	$102.27

Crew B-3C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$48.05	$71.66
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Crawler Loader, 4 C.Y.		1456.00		1601.60	45.50	50.05
32 L.H., Daily Totals		$2993.60		$3894.80	$93.55	$121.71

Crew B-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.88	$68.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Truck Tractor, 220 H.P.		310.80		341.88		
1 Flatbed Trailer, 40 Ton		188.45		207.29	10.40	11.44
48 L.H., Daily Totals		$2701.65		$3836.78	$56.28	$79.93

Crew B-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.86	$72.86
4 Laborers	44.40	1420.80	66.25	2120.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Air Compressor, 250 cfm		202.85		223.13		
2 Breakers, Pavement, 60 lb.		107.20		117.92		
2 -50' Air Hoses, 1.5"		45.60		50.16		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60	26.82	29.50
56 L.H., Daily Totals		$4237.65		$5732.22	$75.67	$102.36

Crew B-5A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.08	$73.22
6 Laborers	44.40	2131.20	66.25	3180.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Air Compressor, 365 cfm		343.55		377.90		
2 Breakers, Pavement, 60 lb.		107.20		117.92		
8 -50' Air Hoses, 1"		64.40		70.84		
2 Dump Trucks, 8 C.Y., 220 H.P.		815.20		896.72	13.86	15.24
96 L.H., Daily Totals		$6041.55		$8492.58	$62.93	$88.46

Crew B-5B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Powderman	$57.10	$456.80	$85.90	$687.20	$54.83	$81.97
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
3 Truck Drivers (heavy)	51.30	1231.20	76.70	1840.80		
1 F.E. Loader, W.M., 2.5 C.Y.		638.30		702.13		
3 Dump Trucks, 12 C.Y., 400 H.P.		1738.05		1911.86		
1 Air Compressor, 365 cfm		343.55		377.90	56.66	62.33
48 L.H., Daily Totals		$5351.90		$6926.29	$111.50	$144.30

Crew B-5C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$51.09	$76.23
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
2 Dump Trucks, 12 C.Y., 400 H.P.		1158.70		1274.57		
1 Crawler Loader, 4 C.Y.		1456.00		1601.60		
1 S.P. Crane, 4x4, 25 Ton		1155.00		1270.50	58.90	64.79
64 L.H., Daily Totals		$7039.70		$9025.47	$110.00	$141.02

Crew B-5D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.16	$73.34
4 Laborers	44.40	1420.80	66.25	2120.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Air Compressor, 250 cfm		202.85		223.13		
2 Breakers, Pavement, 60 lb.		107.20		117.92		
2 -50' Air Hoses, 1.5"		45.60		50.16		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	32.52	35.77
64 L.H., Daily Totals		$5227.40		$6983.10	$81.68	$109.11

Crew B-5E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.16	$73.34
4 Laborers	44.40	1420.80	66.25	2120.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51		
1 High Pressure Water Jet 40 KSI		820.75		902.83		
2 -50' Air Hoses, 1.5"		45.60		50.16		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	42.90	47.19
64 L.H., Daily Totals		$5892.20		$7714.38	$92.07	$120.54

Crew B-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.10	$71.73
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Backhoe Loader, 48 H.P.		216.20		237.82	9.01	9.91
24 L.H., Daily Totals		$1370.60		$1959.42	$57.11	$81.64

Crew B-6A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.5 Labor Foreman (outside)	$46.40	$185.60	$69.25	$277.00	$50.64	$75.51
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Vacuum Truck, 5000 Gal.		371.95		409.14	18.60	20.46
20 L.H., Daily Totals		$1384.75		$1919.35	$69.24	$95.97

Crew B-6B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.07	$67.25
4 Laborers	44.40	1420.80	66.25	2120.00		
1 S.P. Crane, 4x4, 5 Ton		381.95		420.14		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Butt Fusion Mach., 4"-12" diam.		420.75		462.82	20.86	22.94
48 L.H., Daily Totals		$3164.40		$4329.32	$65.92	$90.19

Crews - Standard

Crew B-6C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.07	$67.25
4 Laborers	44.40	1420.80	66.25	2120.00		
1 S.P. Crane, 4x4, 12 Ton		432.65		475.92		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Butt Fusion Mach., 8″-24″ diam.		1086.00		1194.60	49.35	54.28
48 L.H., Daily Totals		$4531.90		$5833.57	$94.41	$121.53

Crew B-6D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.5 Labor Foreman (outside)	$46.40	$185.60	$69.25	$277.00	$50.64	$75.51
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Hydro Excavator, 12 C.Y.		1277.00		1404.70	63.85	70.23
20 L.H., Daily Totals		$2289.80		$2914.90	$114.49	$145.75

Crew B-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.17	$70.36
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Brush Chipper, 12″, 130 H.P.		366.05		402.65		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
2 Chain Saws, Gas, 36″ Long		83.30		91.63	33.24	36.56
48 L.H., Daily Totals		$3859.35		$5132.09	$80.40	$106.92

Crew B-7A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.10	$71.73
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Rake w/Tractor		343.50		377.85		
2 Chain Saws, Gas, 18″		104.40		114.84	18.66	20.53
24 L.H., Daily Totals		$1602.30		$2214.29	$66.76	$92.26

Crew B-7B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.76	$71.26
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Brush Chipper, 12″, 130 H.P.		366.05		402.65		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
2 Chain Saws, Gas, 36″ Long		83.30		91.63		
1 Dump Truck, 8 C.Y., 220 H.P.		407.60		448.36	35.77	39.34
56 L.H., Daily Totals		$4677.35		$6194.05	$83.52	$110.61

Crew B-7C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.76	$71.26
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Brush Chipper, 12″, 130 H.P.		366.05		402.65		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
2 Chain Saws, Gas, 36″ Long		83.30		91.63		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	38.83	42.72
56 L.H., Daily Totals		$4849.10		$6382.97	$86.59	$113.98

Crew B-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.04	$76.15
2 Laborers	44.40	710.40	66.25	1060.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Hyd. Crane, 25 Ton		586.70		645.37		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60		
2 Dump Trucks, 12 C.Y., 400 H.P.		1158.70		1274.57	45.18	49.70
64 L.H., Daily Totals		$6157.80		$8054.14	$96.22	$125.85

Crew B-9	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.80	$66.85
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Air Compressor, 250 cfm		202.85		223.13		
2 Breakers, Pavement, 60 lb.		107.20		117.92		
2 -50′ Air Hoses, 1.5″		45.60		50.16	8.89	9.78
40 L.H., Daily Totals		$2147.65		$3065.22	$53.69	$76.63

Crew B-9A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$46.70	$69.73
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51		
1 Truck Tractor, 220 H.P.		310.80		341.88		
2 -50′ Discharge Hoses, 3″		9.00		9.90	19.75	21.72
24 L.H., Daily Totals		$1594.70		$2194.89	$66.45	$91.45

Crew B-9B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$46.70	$69.73
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
2 -50′ Discharge Hoses, 3″		9.00		9.90		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51		
1 Truck Tractor, 220 H.P.		310.80		341.88		
1 Pressure Washer		97.35		107.08	23.80	26.18
24 L.H., Daily Totals		$1692.05		$2301.97	$70.50	$95.92

Crew B-9D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.80	$66.85
4 Common Laborers	44.40	1420.80	66.25	2120.00		
1 Air Compressor, 250 cfm		202.85		223.13		
2 -50′ Air Hoses, 1.5″		45.60		50.16		
2 Air Powered Tampers		79.50		87.45	8.20	9.02
40 L.H., Daily Totals		$2119.95		$3034.74	$53.00	$75.87

Crew B-9E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$48.10	$71.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Chip. Hammers, 12 Lb., Elec.		32.85		36.13	2.05	2.26
16 L.H., Daily Totals		$802.45		$1173.34	$50.15	$73.33

Crew B-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
12 L.H., Daily Totals		$649.60		$968.20	$54.13	$80.68

Crew B-10A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Roller, 2-Drum, W.B., 7.5 H.P.		166.75		183.43	13.90	15.29
12 L.H., Daily Totals		$816.35		$1151.63	$68.03	$95.97

Crews - Standard

Crew B-10B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 200 H.P.		1520.00		1672.00	126.67	139.33
12 L.H., Daily Totals		$2169.60		$2640.20	$180.80	$220.02

Crew B-10C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Vibratory Roller, Towed, 23 Ton		520.35		572.38	170.03	187.03
12 L.H., Daily Totals		$2689.95		$3212.59	$224.16	$267.72

Crew B-10D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Sheepsft. Roller, Towed		426.95		469.64	162.25	178.47
12 L.H., Daily Totals		$2596.55		$3109.84	$216.38	$259.15

Crew B-10E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Tandem Roller, 5 Ton		258.75		284.63	21.56	23.72
12 L.H., Daily Totals		$908.35		$1252.83	$75.70	$104.40

Crew B-10F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Tandem Roller, 10 Ton		246.80		271.48	20.57	22.62
12 L.H., Daily Totals		$896.40		$1239.68	$74.70	$103.31

Crew B-10G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Sheepsfoot Roller, 240 H.P.		1363.00		1499.30	113.58	124.94
12 L.H., Daily Totals		$2012.60		$2467.50	$167.72	$205.63

Crew B-10H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Diaphragm Water Pump, 2″		87.70		96.47		
1 -20′ Suction Hose, 2″		3.55		3.90		
2 -50′ Discharge Hoses, 2″		8.00		8.80	8.27	9.10
12 L.H., Daily Totals		$748.85		$1077.38	$62.40	$89.78

Crew B-10I	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Diaphragm Water Pump, 4″		106.35		116.99		
1 -20′ Suction Hose, 4″		17.25		18.98		
2 -50′ Discharge Hoses, 4″		25.60		28.16	12.43	13.68
12 L.H., Daily Totals		$798.80		$1132.32	$66.57	$94.36

Crew B-10J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Centrifugal Water Pump, 3″		74.40		81.84		
1 -20′ Suction Hose, 3″		8.75		9.63		
2 -50′ Discharge Hoses, 3″		9.00		9.90	7.68	8.45
12 L.H., Daily Totals		$741.75		$1069.57	$61.81	$89.13

Crew B-10K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Centr. Water Pump, 6″		235.25		258.77		
1 -20′ Suction Hose, 6″		25.50		28.05		
2 -50′ Discharge Hoses, 6″		36.20		39.82	24.75	27.22
12 L.H., Daily Totals		$946.55		$1294.85	$78.88	$107.90

Crew B-10L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 80 H.P.		405.85		446.44	33.82	37.20
12 L.H., Daily Totals		$1055.45		$1414.64	$87.95	$117.89

Crew B-10M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 300 H.P.		1785.00		1963.50	148.75	163.63
12 L.H., Daily Totals		$2434.60		$2931.70	$202.88	$244.31

Crew B-10N	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, T.M., 1.5 C.Y.		572.00		629.20	47.67	52.43
12 L.H., Daily Totals		$1221.60		$1597.40	$101.80	$133.12

Crew B-10O	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, T.M., 2.25 C.Y.		925.50		1018.05	77.13	84.84
12 L.H., Daily Totals		$1575.10		$1986.25	$131.26	$165.52

Crew B-10P	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Crawler Loader, 3 C.Y.		1146.00		1260.60	95.50	105.05
12 L.H., Daily Totals		$1795.60		$2228.80	$149.63	$185.73

Crew B-10Q	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Crawler Loader, 4 C.Y.		1456.00		1601.60	121.33	133.47
12 L.H., Daily Totals		$2105.60		$2569.80	$175.47	$214.15

Crew B-10R	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, W.M., 1 C.Y.		305.60		336.16	25.47	28.01
12 L.H., Daily Totals		$955.20		$1304.36	$79.60	$108.70

Crew B-10S	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, W.M., 1.5 C.Y.		441.40		485.54	36.78	40.46
12 L.H., Daily Totals		$1091.00		$1453.74	$90.92	$121.15

Crew B-10T	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, W.M., 2.5 C.Y.		638.30		702.13	53.19	58.51
12 L.H., Daily Totals		$1287.90		$1670.33	$107.33	$139.19

Crews - Standard

Crew B-10U	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, W.M., 5.5 C.Y.		967.95		1064.74	80.66	88.73
12 L.H., Daily Totals		$1617.55		$2032.94	$134.80	$169.41

Crew B-10V	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 700 H.P.		5175.00		5692.50	431.25	474.38
12 L.H., Daily Totals		$5824.60		$6660.70	$485.38	$555.06

Crew B-10W	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 105 H.P.		640.80		704.88	53.40	58.74
12 L.H., Daily Totals		$1290.40		$1673.08	$107.53	$139.42

Crew B-10X	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 410 H.P.		2807.00		3087.70	233.92	257.31
12 L.H., Daily Totals		$3456.60		$4055.90	$288.05	$337.99

Crew B-10Y	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Vibr. Roller, Towed, 12 Ton		584.80		643.28	48.73	53.61
12 L.H., Daily Totals		$1234.40		$1611.48	$102.87	$134.29

Crew B-11A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Dozer, 200 H.P.		1520.00		1672.00	95.00	104.50
16 L.H., Daily Totals		$2347.20		$2905.20	$146.70	$181.57

Crew B-11B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (light)	$55.50	$444.00	$82.70	$661.60	$49.95	$74.47
1 Laborer	44.40	355.20	66.25	530.00		
1 Air Powered Tamper		39.75		43.73		
1 Air Compressor, 365 cfm		343.55		377.90		
2 -50' Air Hoses, 1.5"		45.60		50.16	26.81	29.49
16 L.H., Daily Totals		$1228.10		$1663.39	$76.76	$103.96

Crew B-11C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Backhoe Loader, 48 H.P.		216.20		237.82	13.51	14.86
16 L.H., Daily Totals		$1043.40		$1471.02	$65.21	$91.94

Crew B-11J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Ripper, Beam & 1 Shank		91.60		100.76	72.79	80.07
16 L.H., Daily Totals		$1991.80		$2514.26	$124.49	$157.14

Crew B-11K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Trencher, Chain Type, 8' D		1894.00		2083.40	118.38	130.21
16 L.H., Daily Totals		$2721.20		$3316.60	$170.07	$207.29

Crew B-11L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Grader, 30,000 Lbs.		1073.00		1180.30	67.06	73.77
16 L.H., Daily Totals		$1900.20		$2413.50	$118.76	$150.84

Crew B-11M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Backhoe Loader, 80 H.P.		235.05		258.56	14.69	16.16
16 L.H., Daily Totals		$1062.25		$1491.76	$66.39	$93.23

Crew B-11N	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.47	$78.36
2 Equipment Operators (med.)	59.00	944.00	87.90	1406.40		
6 Truck Drivers (heavy)	51.30	2462.40	76.70	3681.60		
1 F.E. Loader, W.M., 5.5 C.Y.		967.95		1064.74		
1 Dozer, 410 H.P.		2807.00		3087.70		
6 Dump Trucks, Off Hwy., 50 Ton		11874.00		13061.40	217.35	239.08
72 L.H., Daily Totals		$19426.55		$22855.85	$269.81	$317.44

Crew B-11Q	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 140 H.P.		729.15		802.07	60.76	66.84
12 L.H., Daily Totals		$1378.75		$1770.27	$114.90	$147.52

Crew B-11R	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 200 H.P.		1520.00		1672.00	126.67	139.33
12 L.H., Daily Totals		$2169.60		$2640.20	$180.80	$220.02

Crew B-11S	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 300 H.P.		1785.00		1963.50		
1 Ripper, Beam & 1 Shank		91.60		100.76	156.38	172.02
12 L.H., Daily Totals		$2526.20		$3032.46	$210.52	$252.71

Crew B-11T	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 410 H.P.		2807.00		3087.70		
1 Ripper, Beam & 2 Shanks		140.40		154.44	245.62	270.18
12 L.H., Daily Totals		$3597.00		$4210.34	$299.75	$350.86

Crew B-11U	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 Dozer, 520 H.P.		3434.00		3777.40	286.17	314.78
12 L.H., Daily Totals		$4083.60		$4745.60	$340.30	$395.47

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-11V	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$44.40	$66.25
1 Roller, 2-Drum, W.B., 7.5 H.P.		166.75		183.43	6.95	7.64
24 L.H., Daily Totals		$1232.35		$1773.43	$51.35	$73.89
Crew B-11W	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$51.37	$76.76
1 Common Laborer	44.40	355.20	66.25	530.00		
10 Truck Drivers (heavy)	51.30	4104.00	76.70	6136.00		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Vibratory Roller, Towed, 23 Ton		520.35		572.38		
10 Dump Trucks, 8 C.Y., 220 H.P.		4076.00		4483.60	63.71	70.08
96 L.H., Daily Totals		$11047.55		$14097.18	$115.08	$146.85
Crew B-11Y	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.49	$73.80
5 Common Laborers	44.40	1776.00	66.25	2650.00		
3 Equipment Operators (med.)	59.00	1416.00	87.90	2109.60		
1 Dozer, 80 H.P.		405.85		446.44		
2 Rollers, 2-Drum, W.B., 7.5 H.P.		333.50		366.85		
4 Vibrating Plates, Gas, 21"		662.40		728.64	19.47	21.42
72 L.H., Daily Totals		$4964.95		$6855.52	$68.96	$95.22
Crew B-12A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 1 C.Y.		832.65		915.91	52.04	57.24
16 L.H., Daily Totals		$1679.45		$2178.32	$104.97	$136.14
Crew B-12B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38	43.49	47.84
16 L.H., Daily Totals		$1542.60		$2027.78	$96.41	$126.74
Crew B-12C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 2 C.Y.		942.70		1036.97	58.92	64.81
16 L.H., Daily Totals		$1789.50		$2299.37	$111.84	$143.71
Crew B-12D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 3.5 C.Y.		2184.00		2402.40	136.50	150.15
16 L.H., Daily Totals		$3030.80		$3664.80	$189.43	$229.05
Crew B-12E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, .5 C.Y.		457.00		502.70	28.56	31.42
16 L.H., Daily Totals		$1303.80		$1765.10	$81.49	$110.32
Crew B-12F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, .75 C.Y.		701.80		771.98	43.86	48.25
16 L.H., Daily Totals		$1548.60		$2034.38	$96.79	$127.15

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-12G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 15 Ton		810.30		891.33		
1 Clamshell Bucket, .5 C.Y.		67.80		74.58	54.88	60.37
16 L.H., Daily Totals		$1724.90		$2228.31	$107.81	$139.27
Crew B-12H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 25 Ton		1152.00		1267.20		
1 Clamshell Bucket, 1 C.Y.		69.25		76.17	76.33	83.96
16 L.H., Daily Totals		$2068.05		$2605.78	$129.25	$162.86
Crew B-12I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 20 Ton		1013.00		1114.30		
1 Dragline Bucket, .75 C.Y.		61.85		68.03	67.18	73.90
16 L.H., Daily Totals		$1921.65		$2444.74	$120.10	$152.80
Crew B-12J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Gradall, 5/8 C.Y.		850.65		935.72	53.17	58.48
16 L.H., Daily Totals		$1697.45		$2198.11	$106.09	$137.38
Crew B-12K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Gradall, 3 Ton, 1 C.Y.		984.55		1083.01	61.53	67.69
16 L.H., Daily Totals		$1831.35		$2345.41	$114.46	$146.59
Crew B-12L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 15 Ton		810.30		891.33		
1 F.E. Attachment, .5 C.Y.		66.05		72.66	54.77	60.25
16 L.H., Daily Totals		$1723.15		$2226.39	$107.70	$139.15
Crew B-12M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 20 Ton		1013.00		1114.30		
1 F.E. Attachment, .75 C.Y.		71.25		78.38	67.77	74.54
16 L.H., Daily Totals		$1931.05		$2455.07	$120.69	$153.44
Crew B-12N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 25 Ton		1152.00		1267.20		
1 F.E. Attachment, 1 C.Y.		77.35		85.08	76.83	84.52
16 L.H., Daily Totals		$2076.15		$2614.68	$129.76	$163.42
Crew B-12O	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 F.E. Attachment, 1.5 C.Y.		88.65		97.52	82.48	90.73
16 L.H., Daily Totals		$2166.45		$2714.01	$135.40	$169.63

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-12P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Dragline Bucket, 1.5 C.Y.		65.70		72.27	81.04	89.15
16 L.H., Daily Totals		$2143.50		$2688.77	$133.97	$168.05
Crew B-12Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 5/8 C.Y.		604.75		665.23	37.80	41.58
16 L.H., Daily Totals		$1451.55		$1927.63	$90.72	$120.48
Crew B-12S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Hyd. Excavator, 2.5 C.Y.		1567.00		1723.70	97.94	107.73
16 L.H., Daily Totals		$2413.80		$2986.10	$150.86	$186.63
Crew B-12T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 75 Ton		1967.00		2163.70		
1 F.E. Attachment, 3 C.Y.		115.55		127.11	130.16	143.18
16 L.H., Daily Totals		$2929.35		$3553.20	$183.08	$222.08
Crew B-12V	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$52.92	$78.90
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 75 Ton		1967.00		2163.70		
1 Dragline Bucket, 3 C.Y.		72.30		79.53	127.46	140.20
16 L.H., Daily Totals		$2886.10		$3505.63	$180.38	$219.10
Crew B-12Y	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$50.08	$74.68
2 Laborers	44.40	710.40	66.25	1060.00		
1 Hyd. Excavator, 3.5 C.Y.		2184.00		2402.40	91.00	100.10
24 L.H., Daily Totals		$3386.00		$4194.80	$141.08	$174.78
Crew B-12Z	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$50.08	$74.68
2 Laborers	44.40	710.40	66.25	1060.00		
1 Hyd. Excavator, 2.5 C.Y.		1567.00		1723.70	65.29	71.82
24 L.H., Daily Totals		$2769.00		$3516.10	$115.38	$146.50
Crew B-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.28	$72.01
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 25 Ton		586.70		645.37	10.48	11.52
56 L.H., Daily Totals		$3290.30		$4677.77	$58.76	$83.53

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-13A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.83	$75.85
2 Laborers	44.40	710.40	66.25	1060.00		
2 Equipment Operators (med.)	59.00	944.00	87.90	1406.40		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Crawler Crane, 75 Ton		1967.00		2163.70		
1 Crawler Loader, 4 C.Y.		1456.00		1601.60		
2 Dump Trucks, 8 C.Y., 220 H.P.		815.20		896.72	75.68	83.25
56 L.H., Daily Totals		$7084.60		$8909.62	$126.51	$159.10
Crew B-13B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.28	$72.01
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 55 Ton		990.15		1089.17	17.68	19.45
56 L.H., Daily Totals		$3693.75		$5121.56	$65.96	$91.46
Crew B-13C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.28	$72.01
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 100 Ton		2310.00		2541.00	41.25	45.38
56 L.H., Daily Totals		$5013.60		$6573.40	$89.53	$117.38
Crew B-13D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Excavator, 1 C.Y.		832.65		915.91		
1 Trench Box		119.15		131.07	59.49	65.44
16 L.H., Daily Totals		$1798.60		$2309.38	$112.41	$144.34
Crew B-13E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38		
1 Trench Box		119.15		131.07	50.93	56.03
16 L.H., Daily Totals		$1661.75		$2158.84	$103.86	$134.93
Crew B-13F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Excavator, 3.5 C.Y.		2184.00		2402.40		
1 Trench Box		119.15		131.07	143.95	158.34
16 L.H., Daily Totals		$3149.95		$3795.86	$196.87	$237.24
Crew B-13G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Excavator, .75 C.Y.		701.80		771.98		
1 Trench Box		119.15		131.07	51.31	56.44
16 L.H., Daily Totals		$1667.75		$2165.45	$104.23	$135.34
Crew B-13H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Gradall, 5/8 C.Y.		850.65		935.72		
1 Trench Box		119.15		131.07	60.61	66.67
16 L.H., Daily Totals		$1816.60		$2329.18	$113.54	$145.57

Crews - Standard

Crew B-13I	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Gradall, 3 Ton, 1 C.Y.		984.55		1083.01		
1 Trench Box		119.15		131.07	68.98	75.88
16 L.H., Daily Totals		$1950.50		$2476.47	$121.91	$154.78

Crew B-13J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$52.92	$78.90
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Excavator, 2.5 C.Y.		1567.00		1723.70		
1 Trench Box		119.15		131.07	105.38	115.92
16 L.H., Daily Totals		$2532.95		$3117.17	$158.31	$194.82

Crew B-13K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Equip. Opers. (crane)	$61.45	$983.20	$91.55	$1464.80	$61.45	$91.55
1 Hyd. Excavator, .75 C.Y.		701.80		771.98		
1 Hyd. Hammer, 4000 ft-lb		649.20		714.12		
1 Hyd. Excavator, .75 C.Y.		701.80		771.98	128.30	141.13
16 L.H., Daily Totals		$3036.00		$3722.88	$189.75	$232.68

Crew B-13L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Equip. Opers. (crane)	$61.45	$983.20	$91.55	$1464.80	$61.45	$91.55
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38		
1 Hyd. Hammer, 5000 ft-lb		705.60		776.16		
1 Hyd. Excavator, .75 C.Y.		701.80		771.98	131.45	144.60
16 L.H., Daily Totals		$3086.40		$3778.32	$192.90	$236.15

Crew B-13M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Equip. Opers. (crane)	$61.45	$983.20	$91.55	$1464.80	$61.45	$91.55
1 Hyd. Excavator, 2.5 C.Y.		1567.00		1723.70		
1 Hyd. Hammer, 8000 ft-lb		918.65		1010.52		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38	198.84	218.72
16 L.H., Daily Totals		$4164.65		$4964.40	$260.29	$310.27

Crew B-13N	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Equip. Opers. (crane)	$61.45	$983.20	$91.55	$1464.80	$61.45	$91.55
1 Hyd. Excavator, 3.5 C.Y.		2184.00		2402.40		
1 Hyd. Hammer, 12,000 ft-lb		882.20		970.42		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38	235.13	258.64
16 L.H., Daily Totals		$4745.20		$5603.00	$296.57	$350.19

Crew B-14	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Backhoe Loader, 48 H.P.		216.20		237.82	4.50	4.95
48 L.H., Daily Totals		$2452.20		$3573.42	$51.09	$74.45

Crew B-14A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$55.77	$83.12
.5 Laborer	44.40	177.60	66.25	265.00		
1 Hyd. Excavator, 4.5 C.Y.		3450.00		3795.00	287.50	316.25
12 L.H., Daily Totals		$4119.20		$4792.40	$343.27	$399.37

Crew B-14B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$55.77	$83.12
.5 Laborer	44.40	177.60	66.25	265.00		
1 Hyd. Excavator, 6 C.Y.		3506.00		3856.60	292.17	321.38
12 L.H., Daily Totals		$4175.20		$4854.00	$347.93	$404.50

Crew B-14C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$55.77	$83.12
.5 Laborer	44.40	177.60	66.25	265.00		
1 Hyd. Excavator, 7 C.Y.		3475.00		3822.50	289.58	318.54
12 L.H., Daily Totals		$4144.20		$4819.90	$345.35	$401.66

Crew B-14F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$55.77	$83.12
.5 Laborer	44.40	177.60	66.25	265.00		
1 Hyd. Shovel, 7 C.Y.		4148.00		4562.80	345.67	380.23
12 L.H., Daily Totals		$4817.20		$5560.20	$401.43	$463.35

Crew B-14G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (crane)	$61.45	$491.60	$91.55	$732.40	$55.77	$83.12
.5 Laborer	44.40	177.60	66.25	265.00		
1 Hyd. Shovel, 12 C.Y.		6022.00		6624.20	501.83	552.02
12 L.H., Daily Totals		$6691.20		$7621.60	$557.60	$635.13

Crew B-14J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, 8 C.Y.		2285.00		2513.50	190.42	209.46
12 L.H., Daily Totals		$2934.60		$3481.70	$244.55	$290.14

Crew B-14K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.13	$80.68
.5 Laborer	44.40	177.60	66.25	265.00		
1 F.E. Loader, 10 C.Y.		2706.00		2976.60	225.50	248.05
12 L.H., Daily Totals		$3355.60		$3944.80	$279.63	$328.73

Crew B-15	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Oper. (med.)	$59.00	$472.00	$87.90	$703.20	$52.51	$78.41
.5 Laborer	44.40	177.60	66.25	265.00		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
2 Dump Trucks, 12 C.Y., 400 H.P.		1158.70		1274.57		
1 Dozer, 200 H.P.		1520.00		1672.00	95.67	105.23
28 L.H., Daily Totals		$4149.10		$5141.97	$148.18	$183.64

Crew B-16	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.63	$69.61
2 Laborers	44.40	710.40	66.25	1060.00		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	18.10	19.92
32 L.H., Daily Totals		$2071.35		$2864.89	$64.73	$89.53

Crew B-17	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.90	$72.97
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Backhoe Loader, 48 H.P.		216.20		237.82		
1 Dump Truck, 8 C.Y., 220 H.P.		407.60		448.36	19.49	21.44
32 L.H., Daily Totals		$2188.60		$3021.38	$68.39	$94.42

Crew B-17A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$47.54	$71.08
6 Laborers	44.40	2131.20	66.25	3180.00		
1 Skilled Worker Foreman (out)	59.10	472.80	88.90	711.20		
1 Skilled Worker	57.10	456.80	85.90	687.20		
80 L.H., Daily Totals		$3803.20		$5686.40	$47.54	$71.08

Crews - Standard

Crew B-17B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.90	$72.97
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Backhoe Loader, 48 H.P.		216.20		237.82		
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	24.86	27.35
32 L.H., Daily Totals		$2360.35		$3210.30	$73.76	$100.32

Crew B-18	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Laborers	44.40	710.40	66.25	1060.00		
1 Vibrating Plate, Gas, 21″		165.60		182.16	6.90	7.59
24 L.H., Daily Totals		$1247.20		$1796.16	$51.97	$74.84

Crew B-19	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$57.11	$87.06
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Lead, 90′ High		371.85		409.04		
1 Hammer, Diesel, 22k ft-lb		441.70		485.87	31.95	35.14
64 L.H., Daily Totals		$5699.75		$7820.60	$89.06	$122.20

Crew B-19A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$57.11	$87.06
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 75 Ton		1967.00		2163.70		
1 Lead, 90′ High		371.85		409.04		
1 Hammer, Diesel, 41k ft-lb		583.55		641.90	45.66	50.23
64 L.H., Daily Totals		$6577.60		$8786.24	$102.78	$137.29

Crew B-19B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$57.11	$87.06
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Lead, 90′ High		371.85		409.04		
1 Hammer, Diesel, 22k ft-lb		441.70		485.87		
1 Barge, 400 Ton		869.15		956.07	45.53	50.08
64 L.H., Daily Totals		$6568.90		$8776.67	$102.64	$137.14

Crew B-19C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$57.11	$87.06
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 75 Ton		1967.00		2163.70		
1 Lead, 90′ High		371.85		409.04		
1 Hammer, Diesel, 41k ft-lb		583.55		641.90		
1 Barge, 400 Ton		869.15		956.07	59.24	65.17
64 L.H., Daily Totals		$7446.75		$9742.31	$116.36	$152.22

Crew B-20	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.30	$73.80
1 Skilled Worker	57.10	456.80	85.90	687.20		
1 Laborer	44.40	355.20	66.25	530.00		
24 L.H., Daily Totals		$1183.20		$1771.20	$49.30	$73.80

Crew B-20A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.16	$79.34
1 Laborer	44.40	355.20	66.25	530.00		
1 Plumber	67.70	541.60	101.05	808.40		
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
32 L.H., Daily Totals		$1701.20		$2538.80	$53.16	$79.34

Crew B-21	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.04	$76.34
1 Skilled Worker	57.10	456.80	85.90	687.20		
1 Laborer	44.40	355.20	66.25	530.00		
.5 Equip. Oper. (crane)	61.45	245.80	91.55	366.20		
.5 S.P. Crane, 4x4, 5 Ton		190.97		210.07	6.82	7.50
28 L.H., Daily Totals		$1619.97		$2347.47	$57.86	$83.84

Crew B-21A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$54.82	$81.78
1 Laborer	44.40	355.20	66.25	530.00		
1 Plumber	67.70	541.60	101.05	808.40		
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 12 Ton		432.65		475.92	10.82	11.90
40 L.H., Daily Totals		$2625.45		$3747.11	$65.64	$93.68

Crew B-21B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.21	$71.91
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	11.90	13.08
40 L.H., Daily Totals		$2404.20		$3399.78	$60.10	$84.99

Crew B-21C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.28	$72.01
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
2 Cutting Torches		25.90		28.49		
2 Sets of Gases		347.20		381.92		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30	37.25	40.98
56 L.H., Daily Totals		$4789.70		$6327.11	$85.53	$112.98

Crew B-22	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.73	$77.35
1 Skilled Worker	57.10	456.80	85.90	687.20		
1 Laborer	44.40	355.20	66.25	530.00		
.75 Equip. Oper. (crane)	61.45	368.70	91.55	549.30		
.75 S.P. Crane, 4x4, 5 Ton		286.46		315.11	9.55	10.50
30 L.H., Daily Totals		$1838.36		$2635.61	$61.28	$87.85

Crew B-22A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.75	$75.84
1 Skilled Worker	57.10	456.80	85.90	687.20		
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equipment Operator, Crane	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 5 Ton		381.95		420.14		
1 Butt Fusion Mach., 4″-12″ diam.		420.75		462.82	20.07	22.07
40 L.H., Daily Totals		$2832.70		$3916.57	$70.82	$97.91

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-22B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.75	$75.84
1 Skilled Worker	57.10	456.80	85.90	687.20		
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 5 Ton		381.95		420.14		
1 Butt Fusion Mach., 8″-24″ diam.		1086.00		1194.60	36.70	40.37
40 L.H., Daily Totals		$3497.95		$4648.35	$87.45	$116.21
Crew B-22C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Skilled Worker	$57.10	$456.80	$85.90	$687.20	$50.75	$76.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Butt Fusion Mach., 2″-8″ diam.		134.95		148.44	8.43	9.28
16 L.H., Daily Totals		$946.95		$1365.65	$59.18	$85.35
Crew B-23	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.80	$66.85
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Drill Rig, Truck-Mounted		768.40		845.24		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	40.46	44.51
40 L.H., Daily Totals		$3410.45		$4454.30	$85.26	$111.36
Crew B-23A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.93	$74.47
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Drill Rig, Truck-Mounted		768.40		845.24		
1 Pickup Truck, 3/4 Ton		112.20		123.42	36.69	40.36
24 L.H., Daily Totals		$2079.00		$2755.86	$86.63	$114.83
Crew B-23B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.93	$74.47
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Drill Rig, Truck-Mounted		768.40		845.24		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
1 Centr. Water Pump, 6″		235.25		258.77	46.49	51.14
24 L.H., Daily Totals		$2314.25		$3014.64	$96.43	$125.61
Crew B-24	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$50.30	$74.60
1 Laborer	44.40	355.20	66.25	530.00		
1 Carpenter	54.70	437.60	81.65	653.20		
24 L.H., Daily Totals		$1207.20		$1790.40	$50.30	$74.60
Crew B-25	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.56	$72.43
7 Laborers	44.40	2486.40	66.25	3710.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Asphalt Paver, 130 H.P.		2143.00		2357.30		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	31.13	34.25
88 L.H., Daily Totals		$7013.30		$9387.27	$79.70	$106.67
Crew B-25B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.43	$73.72
7 Laborers	44.40	2486.40	66.25	3710.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Asphalt Paver, 130 H.P.		2143.00		2357.30		
2 Tandem Rollers, 10 Ton		493.60		542.96		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	31.11	34.22
96 L.H., Daily Totals		$7732.10		$10361.95	$80.54	$107.94

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-25C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.60	$73.97
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Asphalt Paver, 130 H.P.		2143.00		2357.30		
1 Tandem Roller, 10 Ton		246.80		271.48	49.79	54.77
48 L.H., Daily Totals		$4770.60		$6179.18	$99.39	$128.73
Crew B-25D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.82	$74.30
3 Laborers	44.40	1065.60	66.25	1590.00		
2.125 Equip. Oper. (medium)	59.00	1003.00	87.90	1494.30		
.125 Truck Driver (heavy)	51.30	51.30	76.70	76.70		
.125 Truck Tractor, 6x4, 380 H.P.		62.39		68.63		
.125 Dist. Tanker, 3000 Gallon		41.76		45.94		
1 Asphalt Paver, 130 H.P.		2143.00		2357.30		
1 Tandem Roller, 10 Ton		246.80		271.48	49.88	54.87
50 L.H., Daily Totals		$4985.06		$6458.35	$99.70	$129.17
Crew B-25E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.03	$74.61
3 Laborers	44.40	1065.60	66.25	1590.00		
2.250 Equip. Oper. (medium)	59.00	1062.00	87.90	1582.20		
.25 Truck Driver (heavy)	51.30	102.60	76.70	153.40		
.25 Truck Tractor, 6x4, 380 H.P.		124.79		137.27		
.25 Dist. Tanker, 3000 Gallon		83.53		91.88		
1 Asphalt Paver, 130 H.P.		2143.00		2357.30		
1 Tandem Roller, 10 Ton		246.80		271.48	49.96	54.96
52 L.H., Daily Totals		$5199.51		$6737.52	$99.99	$129.57
Crew B-26	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.23	$73.32
6 Laborers	44.40	2131.20	66.25	3180.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Paving Mach. & Equip.		2503.00		2753.30	40.64	44.70
88 L.H., Daily Totals		$7908.00		$10385.60	$89.86	$118.02
Crew B-26A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.23	$73.32
6 Laborers	44.40	2131.20	66.25	3180.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Paving Mach. & Equip.		2503.00		2753.30		
1 Concrete Saw		112.85		124.14	41.92	46.11
88 L.H., Daily Totals		$8020.85		$10509.74	$91.15	$119.43
Crew B-26B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.04	$74.53
6 Laborers	44.40	2131.20	66.25	3180.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Paving Mach. & Equip.		2503.00		2753.30		
1 Concrete Pump, 110′ Boom		493.65		543.01	42.39	46.63
96 L.H., Daily Totals		$8873.65		$11631.82	$92.43	$121.16

Crew B-26C	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.25	$71.86
6 Laborers	44.40	2131.20	66.25	3180.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Paving Mach. & Equip.		2503.00		2753.30		
1 Concrete Saw		112.85		124.14	32.70	35.97
80 L.H., Daily Totals		$6475.85		$8626.24	$80.95	$107.83

Crew B-27	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.90	$67.00
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Berm Machine		253.55		278.90	7.92	8.72
32 L.H., Daily Totals		$1690.35		$2422.91	$52.82	$75.72

Crew B-28	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$51.27	$76.52
1 Laborer	44.40	355.20	66.25	530.00		
24 L.H., Daily Totals		$1230.40		$1836.40	$51.27	$76.52

Crew B-29	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.28	$72.01
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Gradall, 5/8 C.Y.		850.65		935.72	15.19	16.71
56 L.H., Daily Totals		$3554.25		$4968.11	$63.47	$88.72

Crew B-30	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$53.87	$80.43
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Hyd. Excavator, 1.5 C.Y.		695.80		765.38		
2 Dump Trucks, 12 C.Y., 400 H.P.		1158.70		1274.57	77.27	85.00
24 L.H., Daily Totals		$3147.30		$3970.35	$131.14	$165.43

Crew B-31	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.86	$69.93
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Carpenter	54.70	437.60	81.65	653.20		
1 Air Compressor, 250 cfm		202.85		223.13		
1 Sheeting Driver		7.45		8.20		
2 -50' Air Hoses, 1.5"		45.60		50.16	6.40	7.04
40 L.H., Daily Totals		$2130.30		$3078.69	$53.26	$76.97

Crew B-32	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$55.35	$82.49
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Dozer, 200 H.P.		1520.00		1672.00	88.74	97.62
32 L.H., Daily Totals		$4611.00		$5763.38	$144.09	$180.11

Crew B-32A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$54.13	$80.68
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Roller, Vibratory, 25 Ton		672.35		739.59	72.72	80.00
24 L.H., Daily Totals		$3044.55		$3856.28	$126.86	$160.68

Crew B-32B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$54.13	$80.68
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Roller, Vibratory, 25 Ton		672.35		739.59	91.35	100.48
24 L.H., Daily Totals		$3491.55		$4347.98	$145.48	$181.17

Crew B-32C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.03	$77.58
2 Laborers	44.40	710.40	66.25	1060.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Dozer, 200 H.P.		1520.00		1672.00	59.16	65.08
48 L.H., Daily Totals		$5337.40		$6847.38	$111.20	$142.65

Crew B-33A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 Scraper, Towed, 7 C.Y.		129.30		142.23		
1.25 Dozers, 300 H.P.		2231.25		2454.38	168.61	185.47
14 L.H., Daily Totals		$3128.15		$3740.61	$223.44	$267.19

Crew B-33B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 Scraper, Towed, 10 C.Y.		161.65		177.82		
1.25 Dozers, 300 H.P.		2231.25		2454.38	170.92	188.01
14 L.H., Daily Totals		$3160.50		$3776.19	$225.75	$269.73

Crew B-33C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 Scraper, Towed, 15 C.Y.		178.85		196.74		
1.25 Dozers, 300 H.P.		2231.25		2454.38	172.15	189.37
14 L.H., Daily Totals		$3177.70		$3795.11	$226.98	$271.08

Crew B-33D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 S.P. Scraper, 14 C.Y.		2424.00		2666.40		
.25 Dozer, 300 H.P.		446.25		490.88	205.02	225.52
14 L.H., Daily Totals		$3637.85		$4301.27	$259.85	$307.23

Crew B-33E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 S.P. Scraper, 21 C.Y.		2656.00		2921.60		
.25 Dozer, 300 H.P.		446.25		490.88	221.59	243.75
14 L.H., Daily Totals		$3869.85		$4556.48	$276.42	$325.46

Crews - Standard

Crew B-33F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 Elev. Scraper, 11 C.Y.		1059.00		1164.90		
.25 Dozer, 300 H.P.		446.25		490.88	107.52	118.27
14 L.H., Daily Totals		$2272.85		$2799.78	$162.35	$199.98

Crew B-33G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.5 Laborer	44.40	177.60	66.25	265.00		
.25 Equip. Oper. (medium)	59.00	118.00	87.90	175.80		
1 Elev. Scraper, 22 C.Y.		1895.00		2084.50		
.25 Dozer, 300 H.P.		446.25		490.88	167.23	183.96
14 L.H., Daily Totals		$3108.85		$3719.38	$222.06	$265.67

Crew B-33H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.5 Laborer	$44.40	$177.60	$66.25	$265.00	$54.83	$81.71
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
.25 Equipment Operator (med.)	59.00	118.00	87.90	175.80		
1 S.P. Scraper, 44 C.Y.		4695.00		5164.50		
.25 Dozer, 410 H.P.		701.75		771.92	385.48	424.03
14 L.H., Daily Totals		$6164.35		$7080.43	$440.31	$505.74

Crew B-33J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 S.P. Scraper, 14 C.Y.		2424.00		2666.40	303.00	333.30
8 L.H., Daily Totals		$2896.00		$3369.60	$362.00	$421.20

Crew B-33K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equipment Operator (med.)	$59.00	$472.00	$87.90	$703.20	$54.83	$81.71
.25 Equipment Operator (med.)	59.00	118.00	87.90	175.80		
.5 Laborer	44.40	177.60	66.25	265.00		
1 S.P. Scraper, 31 C.Y.		3707.00		4077.70		
.25 Dozer, 410 H.P.		701.75		771.92	314.91	346.40
14 L.H., Daily Totals		$5176.35		$5993.63	$369.74	$428.12

Crew B-34A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, 8 C.Y., 220 H.P.		407.60		448.36	50.95	56.05
8 L.H., Daily Totals		$818.00		$1061.96	$102.25	$132.75

Crew B-34B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, 12 C.Y., 400 H.P.		579.35		637.28	72.42	79.66
8 L.H., Daily Totals		$989.75		$1250.89	$123.72	$156.36

Crew B-34C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Dump Trailer, 16.5 C.Y.		138.35		152.19	79.69	87.66
8 L.H., Daily Totals		$1047.90		$1314.85	$130.99	$164.36

Crew B-34D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Dump Trailer, 20 C.Y.		153.55		168.91	81.59	89.75
8 L.H., Daily Totals		$1063.10		$1331.57	$132.89	$166.45

Crew B-34E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, Off Hwy., 25 Ton		1427.00		1569.70	178.38	196.21
8 L.H., Daily Totals		$1837.40		$2183.30	$229.68	$272.91

Crew B-34F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, Off Hwy., 35 Ton		945.65		1040.21	118.21	130.03
8 L.H., Daily Totals		$1356.05		$1653.82	$169.51	$206.73

Crew B-34G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, Off Hwy., 50 Ton		1979.00		2176.90	247.38	272.11
8 L.H., Daily Totals		$2389.40		$2790.50	$298.68	$348.81

Crew B-34H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, Off Hwy., 65 Ton		1938.00		2131.80	242.25	266.48
8 L.H., Daily Totals		$2348.40		$2745.40	$293.55	$343.18

Crew B-34I	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, 18 C.Y., 450 H.P.		753.60		828.96	94.20	103.62
8 L.H., Daily Totals		$1164.00		$1442.56	$145.50	$180.32

Crew B-34J	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Dump Truck, Off Hwy., 100 Ton		2769.00		3045.90	346.13	380.74
8 L.H., Daily Totals		$3179.40		$3659.50	$397.43	$457.44

Crew B-34K	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Truck Tractor, 6x4, 450 H.P.		608.95		669.85		
1 Lowbed Trailer, 75 Ton		258.10		283.91	108.38	119.22
8 L.H., Daily Totals		$1277.45		$1567.36	$159.68	$195.92

Crew B-34L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	24.81	27.29
8 L.H., Daily Totals		$642.50		$879.95	$80.31	$109.99

Crew B-34M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	106.26	116.88
8 L.H., Daily Totals		$1294.05		$1596.66	$161.76	$199.58

Crew B-34N	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$55.15	$82.30
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Flatbed Trailer, 40 Ton		188.45		207.29	42.98	47.27
16 L.H., Daily Totals		$1570.00		$2073.16	$98.13	$129.57

Crew B-34P	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pipe Fitter	$68.35	$546.80	$102.00	$816.00	$58.72	$87.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Backhoe Loader, 48 H.P.		216.20		237.82	44.43	48.87
24 L.H., Daily Totals		$2475.45		$3276.07	$103.14	$136.50

Crew B-34Q	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Bare Costs	Incl. O&P
1 Pipe Fitter	$68.35	$546.80	$102.00	$816.00	$59.53	$88.85
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Flatbed Trailer, 25 Ton		137.20		150.92		
1 Dump Truck, 8 C.Y., 220 H.P.		407.60		448.36		
1 Hyd. Crane, 25 Ton		586.70		645.37	47.15	51.86
24 L.H., Daily Totals		$2560.30		$3377.05	$106.68	$140.71

Crew B-34R	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pipe Fitter	$68.35	$546.80	$102.00	$816.00	$59.53	$88.85
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Flatbed Trailer, 25 Ton		137.20		150.92		
1 Dump Truck, 8 C.Y., 220 H.P.		407.60		448.36		
1 Hyd. Crane, 25 Ton		586.70		645.37		
1 Hyd. Excavator, 1 C.Y.		832.65		915.91	81.84	90.02
24 L.H., Daily Totals		$3392.95		$4292.97	$141.37	$178.87

Crew B-34S	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Pipe Fitters	$68.35	$1093.60	$102.00	$1632.00	$62.36	$93.06
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Flatbed Trailer, 40 Ton		188.45		207.29		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Hyd. Crane, 80 Ton		1458.00		1603.80		
1 Hyd. Excavator, 2 C.Y.		942.70		1036.97	96.51	106.16
32 L.H., Daily Totals		$5083.90		$6375.13	$158.87	$199.22

Crew B-34T	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Pipe Fitters	$68.35	$1093.60	$102.00	$1632.00	$62.36	$93.06
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Flatbed Trailer, 40 Ton		188.45		207.29		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Hyd. Crane, 80 Ton		1458.00		1603.80	67.05	73.75
32 L.H., Daily Totals		$4141.20		$5338.16	$129.41	$166.82

Crew B-34U	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$53.40	$79.70
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Truck Tractor, 220 H.P.		310.80		341.88		
1 Flatbed Trailer, 25 Ton		137.20		150.92	28.00	30.80
16 L.H., Daily Totals		$1302.40		$1768.00	$81.40	$110.50

Crew B-34V	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$56.08	$83.65
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Truck Tractor, 6x4, 450 H.P.		608.95		669.85		
1 Equipment Trailer, 50 Ton		207.25		227.97		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43	41.37	45.51
24 L.H., Daily Totals		$2338.95		$3099.84	$97.46	$129.16

Crew B-34W	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
5 Truck Drivers (heavy)	$51.30	$2052.00	$76.70	$3068.00	$53.92	$80.50
2 Equip. Opers. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (mechanic)	61.50	492.00	91.65	733.20		
1 Laborer	44.40	355.20	66.25	530.00		
4 Truck Tractors, 6x4, 380 H.P.		1996.60		2196.26		
2 Equipment Trailers, 50 Ton		414.50		455.95		
2 Flatbed Trailers, 40 Ton		376.90		414.59		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 S.P. Crane, 4x4, 20 Ton		574.35		631.78	49.15	54.07
72 L.H., Daily Totals		$7421.50		$9689.01	$103.08	$134.57

Crew B-35	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$56.75	$84.76
1 Skilled Worker	57.10	456.80	85.90	687.20		
2 Welders	67.70	1083.20	101.05	1616.80		
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
2 Welder, Electric, 300 amp		215.10		236.61		
1 Hyd. Excavator, .75 C.Y.		701.80		771.98	16.37	18.01
56 L.H., Daily Totals		$4094.90		$5754.99	$73.12	$102.77

Crew B-35A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.42	$79.79
2 Laborers	44.40	710.40	66.25	1060.00		
1 Skilled Worker	57.10	456.80	85.90	687.20		
1 Welder (plumber)	67.70	541.60	101.05	808.40		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Welder, Gas Engine, 300 amp		148.75		163.63		
1 Crawler Crane, 75 Ton		1967.00		2163.70	37.78	41.56
56 L.H., Daily Totals		$5107.35		$6795.32	$91.20	$121.35

Crew B-36	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.64	$75.51
2 Laborers	44.40	710.40	66.25	1060.00		
2 Equip. Oper. (medium)	59.00	944.00	87.90	1406.40		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Aggregate Spreader		59.95		65.94		
1 Tandem Roller, 10 Ton		246.80		271.48	45.67	50.24
40 L.H., Daily Totals		$3852.35		$5029.82	$96.31	$125.75

Crew B-36A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.03	$79.05
2 Laborers	44.40	710.40	66.25	1060.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Aggregate Spreader		59.95		65.94		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	38.87	42.76
56 L.H., Daily Totals		$5146.25		$6821.11	$91.90	$121.81

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-36B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.81	$78.76
2 Laborers	44.40	710.40	66.25	1060.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 F.E. Loader, Crl, 1.5 C.Y.		668.35		735.18		
1 Dozer, 300 H.P.		1785.00		1963.50		
1 Roller, Vibratory, 25 Ton		672.35		739.59		
1 Truck Tractor, 6x4, 450 H.P.		608.95		669.85		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51	77.53	85.28
64 L.H., Daily Totals		$8341.75		$10498.33	$130.34	$164.04
Crew B-36C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$54.94	$81.93
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Dozer, 300 H.P.		1785.00		1963.50		
1 Roller, Vibratory, 25 Ton		672.35		739.59		
1 Truck Tractor, 6x4, 450 H.P.		608.95		669.85		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51	107.33	118.07
40 L.H., Daily Totals		$6491.00		$7999.94	$162.28	$200.00
Crew B-36D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$55.85	$83.24
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Dozer, 300 H.P.		1785.00		1963.50		
1 Roller, Vibratory, 25 Ton		672.35		739.59	110.32	121.36
32 L.H., Daily Totals		$5317.55		$6546.98	$166.17	$204.59
Crew B-37	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Tandem Roller, 5 Ton		258.75		284.63	5.39	5.93
48 L.H., Daily Totals		$2494.75		$3620.22	$51.97	$75.42
Crew B-37A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.87	$68.50
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Tar Kettle, T.M.		156.70		172.37	14.80	16.28
24 L.H., Daily Totals		$1456.00		$2034.72	$60.67	$84.78
Crew B-37B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$45.50	$67.94
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Tar Kettle, T.M.		156.70		172.37	11.10	12.21
32 L.H., Daily Totals		$1811.20		$2564.72	$56.60	$80.15
Crew B-37C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$46.60	$69.63
2 Truck Drivers (light)	48.80	780.80	73.00	1168.00		
2 Flatbed Trucks, Gas, 1.5 Ton		397.00		436.70		
1 Tar Kettle, T.M.		156.70		172.37	17.30	19.03
32 L.H., Daily Totals		$2044.90		$2837.07	$63.90	$88.66

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-37D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$46.60	$69.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Pickup Truck, 3/4 Ton		112.20		123.42	7.01	7.71
16 L.H., Daily Totals		$857.80		$1237.42	$53.61	$77.34
Crew B-37E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$49.33	$73.62
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Truck Drivers (light)	48.80	780.80	73.00	1168.00		
4 Barrels w/ Flasher		16.60		18.26		
1 Concrete Saw		112.85		124.14		
1 Rotary Hammer Drill		52.25		57.48		
1 Hammer Drill Bit		25.25		27.77		
1 Loader, Skid Steer, 30 H.P.		179.50		197.45		
1 Conc. Hammer Attach.		118.50		130.35		
1 Vibrating Plate, Gas, 18″		31.90		35.09		
2 Flatbed Trucks, Gas, 1.5 Ton		397.00		436.70	16.68	18.34
56 L.H., Daily Totals		$3696.25		$5150.03	$66.00	$91.96
Crew B-37F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$45.50	$67.94
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
4 Barrels w/ Flasher		16.60		18.26		
1 Concrete Mixer, 10 C.F.		147.15		161.87		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50′ Air Hose, 3/4″		7.15		7.87		
1 Spade (Chipper)		8.55		9.40		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	16.62	18.28
32 L.H., Daily Totals		$1987.80		$2758.98	$62.12	$86.22
Crew B-37G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Berm Machine		253.55		278.90		
1 Tandem Roller, 5 Ton		258.75		284.63	10.67	11.74
48 L.H., Daily Totals		$2748.30		$3899.13	$57.26	$81.23
Crew B-37H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Tandem Roller, 5 Ton		258.75		284.63		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Tar Kettle, T.M.		156.70		172.37	12.79	14.07
48 L.H., Daily Totals		$2849.95		$4010.95	$59.37	$83.56

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-37I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$49.33	$73.62
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Truck Drivers (light)	48.80	780.80	73.00	1168.00		
4 Barrels w/ Flasher		16.60		18.26		
1 Concrete Saw		112.85		124.14		
1 Rotary Hammer Drill		52.25		57.48		
1 Hammer Drill Bit		25.25		27.77		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50′ Air Hose, 3/4″		7.15		7.87		
1 Spade (Chipper)		8.55		9.40		
1 Loader, Skid Steer, 30 H.P.		179.50		197.45		
1 Conc. Hammer Attach.		118.50		130.35		
1 Concrete Mixer, 10 C.F.		147.15		161.87		
1 Vibrating Plate, Gas, 18″		31.90		35.09		
2 Flatbed Trucks, Gas, 1.5 Ton		397.00		436.70	22.33	24.56
56 L.H., Daily Totals		$4012.95		$5498.40	$71.66	$98.19
Crew B-37J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50′ Air Hose, 3/4″		7.15		7.87		
2 Concrete Mixers, 10 C.F.		294.30		323.73		
2 Flatbed Trucks, Gas, 1.5 Ton		397.00		436.70		
1 Shot Blaster, 20″		208.70		229.57	22.10	24.31
48 L.H., Daily Totals		$3297.00		$4502.70	$68.69	$93.81
Crew B-37K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50′ Air Hose, 3/4″		7.15		7.87		
2 Flatbed Trucks, Gas, 1.5 Ton		397.00		436.70		
1 Shot Blaster, 20″		208.70		229.57	15.97	17.57
48 L.H., Daily Totals		$3002.70		$4178.97	$62.56	$87.06
Crew B-38	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.94	$74.47
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Backhoe Loader, 48 H.P.		216.20		237.82		
1 Hyd. Hammer (1200 lb.)		177.25		194.97		
1 F.E. Loader, W.M., 4 C.Y.		759.00		834.90		
1 Pvmt. Rem. Bucket		63.80		70.18	30.41	33.45
40 L.H., Daily Totals		$3213.85		$4316.68	$80.35	$107.92
Crew B-39	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.58	$69.49
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 250 cfm		202.85		223.13		
2 Breakers, Pavement, 60 lb.		107.20		117.92		
2 -50′ Air Hoses, 1.5″		45.60		50.16	7.41	8.15
48 L.H., Daily Totals		$2591.65		$3726.82	$53.99	$77.64

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-40	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$57.11	$87.06
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Vibratory Hammer & Gen.		2298.00		2527.80	55.14	60.65
64 L.H., Daily Totals		$7184.20		$9453.50	$112.25	$147.71
Crew B-40B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.92	$72.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 40 Ton		2127.00		2339.70	44.31	48.74
48 L.H., Daily Totals		$4475.40		$5842.10	$93.24	$121.71
Crew B-41	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.91	$68.49
4 Laborers	44.40	1420.80	66.25	2120.00		
.25 Equip. Oper. (crane)	61.45	122.90	91.55	183.10		
.25 Equip. Oper. (oiler)	52.50	105.00	78.25	156.50		
.25 Crawler Crane, 40 Ton		307.75		338.52	6.99	7.69
44 L.H., Daily Totals		$2327.65		$3352.13	$52.90	$76.18
Crew B-42	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.78	$74.67
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Welder	60.30	482.40	93.30	746.40		
1 Hyd. Crane, 25 Ton		586.70		645.37		
1 Welder, Gas Engine, 300 amp		148.75		163.63		
1 Horz. Boring Csg. Mch.		329.75		362.73	16.64	18.31
64 L.H., Daily Totals		$4251.20		$5950.52	$66.43	$92.98
Crew B-43	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.92	$72.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Drill Rig, Truck-Mounted		768.40		845.24	16.01	17.61
48 L.H., Daily Totals		$3116.80		$4347.64	$64.93	$90.58
Crew B-44	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$56.10	$85.56
4 Pile Drivers	55.90	1788.80	86.40	2764.80		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Laborer	44.40	355.20	66.25	530.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Lead, 60′ High		211.80		232.98		
1 Hammer, Diesel, 15K ft.-lbs.		624.45		686.89	32.30	35.53
64 L.H., Daily Totals		$5657.65		$7749.57	$88.40	$121.09
Crew B-45	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$55.15	$82.30
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Dist. Tanker, 3000 Gallon		334.10		367.51		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07	52.08	57.29
16 L.H., Daily Totals		$1715.65		$2233.38	$107.23	$139.59

Crews - Standard

Crew B-46	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Pile Driver Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$50.48	$76.84
2 Pile Drivers	55.90	894.40	86.40	1382.40		
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Chain Saw, Gas, 36" Long		41.65		45.81	.87	.95
48 L.H., Daily Totals		$2464.85		$3734.22	$51.35	$77.80

Crew B-47	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Blast Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.77	$72.73
1 Driller	44.40	355.20	66.25	530.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Track Drill, 4"		1127.00		1239.70		
1 Air Compressor, 600 cfm		426.55		469.20		
2 -50' Air Hoses, 3"		76.70		84.37	67.93	74.72
24 L.H., Daily Totals		$2800.65		$3538.88	$116.69	$147.45

Crew B-47A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Drilling Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.45	$79.68
1 Equip. Oper. (heavy)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Air Track Drill, 5"		1127.00		1239.70	46.96	51.65
24 L.H., Daily Totals		$2409.80		$3152.10	$100.41	$131.34

Crew B-47C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.95	$74.47
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 750 cfm		596.30		655.93		
2 -50' Air Hoses, 3"		76.70		84.37		
1 Air Track Drill, 4"		1127.00		1239.70	112.50	123.75
16 L.H., Daily Totals		$2599.20		$3171.60	$162.45	$198.22

Crew B-47E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.90	$67.00
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	26.56	29.22
32 L.H., Daily Totals		$2286.85		$3079.05	$71.46	$96.22

Crew B-47G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.67	$71.11
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Track Drill, 4"		1127.00		1239.70		
1 Air Compressor, 600 cfm		426.55		469.20		
2 -50' Air Hoses, 3"		76.70		84.37		
1 Gunite Pump Rig		321.75		353.93	61.00	67.10
32 L.H., Daily Totals		$3477.60		$4422.80	$108.68	$138.21

Crew B-47H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Skilled Worker Foreman (out)	$59.10	$472.80	$88.90	$711.20	$57.60	$86.65
3 Skilled Workers	57.10	1370.40	85.90	2061.60		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	26.56	29.22
32 L.H., Daily Totals		$2693.25		$3707.86	$84.16	$115.87

Crew B-48	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.86	$74.36
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Centr. Water Pump, 6"		235.25		258.77		
1 -20' Suction Hose, 6"		25.50		28.05		
1 -50' Discharge Hose, 6"		18.10		19.91		
1 Drill Rig, Truck-Mounted		768.40		845.24	18.70	20.57
56 L.H., Daily Totals		$3839.65		$5315.98	$68.57	$94.93

Crew B-49	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.25	$78.46
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
2 Equip. Oper. (oilers)	52.50	840.00	78.25	1252.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
2 Pile Drivers	55.90	894.40	86.40	1382.40		
1 Hyd. Crane, 25 Ton		586.70		645.37		
1 Centr. Water Pump, 6"		235.25		258.77		
1 -20' Suction Hose, 6"		25.50		28.05		
1 -50' Discharge Hose, 6"		18.10		19.91		
1 Drill Rig, Truck-Mounted		768.40		845.24	18.57	20.42
88 L.H., Daily Totals		$6232.35		$8702.15	$70.82	$98.89

Crew B-50	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Pile Driver Foremen (outside)	$57.90	$926.40	$89.50	$1432.00	$54.27	$82.68
6 Pile Drivers	55.90	2683.20	86.40	4147.20		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Lead, 60' High		211.80		232.98		
1 Hammer, Diesel, 15K ft.-lbs.		624.45		686.89		
1 Air Compressor, 600 cfm		426.55		469.20		
2 -50' Air Hoses, 3"		76.70		84.37		
1 Chain Saw, Gas, 36" Long		41.65		45.81	23.32	25.66
112 L.H., Daily Totals		$8690.55		$12133.37	$77.59	$108.33

Crew B-51	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.47	$67.88
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	4.14	4.55
48 L.H., Daily Totals		$2380.90		$3476.35	$49.60	$72.42

Crew B-52	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$50.76	$75.55
1 Carpenter	54.70	437.60	81.65	653.20		
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
.5 Rodman (reinf.)	58.90	235.60	88.05	352.20		
.5 Equip. Oper. (medium)	59.00	236.00	87.90	351.60		
.5 Crawler Loader, 3 C.Y.		573.00		630.30	10.23	11.26
56 L.H., Daily Totals		$3415.80		$4861.30	$61.00	$86.81

Crew B-53	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Trencher, Chain, 12 H.P.		158.60		174.46	19.82	21.81
8 L.H., Daily Totals		$602.60		$836.06	$75.33	$104.51

Crews - Standard

Crew B-54	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Trencher, Chain, 40 H.P.		450.70		495.77	56.34	61.97
8 L.H., Daily Totals		$894.70		$1157.37	$111.84	$144.67

Crew B-54A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.17 Labor Foreman (outside)	$46.40	$63.10	$69.25	$94.18	$57.17	$85.19
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Wheel Trencher, 67 H.P.		1140.00		1254.00	121.79	133.97
9.36 L.H., Daily Totals		$1675.10		$2051.38	$178.96	$219.16

Crew B-54B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.25 Labor Foreman (outside)	$46.40	$92.80	$69.25	$138.50	$56.48	$84.17
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Wheel Trencher, 150 H.P.		1238.00		1361.80	123.80	136.18
10 L.H., Daily Totals		$1802.80		$2203.50	$180.28	$220.35

Crew B-54C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.70	$77.08
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Wheel Trencher, 67 H.P.		1140.00		1254.00	71.25	78.38
16 L.H., Daily Totals		$1967.20		$2487.20	$122.95	$155.45

Crew B-54D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.70	$77.08
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Rock Trencher, 6″ Width		434.20		477.62	27.14	29.85
16 L.H., Daily Totals		$1261.40		$1710.82	$78.84	$106.93

Crew B-54E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.70	$77.08
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Rock Trencher, 18″ Width		1015.00		1116.50	63.44	69.78
16 L.H., Daily Totals		$1842.20		$2349.70	$115.14	$146.86

Crew B-55	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.87	$68.50
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Truck-Mounted Earth Auger		394.15		433.57		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	51.84	57.03
24 L.H., Daily Totals		$2345.00		$3012.62	$97.71	$125.53

Crew B-56	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.95	$74.47
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Track Drill, 4″		1127.00		1239.70		
1 Air Compressor, 600 cfm		426.55		469.20		
1 -50′ Air Hose, 3″		38.35		42.19	99.49	109.44
16 L.H., Daily Totals		$2391.10		$2942.69	$149.44	$183.92

Crew B-57	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.77	$75.71
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 25 Ton		1152.00		1267.20		
1 Clamshell Bucket, 1 C.Y.		69.25		76.17		
1 Centr. Water Pump, 6″		235.25		258.77		
1 -20′ Suction Hose, 6″		25.50		28.05		
20 -50′ Discharge Hoses, 6″		362.00		398.20	38.42	42.26
48 L.H., Daily Totals		$4281.20		$5662.40	$89.19	$117.97

Crew B-58	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.10	$71.73
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Backhoe Loader, 48 H.P.		216.20		237.82		
1 Small Helicopter, w/ Pilot		2101.00		2311.10	96.55	106.21
24 L.H., Daily Totals		$3471.60		$4270.52	$144.65	$177.94

Crew B-59	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Truck Driver (heavy)	$51.30	$410.40	$76.70	$613.60	$51.30	$76.70
1 Truck Tractor, 220 H.P.		310.80		341.88		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51	58.11	63.92
8 L.H., Daily Totals		$875.30		$1124.99	$109.41	$140.62

Crew B-59A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$46.70	$69.73
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51		
1 Truck Tractor, 220 H.P.		310.80		341.88	19.37	21.31
24 L.H., Daily Totals		$1585.70		$2184.99	$66.07	$91.04

Crew B-60	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.45	$76.71
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
2 Equip. Oper. (light)	55.50	888.00	82.70	1323.20		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 40 Ton		1231.00		1354.10		
1 Lead, 60′ High		211.80		232.98		
1 Hammer, Diesel, 15K ft.-lbs.		624.45		686.89		
1 Backhoe Loader, 48 H.P.		216.20		237.82	40.78	44.85
56 L.H., Daily Totals		$5164.65		$6807.40	$92.23	$121.56

Crew B-61	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.02	$70.14
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Cement Mixer, 2 C.Y.		112.35		123.58		
1 Air Compressor, 160 cfm		212.30		233.53	8.12	8.93
40 L.H., Daily Totals		$2205.45		$3162.72	$55.14	$79.07

Crew B-62	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.10	$71.73
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Loader, Skid Steer, 30 H.P.		179.50		197.45	7.48	8.23
24 L.H., Daily Totals		$1333.90		$1919.05	$55.58	$79.96

Crew B-62A	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$48.10	$71.73
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Loader, Skid Steer, 30 H.P.		179.50		197.45		
1 Trencher Attachment		66.25		72.88	10.24	11.26
24 L.H., Daily Totals		$1400.15		$1991.93	$58.34	$83.00

Crew B-63	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
4 Laborers	$44.40	$1420.80	$66.25	$2120.00	$46.62	$69.54
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Loader, Skid Steer, 30 H.P.		179.50		197.45	4.49	4.94
40 L.H., Daily Totals		$2044.30		$2979.05	$51.11	$74.48

Crew B-63B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (inside)	$44.90	$359.20	$67.00	$536.00	$47.30	$70.55
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	13.95	15.34
32 L.H., Daily Totals		$1959.90		$2748.53	$61.25	$85.89

Crew B-64	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$46.60	$69.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Power Mulcher (small)		201.00		221.10		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	24.97	27.47
16 L.H., Daily Totals		$1145.10		$1553.45	$71.57	$97.09

Crew B-65	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$46.60	$69.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Power Mulcher (Large)		345.35		379.88		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35	33.99	37.39
16 L.H., Daily Totals		$1289.45		$1712.23	$80.59	$107.01

Crew B-66	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Loader-Backhoe, 40 H.P.		267.55		294.31	33.44	36.79
8 L.H., Daily Totals		$711.55		$955.90	$88.94	$119.49

Crew B-67	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Millwright	$58.75	$470.00	$84.90	$679.20	$57.13	$83.80
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 R.T. Forklift, 5,000 Lb., diesel		272.85		300.13	17.05	18.76
16 L.H., Daily Totals		$1186.85		$1640.93	$74.18	$102.56

Crew B-67B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Millwright Foreman (inside)	$59.25	$474.00	$85.60	$684.80	$59.00	$85.25
1 Millwright	58.75	470.00	84.90	679.20		
16 L.H., Daily Totals		$944.00		$1364.00	$59.00	$85.25

Crew B-68	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Millwrights	$58.75	$940.00	$84.90	$1358.40	$57.67	$84.17
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 R.T. Forklift, 5,000 Lb., diesel		272.85		300.13	11.37	12.51
24 L.H., Daily Totals		$1656.85		$2320.14	$69.04	$96.67

Crew B-68A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Millwright Foreman (inside)	$59.25	$474.00	$85.60	$684.80	$58.92	$85.13
2 Millwrights	58.75	940.00	84.90	1358.40		
1 Forklift, Smooth Floor, 8,000 Lb.		283.25		311.57	11.80	12.98
24 L.H., Daily Totals		$1697.25		$2354.78	$70.72	$98.12

Crew B-68B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Millwright Foreman (inside)	$59.25	$474.00	$85.60	$684.80	$62.79	$92.40
2 Millwrights	58.75	940.00	84.90	1358.40		
2 Electricians	63.70	1019.20	94.65	1514.40		
2 Plumbers	67.70	1083.20	101.05	1616.80		
1 R.T. Forklift, 5,000 Lb., gas		283.30		311.63	5.06	5.56
56 L.H., Daily Totals		$3799.70		$5486.03	$67.85	$97.96

Crew B-68C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Millwright Foreman (inside)	$59.25	$474.00	$85.60	$684.80	$62.35	$91.55
1 Millwright	58.75	470.00	84.90	679.20		
1 Electrician	63.70	509.60	94.65	757.20		
1 Plumber	67.70	541.60	101.05	808.40		
1 R.T. Forklift, 5,000 Lb., gas		283.30		311.63	8.85	9.74
32 L.H., Daily Totals		$2278.50		$3241.23	$71.20	$101.29

Crew B-68D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (inside)	$44.90	$359.20	$67.00	$536.00	$48.27	$71.98
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 R.T. Forklift, 5,000 Lb., gas		283.30		311.63	11.80	12.98
24 L.H., Daily Totals		$1441.70		$2039.23	$60.07	$84.97

Crew B-68E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (inside)	$60.80	$486.40	$94.10	$752.80	$60.40	$93.46
3 Struc. Steel Workers	60.30	1447.20	93.30	2239.20		
1 Welder	60.30	482.40	93.30	746.40		
1 Forklift, Smooth Floor, 8,000 Lb.		283.25		311.57	7.08	7.79
40 L.H., Daily Totals		$2699.25		$4049.97	$67.48	$101.25

Crew B-68F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Skilled Worker Foreman (out)	$59.10	$472.80	$88.90	$711.20	$57.77	$86.90
2 Skilled Workers	57.10	913.60	85.90	1374.40		
1 R.T. Forklift, 5,000 Lb., gas		283.30		311.63	11.80	12.98
24 L.H., Daily Totals		$1669.70		$2397.23	$69.57	$99.88

Crew B-68G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Structural Steel Workers	$60.30	$964.80	$93.30	$1492.80	$60.30	$93.30
1 R.T. Forklift, 5,000 Lb., gas		283.30		311.63	17.71	19.48
16 L.H., Daily Totals		$1248.10		$1804.43	$78.01	$112.78

Crew B-69	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.92	$72.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 80 Ton		1458.00		1603.80	30.38	33.41
48 L.H., Daily Totals		$3806.40		$5106.20	$79.30	$106.38

Crew B-69A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.40	$71.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Concrete Finisher	51.80	414.40	75.90	607.20		
1 Curb/Gutter Paver, 2-Track		1231.00		1354.10	25.65	28.21
48 L.H., Daily Totals		$3554.20		$4808.50	$74.05	$100.18

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-69B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.40	$71.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Curb/Gutter Paver, 4-Track		801.05		881.15	16.69	18.36
48 L.H., Daily Totals		$3124.25		$4335.56	$65.09	$90.32

Crew B-70	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.94	$75.96
3 Laborers	44.40	1065.60	66.25	1590.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Ripper, Beam & 1 Shank		91.60		100.76		
1 Road Sweeper, S.P., 8' wide		723.65		796.01		
1 F.E. Loader, W.M., 1.5 C.Y.		441.40		485.54	41.60	45.76
56 L.H., Daily Totals		$5182.45		$6816.22	$92.54	$121.72

Crew B-70A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$56.08	$83.57
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Grader, 40,000 Lbs.		1219.00		1340.90		
1 F.E. Loader, W.M., 2.5 C.Y.		638.30		702.13		
1 Dozer, 80 H.P.		405.85		446.44		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	65.33	71.86
40 L.H., Daily Totals		$4856.25		$6217.15	$121.41	$155.43

Crew B-71	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.94	$75.96
3 Laborers	44.40	1065.60	66.25	1590.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Pvmt. Profiler, 750 H.P.		3483.00		3831.30		
1 Road Sweeper, S.P., 8' wide		723.65		796.01		
1 F.E. Loader, W.M., 1.5 C.Y.		441.40		485.54	83.00	91.30
56 L.H., Daily Totals		$7500.85		$9366.45	$133.94	$167.26

Crew B-72	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.95	$77.45
3 Laborers	44.40	1065.60	66.25	1590.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Pvmt. Profiler, 750 H.P.		3483.00		3831.30		
1 Hammermill, 250 H.P.		857.40		943.14		
1 Windrow Loader		1461.00		1607.10		
1 Mix Paver, 165 H.P.		2172.00		2389.20		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	130.05	143.06
64 L.H., Daily Totals		$11648.10		$14112.43	$182.00	$220.51

Crew B-73	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.77	$80.16
2 Laborers	44.40	710.40	66.25	1060.00		
5 Equip. Oper. (medium)	59.00	2360.00	87.90	3516.00		
1 Road Mixer, 310 H.P.		1919.00		2110.90		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Hammermill, 250 H.P.		857.40		943.14		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
.5 F.E. Loader, W.M., 1.5 C.Y.		220.70		242.77		
.5 Truck Tractor, 220 H.P.		155.40		170.94		
.5 Water Tank Trailer, 5000 Gal.		77.05		84.75	71.08	78.19
64 L.H., Daily Totals		$7990.95		$10134.29	$124.86	$158.35

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-74	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.67	$80.06
1 Laborer	44.40	355.20	66.25	530.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Ripper, Beam & 1 Shank		91.60		100.76		
2 Stabilizers, 310 H.P.		2808.00		3088.80		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Chem. Spreader, Towed		85.40		93.94		
1 Roller, Vibratory, 25 Ton		672.35		739.59		
1 Water Tank Trailer, 5000 Gal.		154.10		169.51		
1 Truck Tractor, 220 H.P.		310.80		341.88	94.46	103.90
64 L.H., Daily Totals		$9480.50		$11773.83	$148.13	$183.97

Crew B-75	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$54.01	$80.54
1 Laborer	44.40	355.20	66.25	530.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Grader, 30,000 Lbs.		1073.00		1180.30		
1 Ripper, Beam & 1 Shank		91.60		100.76		
2 Stabilizers, 310 H.P.		2808.00		3088.80		
1 Dist. Tanker, 3000 Gallon		334.10		367.51		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Roller, Vibratory, 25 Ton		672.35		739.59	97.83	107.61
56 L.H., Daily Totals		$8503.00		$10536.42	$151.84	$188.15

Crew B-76	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Dock Builder Foreman (outside)	$57.90	$463.20	$89.50	$716.00	$56.98	$86.98
5 Dock Builders	55.90	2236.00	86.40	3456.00		
2 Equip. Oper. (crane)	61.45	983.20	91.55	1464.80		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 50 Ton		1541.00		1695.10		
1 Barge, 400 Ton		869.15		956.07		
1 Hammer, Diesel, 15K ft.-lbs.		624.45		686.89		
1 Lead, 60' High		211.80		232.98		
1 Air Compressor, 600 cfm		426.55		469.20		
2 -50' Air Hoses, 3"		76.70		84.37	52.08	57.29
72 L.H., Daily Totals		$7852.05		$10387.42	$109.06	$144.27

Crew B-76A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.79	$71.29
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 50 Ton		1541.00		1695.10		
1 Barge, 400 Ton		869.15		956.07	37.66	41.42
64 L.H., Daily Totals		$5468.95		$7213.56	$85.45	$112.71

Crew B-77	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.68	$68.20
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Crack Cleaner, 25 H.P.		53.00		58.30		
1 Crack Filler, Trailer Mtd.		170.95		188.04		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	26.85	29.54
40 L.H., Daily Totals		$2901.20		$3909.40	$72.53	$97.73

Crew B-78	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.47	$67.88
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, S.P., 40 Gallon		128.35		141.19		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Pickup Truck, 3/4 Ton		112.20		123.42	22.72	24.99
48 L.H., Daily Totals		$3273.00		$4457.66	$68.19	$92.87

Crew B-78A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Line Rem. (Metal Balls) 115 H.P.		996.25		1095.88	124.53	136.98
8 L.H., Daily Totals		$1440.25		$1757.47	$180.03	$219.68

Crew B-78B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.63	$68.08
.25 Equip. Oper. (light)	55.50	111.00	82.70	165.40		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
1 Line Rem.,11 H.P.,Walk Behind		114.75		126.22		
.25 Road Sweeper, S.P., 8' wide		180.91		199.00	22.66	24.92
18 L.H., Daily Totals		$1229.26		$1674.05	$68.29	$93.00

Crew B-78C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.47	$67.88
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Pickup Truck, 3/4 Ton		112.20		123.42	32.61	35.87
48 L.H., Daily Totals		$3747.75		$4979.89	$78.08	$103.75

Crew B-78D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.24	$67.53
7 Laborers	44.40	2486.40	66.25	3710.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
3 Pickup Trucks, 3/4 Ton		336.60		370.26		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50' Air Hose, 3/4"		7.15		7.87		
1 Breaker, Pavement, 60 lb.		53.60		58.96	25.05	27.56
80 L.H., Daily Totals		$5623.55		$7606.78	$70.29	$95.08

Crew B-78E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.10	$67.31
9 Laborers	44.40	3196.80	66.25	4770.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
4 Pickup Trucks, 3/4 Ton		448.80		493.68		
2 Air Compressors, 60 cfm		307.70		338.47		
2 -50' Air Hoses, 3/4"		14.30		15.73		
2 Breakers, Pavement, 60 lb.		107.20		117.92	24.28	26.71
96 L.H., Daily Totals		$6660.75		$9026.26	$69.38	$94.02

Crew B-78F	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.00	$67.16
11 Laborers	44.40	3907.20	66.25	5830.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
7 Pickup Trucks, 3/4 Ton		785.40		863.94		
3 Air Compressors, 60 cfm		461.55		507.70		
3 -50' Air Hoses, 3/4"		21.45		23.59		
3 Breakers, Pavement, 60 lb.		160.80		176.88	25.74	28.31
112 L.H., Daily Totals		$7922.35		$10692.58	$70.74	$95.47

Crew B-79	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.68	$68.20
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Heating Kettle, 115 Gallon		107.25		117.97		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
2 Pickup Trucks, 3/4 Ton		224.40		246.84	44.62	49.08
40 L.H., Daily Totals		$3612.00		$4691.28	$90.30	$117.28

Crew B-79A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1.5 Equip. Oper. (light)	$55.50	$666.00	$82.70	$992.40	$55.50	$82.70
.5 Line Remov. (Grinder) 115 H.P.		515.50		567.05		
1 Line Rem. (Metal Balls) 115 H.P.		996.25		1095.88	125.98	138.58
12 L.H., Daily Totals		$2177.75		$2655.32	$181.48	$221.28

Crew B-79B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Set of Gases		173.60		190.96	21.70	23.87
8 L.H., Daily Totals		$528.80		$720.96	$66.10	$90.12

Crew B-79C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.31	$67.64
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Heating Kettle, 115 Gallon		107.25		117.97		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
3 Pickup Trucks, 3/4 Ton		336.60		370.26		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50' Air Hose, 3/4"		7.15		7.87		
1 Breaker, Pavement, 60 lb.		53.60		58.96	37.71	41.48
56 L.H., Daily Totals		$4649.20		$6110.76	$83.02	$109.12

Crew B-79D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.45	$67.84
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Heating Kettle, 115 Gallon		107.25		117.97		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
4 Pickup Trucks, 3/4 Ton		448.80		493.68		
1 Air Compressor, 60 cfm		153.85		169.24		
1 -50' Air Hose, 3/4"		7.15		7.87		
1 Breaker, Pavement, 60 lb.		53.60		58.96	34.75	38.22
64 L.H., Daily Totals		$5132.60		$6788.18	$80.20	$106.07

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew B-79E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Labor Foremen (outside)	$46.40	$742.40	$69.25	$1108.00	$45.24	$67.53
7 Laborers	44.40	2486.40	66.25	3710.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Paint Striper, T.M., 120 Gal.		603.10		663.41		
1 Heating Kettle, 115 Gallon		107.25		117.97		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
5 Pickup Trucks, 3/4 Ton		561.00		617.10		
2 Air Compressors, 60 cfm		307.70		338.47		
2 -50' Air Hoses, 3/4"		14.30		15.73		
2 Breakers, Pavement, 60 lb.		107.20		117.92	31.88	35.07
80 L.H., Daily Totals		$6169.80		$8207.66	$77.12	$102.60

Crew B-80	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.77	$72.80
1 Laborer	44.40	355.20	66.25	530.00		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Earth Auger, Truck-Mtd.		202.55		222.81	32.89	36.18
32 L.H., Daily Totals		$2613.40		$3487.46	$81.67	$108.98

Crew B-80A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$44.40	$66.25
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	35.42	38.96
24 L.H., Daily Totals		$1915.65		$2525.05	$79.82	$105.21

Crew B-80B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$47.17	$70.36
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Crane, Flatbed Mounted, 3 Ton		238.75		262.63	7.46	8.21
32 L.H., Daily Totals		$1748.35		$2514.22	$54.64	$78.57

Crew B-80C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$45.87	$68.50
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Manual Fence Post Auger, Gas		54.40		59.84	10.54	11.59
24 L.H., Daily Totals		$1353.70		$1922.19	$56.40	$80.09

Crew B-81	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.57	$76.95
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Hydromulcher, T.M., 3000 Gal.		256.85		282.54		
1 Truck Tractor, 220 H.P.		310.80		341.88	23.65	26.02
24 L.H., Daily Totals		$1805.25		$2471.22	$75.22	$102.97

Crew B-81A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$46.60	$69.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Hydromulcher, T.M., 600 Gal.		118.15		129.97		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	60.51	66.56
16 L.H., Daily Totals		$1713.80		$2179.02	$107.11	$136.19

Crew B-82	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.95	$74.47
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Horiz. Borer, 6 H.P.		184.15		202.57	11.51	12.66
16 L.H., Daily Totals		$983.35		$1394.17	$61.46	$87.14

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew B-82A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$49.95	$74.47
2 Equip. Opers. (light)	55.50	888.00	82.70	1323.20		
2 Dump Truck, 8 C.Y., 220 H.P.		815.20		896.72		
1 Flatbed Trailer, 25 Ton		137.20		150.92		
1 Horiz. Dir. Drill, 20k lb. Thrust		544.10		598.51		
1 Mud Trailer for HDD, 1500 Gal.		312.15		343.37		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Flatbed Trailer, 3 Ton		71.15		78.27		
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	78.21	86.04
32 L.H., Daily Totals		$4101.25		$5136.34	$128.16	$160.51

Crew B-82B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$49.95	$74.47
2 Equip. Opers. (light)	55.50	888.00	82.70	1323.20		
2 Dump Truck, 8 C.Y., 220 H.P.		815.20		896.72		
1 Flatbed Trailer, 25 Ton		137.20		150.92		
1 Horiz. Dir. Drill, 30k lb. Thrust		647.65		712.41		
1 Mud Trailer for HDD, 1500 Gal.		312.15		343.37		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Flatbed Trailer, 3 Ton		71.15		78.27		
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	81.45	89.59
32 L.H., Daily Totals		$4204.80		$5250.24	$131.40	$164.07

Crew B-82C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Laborers	$44.40	$710.40	$66.25	$1060.00	$49.95	$74.47
2 Equip. Opers. (light)	55.50	888.00	82.70	1323.20		
2 Dump Truck, 8 C.Y., 220 H.P.		815.20		896.72		
1 Flatbed Trailer, 25 Ton		137.20		150.92		
1 Horiz. Dir. Drill, 50k lb. Thrust		824.05		906.46		
1 Mud Trailer for HDD, 1500 Gal.		312.15		343.37		
1 Pickup Truck, 4x4, 3/4 Ton		176.75		194.43		
1 Flatbed Trailer, 3 Ton		71.15		78.27		
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	86.96	95.66
32 L.H., Daily Totals		$4381.20		$5444.28	$136.91	$170.13

Crew B-82D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$55.50	$82.70
1 Mud Trailer for HDD, 1500 Gal.		312.15		343.37	39.02	42.92
8 L.H., Daily Totals		$756.15		$1004.97	$94.52	$125.62

Crew B-83	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Tugboat Captain	$59.00	$472.00	$87.90	$703.20	$51.70	$77.08
1 Tugboat Hand	44.40	355.20	66.25	530.00		
1 Tugboat, 250 H.P.		726.10		798.71	45.38	49.92
16 L.H., Daily Totals		$1553.30		$2031.91	$97.08	$126.99

Crew B-84	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 Rotary Mower/Tractor		371.15		408.26	46.39	51.03
8 L.H., Daily Totals		$843.15		$1111.46	$105.39	$138.93

Crew B-85	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$48.70	$72.67
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Telescoping Boom Lift, to 80'		387.75		426.52		
1 Brush Chipper, 12", 130 H.P.		366.05		402.65		
1 Pruning Saw, Rotary		26.40		29.04	19.50	21.46
40 L.H., Daily Totals		$2728.20		$3765.02	$68.20	$94.13

Crew B-86	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 Stump Chipper, S.P.		189.20		208.12	23.65	26.02
8 L.H., Daily Totals		$661.20		$911.32	$82.65	$113.92

Crew B-86A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 Grader, 30,000 Lbs.		1073.00		1180.30	134.13	147.54
8 L.H., Daily Totals		$1545.00		$1883.50	$193.13	$235.44

Crew B-86B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 Dozer, 200 H.P.		1520.00		1672.00	190.00	209.00
8 L.H., Daily Totals		$1992.00		$2375.20	$249.00	$296.90

Crew B-87	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$56.08	$83.57
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
2 Feller Bunchers, 100 H.P.		1257.60		1383.36		
1 Log Chipper, 22" Tree		555.00		610.50		
1 Dozer, 105 H.P.		640.80		704.88		
1 Chain Saw, Gas, 36" Long		41.65		45.81	62.38	68.61
40 L.H., Daily Totals		$4738.25		$6087.35	$118.46	$152.18

Crew B-88	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$56.91	$84.81
6 Equip. Oper. (medium)	59.00	2832.00	87.90	4219.20		
2 Feller Bunchers, 100 H.P.		1257.60		1383.36		
1 Log Chipper, 22" Tree		555.00		610.50		
2 Log Skidders, 50 H.P.		1826.70		2009.37		
1 Dozer, 105 H.P.		640.80		704.88		
1 Chain Saw, Gas, 36" Long		41.65		45.81	77.17	84.89
56 L.H., Daily Totals		$7508.95		$9503.13	$134.09	$169.70

Crew B-89	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$52.15	$77.85
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05		
1 Concrete Saw		112.85		124.14		
1 Water Tank, 65 Gal.		102.90		113.19	66.61	73.27
16 L.H., Daily Totals		$1900.20		$2417.98	$118.76	$151.12

Crew B-89A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Skilled Worker	$57.10	$456.80	$85.90	$687.20	$50.75	$76.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Core Drill (Large)		121.60		133.76	7.60	8.36
16 L.H., Daily Totals		$933.60		$1350.96	$58.35	$84.44

Crew B-89B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (light)	$55.50	$444.00	$82.70	$661.60	$52.15	$77.85
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Wall Saw, Hydraulic, 10 H.P.		86.40		95.04		
1 Generator, Diesel, 100 kW		521.85		574.03		
1 Water Tank, 65 Gal.		102.90		113.19		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	97.58	107.33
16 L.H., Daily Totals		$2395.60		$2962.92	$149.72	$185.18

Crew B-89C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$51.80	$75.90
1 Masonry cut-off saw, gas		58.15		63.97	7.27	8.00
8 L.H., Daily Totals		$472.55		$671.16	$59.07	$83.90

Crew B-90	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.15	$73.35
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Equip. Oper. (light)	55.50	888.00	82.70	1323.20		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Road Mixer, 310 H.P.		1919.00		2110.90		
1 Dist. Truck, 2000 Gal.		303.25		333.57	34.72	38.19
64 L.H., Daily Totals		$5367.85		$7138.88	$83.87	$111.54

Crew B-90A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$53.03	$79.05
2 Laborers	44.40	710.40	66.25	1060.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
2 Graders, 30,000 Lbs.		2146.00		2360.60		
1 Tandem Roller, 10 Ton		246.80		271.48		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89	48.98	53.87
56 L.H., Daily Totals		$5712.30		$7443.77	$102.01	$132.92

Crew B-90B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.03	$77.58
2 Laborers	44.40	710.40	66.25	1060.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89		
1 Road Mixer, 310 H.P.		1919.00		2110.90	47.27	52.00
48 L.H., Daily Totals		$4766.50		$6219.39	$99.30	$129.57

Crew B-90C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.45	$75.28
4 Laborers	44.40	1420.80	66.25	2120.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
3 Truck Drivers (heavy)	51.30	1231.20	76.70	1840.80		
3 Road Mixers, 310 H.P.		5757.00		6332.70	65.42	71.96
88 L.H., Daily Totals		$10196.20		$12957.10	$115.87	$147.24

Crew B-90D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.52	$73.89
6 Laborers	44.40	2131.20	66.25	3180.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
3 Truck Drivers (heavy)	51.30	1231.20	76.70	1840.80		
3 Road Mixers, 310 H.P.		5757.00		6332.70	55.36	60.89
104 L.H., Daily Totals		$10906.60		$14017.10	$104.87	$134.78

Crew B-90E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$50.26	$74.96
4 Laborers	44.40	1420.80	66.25	2120.00		
3 Equip. Oper. (medium)	59.00	1416.00	87.90	2109.60		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Road Mixer, 310 H.P.		1919.00		2110.90	26.65	29.32
72 L.H., Daily Totals		$5537.40		$7508.10	$76.91	$104.28

Crew B-91	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$52.81	$78.76
2 Laborers	44.40	710.40	66.25	1060.00		
4 Equip. Oper. (medium)	59.00	1888.00	87.90	2812.80		
1 Truck Driver (heavy)	51.30	410.40	76.70	613.60		
1 Dist. Tanker, 3000 Gallon		334.10		367.51		
1 Truck Tractor, 6x4, 380 H.P.		499.15		549.07		
1 Aggreg. Spreader, S.P.		859.10		945.01		
1 Roller, Pneum. Whl., 12 Ton		349.90		384.89		
1 Tandem Roller, 10 Ton		246.80		271.48	35.77	39.34
64 L.H., Daily Totals		$5669.05		$7558.35	$88.58	$118.10

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew B-91B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.70	$77.08
1 Equipment Oper. (med.)	59.00	472.00	87.90	703.20		
1 Road Sweeper, Vac. Assist.		879.45		967.39	54.97	60.46
16 L.H., Daily Totals		$1706.65		$2200.59	$106.67	$137.54

Crew B-91C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$46.60	$69.63
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Catch Basin Cleaning Truck		542.60		596.86	33.91	37.30
16 L.H., Daily Totals		$1288.20		$1710.86	$80.51	$106.93

Crew B-91D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$51.23	$76.42
5 Laborers	44.40	1776.00	66.25	2650.00		
5 Equip. Oper. (medium)	59.00	2360.00	87.90	3516.00		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
1 Aggreg. Spreader, S.P.		859.10		945.01		
2 Truck Tractors, 6x4, 380 H.P.		998.30		1098.13		
2 Dist. Tankers, 3000 Gallon		668.20		735.02		
2 Pavement Brushes, Towed		176.70		194.37		
2 Rollers Pneum. Whl., 12 Ton		699.80		769.78	32.71	35.98
104 L.H., Daily Totals		$8730.10		$11689.51	$83.94	$112.40

Crew B-92	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$44.90	$67.00
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Crack Cleaner, 25 H.P.		53.00		58.30		
1 Air Compressor, 60 cfm		153.85		169.24		
1 Tar Kettle, T.M.		156.70		172.37		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	37.92	41.72
32 L.H., Daily Totals		$2650.40		$3478.96	$82.83	$108.72

Crew B-93	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Equip. Oper. (medium)	$59.00	$472.00	$87.90	$703.20	$59.00	$87.90
1 Feller Buncher, 100 H.P.		628.80		691.68	78.60	86.46
8 L.H., Daily Totals		$1100.80		$1394.88	$137.60	$174.36

Crew B-94A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Diaphragm Water Pump, 2″		87.70		96.47		
1 -20′ Suction Hose, 2″		3.55		3.90		
2 -50′ Discharge Hoses, 2″		8.00		8.80	12.41	13.65
8 L.H., Daily Totals		$454.45		$639.17	$56.81	$79.90

Crew B-94B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Diaphragm Water Pump, 4″		106.35		116.99		
1 -20′ Suction Hose, 4″		17.25		18.98		
2 -50′ Discharge Hoses, 4″		25.60		28.16	18.65	20.52
8 L.H., Daily Totals		$504.40		$694.12	$63.05	$86.77

Crew B-94C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Centrifugal Water Pump, 3″		74.40		81.84		
1 -20′ Suction Hose, 3″		8.75		9.63		
2 -50′ Discharge Hoses, 3″		9.00		9.90	11.52	12.67
8 L.H., Daily Totals		$447.35		$631.37	$55.92	$78.92

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew B-94D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Centr. Water Pump, 6″		235.25		258.77		
1 -20′ Suction Hose, 6″		25.50		28.05		
2 -50′ Discharge Hoses, 6″		36.20		39.82	37.12	40.83
8 L.H., Daily Totals		$652.15		$856.64	$81.52	$107.08

Crew C-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Carpenters	$54.70	$1312.80	$81.65	$1959.60	$52.13	$77.80
1 Laborer	44.40	355.20	66.25	530.00		
32 L.H., Daily Totals		$1668.00		$2489.60	$52.13	$77.80

Crew C-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$53.32	$79.58
4 Carpenters	54.70	1750.40	81.65	2612.80		
1 Laborer	44.40	355.20	66.25	530.00		
48 L.H., Daily Totals		$2559.20		$3819.60	$53.32	$79.58

Crew C-2A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$52.83	$78.62
3 Carpenters	54.70	1312.80	81.65	1959.60		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Laborer	44.40	355.20	66.25	530.00		
48 L.H., Daily Totals		$2536.00		$3773.60	$52.83	$78.62

Crew C-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Rodman Foreman (outside)	$60.90	$487.20	$91.05	$728.40	$55.10	$82.31
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
2 Laborers	44.40	710.40	66.25	1060.00		
3 Stressing Equipment		56.85		62.53		
.5 Grouting Equipment		123.33		135.66	2.82	3.10
64 L.H., Daily Totals		$3706.57		$5465.79	$57.92	$85.40

Crew C-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Rodman Foreman (outside)	$60.90	$487.20	$91.05	$728.40	$59.40	$88.80
3 Rodmen (reinf.)	58.90	1413.60	88.05	2113.20		
3 Stressing Equipment		56.85		62.53	1.78	1.95
32 L.H., Daily Totals		$1957.65		$2904.14	$61.18	$90.75

Crew C-4A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Rodmen (reinf.)	$58.90	$942.40	$88.05	$1408.80	$58.90	$88.05
4 Stressing Equipment		75.80		83.38	4.74	5.21
16 L.H., Daily Totals		$1018.20		$1492.18	$63.64	$93.26

Crew C-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Rodman Foreman (outside)	$60.90	$487.20	$91.05	$728.40	$58.64	$87.58
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 25 Ton		586.70		645.37	10.48	11.52
56 L.H., Daily Totals		$3870.30		$5549.77	$69.11	$99.10

Crew C-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.97	$68.36
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
2 Gas Engine Vibrators		54.30		59.73	1.13	1.24
48 L.H., Daily Totals		$2260.70		$3340.93	$47.10	$69.60

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew C-6A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Cement Finishers	$51.80	$828.80	$75.90	$1214.40	$51.80	$75.90
1 Concrete Vibrator, Elec, 2 HP		45.80		50.38	2.86	3.15
16 L.H., Daily Totals		$874.60		$1264.78	$54.66	$79.05
Crew C-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.97	$71.39
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
2 Gas Engine Vibrators		54.30		59.73		
1 Concrete Bucket, 1 C.Y.		45.90		50.49		
1 Hyd. Crane, 55 Ton		990.15		1089.17	15.14	16.66
72 L.H., Daily Totals		$4543.95		$6339.78	$63.11	$88.05
Crew C-7A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.38	$69.24
5 Laborers	44.40	1776.00	66.25	2650.00		
2 Truck Drivers (heavy)	51.30	820.80	76.70	1227.20		
2 Conc. Transit Mixers		1176.30		1293.93	18.38	20.22
64 L.H., Daily Totals		$4144.30		$5725.13	$64.75	$89.46
Crew C-7B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.79	$71.29
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Equipment Operator, Crane	61.45	491.60	91.55	732.40		
1 Equipment Oiler	52.50	420.00	78.25	626.00		
1 Conc. Bucket, 2 C.Y.		55.65		61.22		
1 Lattice Boom Crane, 165 Ton		2403.00		2643.30	38.42	42.26
64 L.H., Daily Totals		$5517.45		$7266.92	$86.21	$113.55
Crew C-7C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.30	$72.04
5 Laborers	44.40	1776.00	66.25	2650.00		
2 Equipment Operators (med.)	59.00	944.00	87.90	1406.40		
2 F.E. Loaders, W.M., 4 C.Y.		1518.00		1669.80	23.72	26.09
64 L.H., Daily Totals		$4609.20		$6280.20	$72.02	$98.13
Crew C-7D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$46.77	$69.77
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Concrete Conveyer		206.25		226.88	3.68	4.05
56 L.H., Daily Totals		$2825.45		$4134.07	$50.45	$73.82
Crew C-8	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.89	$72.53
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Concrete Pump (Small)		423.65		466.01	7.57	8.32
56 L.H., Daily Totals		$3161.25		$4527.61	$56.45	$80.85
Crew C-8A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.20	$69.97
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
48 L.H., Daily Totals		$2265.60		$3358.40	$47.20	$69.97

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew C-8B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.72	$71.18
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Vibrating Power Screed		87.65		96.42		
1 Roller, Vibratory, 25 Ton		672.35		739.59		
1 Dozer, 200 H.P.		1520.00		1672.00	57.00	62.70
40 L.H., Daily Totals		$4188.80		$5355.20	$104.72	$133.88
Crew C-8C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.40	$71.97
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Shotcrete Rig, 12 C.Y./hr		269.20		296.12		
1 Air Compressor, 160 cfm		212.30		233.53		
4 -50' Air Hoses, 1"		32.20		35.42		
4 -50' Air Hoses, 2"		115.80		127.38	13.11	14.43
48 L.H., Daily Totals		$2952.70		$4146.85	$61.51	$86.39
Crew C-8D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.52	$73.53
1 Laborer	44.40	355.20	66.25	530.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equipment Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 250 cfm		202.85		223.13		
2 -50' Air Hoses, 1"		16.10		17.71	6.84	7.53
32 L.H., Daily Totals		$1803.75		$2593.65	$56.37	$81.05
Crew C-8E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.82	$71.10
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equipment Oper. (light)	55.50	444.00	82.70	661.60		
1 Shotcrete Rig, 35 C.Y./hr.		301.05		331.15		
1 Air Compressor, 250 cfm		202.85		223.13		
4 -50' Air Hoses, 1"		32.20		35.42		
4 -50' Air Hoses, 2"		115.80		127.38	13.58	14.94
48 L.H., Daily Totals		$2947.10		$4129.89	$61.40	$86.04
Crew C-9	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$49.02	$72.78
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equipment Oper. (light)	55.50	444.00	82.70	661.60		
1 Grout Pump, 50 C.F./hr.		190.35		209.38		
1 Air Compressor, 160 cfm		212.30		233.53		
2 -50' Air Hoses, 1"		16.10		17.71		
2 -50' Air Hoses, 2"		57.90		63.69	14.90	16.38
32 L.H., Daily Totals		$2045.45		$2853.11	$63.92	$89.16
Crew C-10	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.33	$72.68
2 Cement Finishers	51.80	828.80	75.90	1214.40		
24 L.H., Daily Totals		$1184.00		$1744.40	$49.33	$72.68
Crew C-10B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
3 Laborers	$44.40	$1065.60	$66.25	$1590.00	$47.36	$70.11
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Concrete Mixer, 10 C.F.		147.15		161.87		
2 Trowels, 48" Walk-Behind		188.60		207.46	8.39	9.23
40 L.H., Daily Totals		$2230.15		$3173.72	$55.75	$79.34

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew C-10C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.33	$72.68
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Trowel, 48″ Walk-Behind		94.30		103.73	3.93	4.32
24 L.H., Daily Totals		$1278.30		$1848.13	$53.26	$77.01
Crew C-10D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.33	$72.68
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Vibrating Power Screed		87.65		96.42		
1 Trowel, 48″ Walk-Behind		94.30		103.73	7.58	8.34
24 L.H., Daily Totals		$1365.95		$1944.55	$56.91	$81.02
Crew C-10E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.33	$72.68
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Vibrating Power Screed		87.65		96.42		
1 Cement Trowel, 96″ Ride-On		171.05		188.16	10.78	11.86
24 L.H., Daily Totals		$1442.70		$2028.97	$60.11	$84.54
Crew C-10F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Laborer	$44.40	$355.20	$66.25	$530.00	$49.33	$72.68
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Telescoping Boom Lift, to 60′		292.45		321.69	12.19	13.40
24 L.H., Daily Totals		$1476.45		$2066.09	$61.52	$86.09
Crew C-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.78	$91.78
6 Struc. Steel Workers	60.30	2894.40	93.30	4478.40		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 150 Ton		2324.00		2556.40	32.28	35.51
72 L.H., Daily Totals		$6628.40		$9164.40	$92.06	$127.28
Crew C-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$54.44	$81.22
3 Carpenters	54.70	1312.80	81.65	1959.60		
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	9.91	10.90
48 L.H., Daily Totals		$3089.00		$4422.18	$64.35	$92.13
Crew C-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Worker	$60.30	$482.40	$93.30	$746.40	$58.43	$89.42
1 Welder	60.30	482.40	93.30	746.40		
1 Carpenter	54.70	437.60	81.65	653.20		
1 Welder, Gas Engine, 300 amp		148.75		163.63	6.20	6.82
24 L.H., Daily Totals		$1551.15		$2309.63	$64.63	$96.23
Crew C-14	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$53.39	$79.54
5 Carpenters	54.70	2188.00	81.65	3266.00		
4 Laborers	44.40	1420.80	66.25	2120.00		
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 80 Ton		1458.00		1603.80	10.13	11.14
144 L.H., Daily Totals		$9145.60		$13057.00	$63.51	$90.67

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew C-14A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$54.68	$81.58
16 Carpenters	54.70	7001.60	81.65	10451.20		
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
2 Laborers	44.40	710.40	66.25	1060.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gas Engine Vibrator		27.15		29.86		
1 Concrete Pump (Small)		423.65		466.01	2.25	2.48
200 L.H., Daily Totals		$11387.60		$16811.88	$56.94	$84.06
Crew C-14B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$54.57	$81.36
16 Carpenters	54.70	7001.60	81.65	10451.20		
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
2 Laborers	44.40	710.40	66.25	1060.00		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gas Engine Vibrator		27.15		29.86		
1 Concrete Pump (Small)		423.65		466.01	2.17	2.38
208 L.H., Daily Totals		$11802.00		$17419.08	$56.74	$83.75
Crew C-14C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$52.29	$77.96
6 Carpenters	54.70	2625.60	81.65	3919.20		
2 Rodmen (reinf.)	58.90	942.40	88.05	1408.80		
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Gas Engine Vibrator		27.15		29.86	.24	.27
112 L.H., Daily Totals		$5883.95		$8761.86	$52.54	$78.23
Crew C-14D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$54.35	$81.07
18 Carpenters	54.70	7876.80	81.65	11757.60		
2 Rodmen (reinf.)	58.90	942.40	88.05	1408.80		
2 Laborers	44.40	710.40	66.25	1060.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gas Engine Vibrator		27.15		29.86		
1 Concrete Pump (Small)		423.65		466.01	2.25	2.48
200 L.H., Daily Totals		$11320.40		$16709.48	$56.60	$83.55
Crew C-14E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$53.34	$79.52
2 Carpenters	54.70	875.20	81.65	1306.40		
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
3 Laborers	44.40	1065.60	66.25	1590.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Gas Engine Vibrator		27.15		29.86	.31	.34
88 L.H., Daily Totals		$4720.75		$7027.86	$53.64	$79.86
Crew C-14F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.56	$73.02
2 Laborers	44.40	710.40	66.25	1060.00		
6 Cement Finishers	51.80	2486.40	75.90	3643.20		
1 Gas Engine Vibrator		27.15		29.86	.38	.41
72 L.H., Daily Totals		$3595.15		$5287.06	$49.93	$73.43

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew C-14G	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.91	$72.19
2 Laborers	44.40	710.40	66.25	1060.00		
4 Cement Finishers	51.80	1657.60	75.90	2428.80		
1 Gas Engine Vibrator		27.15		29.86	.48	.53
56 L.H., Daily Totals		$2766.35		$4072.67	$49.40	$72.73

Crew C-14H	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$53.53	$79.68
2 Carpenters	54.70	875.20	81.65	1306.40		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
1 Laborer	44.40	355.20	66.25	530.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Gas Engine Vibrator		27.15		29.86	.57	.62
48 L.H., Daily Totals		$2596.75		$3854.67	$54.10	$80.31

Crew C-14L	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$51.19	$76.28
6 Carpenters	54.70	2625.60	81.65	3919.20		
4 Laborers	44.40	1420.80	66.25	2120.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Gas Engine Vibrator		27.15		29.86	.28	.31
96 L.H., Daily Totals		$4941.55		$7353.06	$51.47	$76.59

Crew C-14M	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$53.08	$79.03
2 Carpenters	54.70	875.20	81.65	1306.40		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
2 Laborers	44.40	710.40	66.25	1060.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gas Engine Vibrator		27.15		29.86		
1 Concrete Pump (Small)		423.65		466.01	7.04	7.75
64 L.H., Daily Totals		$3847.60		$5553.88	$60.12	$86.78

Crew C-15	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$51.31	$76.28
2 Carpenters	54.70	875.20	81.65	1306.40		
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Rodman (reinf.)	58.90	471.20	88.05	704.40		
72 L.H., Daily Totals		$3694.40		$5492.00	$51.31	$76.28

Crew C-16	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$48.89	$72.53
3 Laborers	44.40	1065.60	66.25	1590.00		
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gunite Pump Rig		321.75		353.93		
2 -50' Air Hoses, 3/4"		14.30		15.73		
2 -50' Air Hoses, 2"		57.90		63.69	7.03	7.74
56 L.H., Daily Totals		$3131.55		$4494.94	$55.92	$80.27

Crew C-16A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$51.75	$76.49
2 Cement Finishers	51.80	828.80	75.90	1214.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Gunite Pump Rig		321.75		353.93		
2 -50' Air Hoses, 3/4"		14.30		15.73		
2 -50' Air Hoses, 2"		57.90		63.69		
1 Telescoping Boom Lift, to 60'		292.45		321.69	21.45	23.59
32 L.H., Daily Totals		$2342.40		$3202.64	$73.20	$100.08

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew C-17	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.50	$86.50
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
80 L.H., Daily Totals		$4600.00		$6920.00	$57.50	$86.50

Crew C-17A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.55	$86.56
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
.125 Equip. Oper. (crane)	61.45	61.45	91.55	91.55		
.125 Hyd. Crane, 80 Ton		182.25		200.47	2.25	2.48
81 L.H., Daily Totals		$4843.70		$7212.02	$59.80	$89.04

Crew C-17B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.60	$86.62
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
.25 Equip. Oper. (crane)	61.45	122.90	91.55	183.10		
.25 Hyd. Crane, 80 Ton		364.50		400.95		
.25 Trowel, 48" Walk-Behind		23.57		25.93	4.73	5.21
82 L.H., Daily Totals		$5110.98		$7529.98	$62.33	$91.83

Crew C-17C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.64	$86.68
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
.375 Equip. Oper. (crane)	61.45	184.35	91.55	274.65		
.375 Hyd. Crane, 80 Ton		546.75		601.42	6.59	7.25
83 L.H., Daily Totals		$5331.10		$7796.07	$64.23	$93.93

Crew C-17D	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.69	$86.74
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
.5 Equip. Oper. (crane)	61.45	245.80	91.55	366.20		
.5 Hyd. Crane, 80 Ton		729.00		801.90	8.68	9.55
84 L.H., Daily Totals		$5574.80		$8088.10	$66.37	$96.29

Crew C-17E	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.50	$86.50
8 Skilled Workers	57.10	3654.40	85.90	5497.60		
1 Hyd. Jack with Rods		36.70		40.37	.46	.50
80 L.H., Daily Totals		$4636.70		$6960.37	$57.96	$87.00

Crew C-18	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.125 Labor Foreman (outside)	$46.40	$46.40	$69.25	$69.25	$44.62	$66.58
1 Laborer	44.40	355.20	66.25	530.00		
1 Concrete Cart, 10 C.F.		116.95		128.65	12.99	14.29
9 L.H., Daily Totals		$518.55		$727.89	$57.62	$80.88

Crew C-19	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.125 Labor Foreman (outside)	$46.40	$46.40	$69.25	$69.25	$44.62	$66.58
1 Laborer	44.40	355.20	66.25	530.00		
1 Concrete Cart, 18 C.F.		138.95		152.85	15.44	16.98
9 L.H., Daily Totals		$540.55		$752.10	$60.06	$83.57

Crew C-20	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.40	$70.54
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Gas Engine Vibrators		54.30		59.73		
1 Concrete Pump (Small)		423.65		466.01	7.47	8.21
64 L.H., Daily Totals		$3511.55		$5040.15	$54.87	$78.75

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew C-21	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$47.40	$70.54
5 Laborers	44.40	1776.00	66.25	2650.00		
1 Cement Finisher	51.80	414.40	75.90	607.20		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
2 Gas Engine Vibrators		54.30		59.73		
1 Concrete Conveyer		206.25		226.88	4.07	4.48
64 L.H., Daily Totals		$3294.15		$4801.01	$51.47	$75.02

Crew C-22	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Rodman Foreman (outside)	$60.90	$487.20	$91.05	$728.40	$59.19	$88.47
4 Rodmen (reinf.)	58.90	1884.80	88.05	2817.60		
.125 Equip. Oper. (crane)	61.45	61.45	91.55	91.55		
.125 Equip. Oper. (oiler)	52.50	52.50	78.25	78.25		
.125 Hyd. Crane, 25 Ton		73.34		80.67	1.75	1.92
42 L.H., Daily Totals		$2559.29		$3796.47	$60.94	$90.39

Crew C-23	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.48	$86.30
6 Skilled Workers	57.10	2740.80	85.90	4123.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30	21.41	23.55
80 L.H., Daily Totals		$6311.00		$8788.30	$78.89	$109.85

Crew C-23A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$49.83	$74.31
2 Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Crawler Crane, 100 Ton		2310.00		2541.00		
3 Conc. Buckets, 8 C.Y.		337.95		371.75	66.20	72.82
40 L.H., Daily Totals		$4641.15		$5885.15	$116.03	$147.13

Crew C-24	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Worker Foremen (out)	$59.10	$945.60	$88.90	$1422.40	$57.48	$86.30
6 Skilled Workers	57.10	2740.80	85.90	4123.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 150 Ton		2324.00		2556.40	29.05	31.95
80 L.H., Daily Totals		$6922.00		$9460.40	$86.53	$118.26

Crew C-25	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Rodmen (reinf.)	$58.90	$942.40	$88.05	$1408.80	$47.42	$73.15
2 Rodmen Helpers	35.95	575.20	58.25	932.00		
32 L.H., Daily Totals		$1517.60		$2340.80	$47.42	$73.15

Crew C-27	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Cement Finishers	$51.80	$828.80	$75.90	$1214.40	$51.80	$75.90
1 Concrete Saw		112.85		124.14	7.05	7.76
16 L.H., Daily Totals		$941.65		$1338.54	$58.85	$83.66

Crew C-28	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$51.80	$75.90
1 Portable Air Compressor, Gas		38.80		42.68	4.85	5.34
8 L.H., Daily Totals		$453.20		$649.88	$56.65	$81.23

Crew C-29	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Pressure Washer		97.35		107.08	12.17	13.39
8 L.H., Daily Totals		$452.55		$637.09	$56.57	$79.64

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	

Crew C-30	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Concrete Mixer, 10 C.F.		147.15		161.87	18.39	20.23
8 L.H., Daily Totals		$502.35		$691.87	$62.79	$86.48

Crew C-31	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$51.80	$75.90
1 Grout Pump		321.75		353.93	40.22	44.24
8 L.H., Daily Totals		$736.15		$961.13	$92.02	$120.14

Crew C-32	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Cement Finisher	$51.80	$414.40	$75.90	$607.20	$48.10	$71.08
1 Laborer	44.40	355.20	66.25	530.00		
1 Crack Chaser Saw, Gas, 6 H.P.		73.25		80.58		
1 Vacuum Pick-Up System		74.95		82.44	9.26	10.19
16 L.H., Daily Totals		$917.80		$1300.22	$57.36	$81.26

Crew D-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer	$53.70	$429.60	$80.90	$647.20	$48.70	$73.38
1 Bricklayer Helper	43.70	349.60	65.85	526.80		
16 L.H., Daily Totals		$779.20		$1174.00	$48.70	$73.38

Crew D-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$50.15	$75.50
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
.5 Carpenter	54.70	218.80	81.65	326.60		
44 L.H., Daily Totals		$2206.80		$3321.80	$50.15	$75.50

Crew D-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$49.94	$75.20
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
.25 Carpenter	54.70	109.40	81.65	163.30		
42 L.H., Daily Totals		$2097.40		$3158.50	$49.94	$75.20

Crew D-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer	$53.70	$429.60	$80.90	$647.20	$49.15	$73.83
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Grout Pump, 50 C.F./hr.		190.35		209.38	5.95	6.54
32 L.H., Daily Totals		$1763.15		$2571.78	$55.10	$80.37

Crew D-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer	53.70	429.60	80.90	647.20	53.70	80.90
8 L.H., Daily Totals		$429.60		$647.20	$53.70	$80.90

Crew D-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$48.94	$73.71
3 Bricklayer Helpers	43.70	1048.80	65.85	1580.40		
.25 Carpenter	54.70	109.40	81.65	163.30		
50 L.H., Daily Totals		$2447.00		$3685.30	$48.94	$73.71

Crew D-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Tile Layer	$51.70	$413.60	$75.55	$604.40	$46.65	$68.17
1 Tile Layer Helper	41.60	332.80	60.80	486.40		
16 L.H., Daily Totals		$746.40		$1090.80	$46.65	$68.17

Crew D-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$49.70	$74.88
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
40 L.H., Daily Totals		$1988.00		$2995.20	$49.70	$74.88

Crews - Standard

Crew D-9	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$48.70	$73.38
3 Bricklayer Helpers	43.70	1048.80	65.85	1580.40		
48 L.H., Daily Totals		$2337.60		$3522.00	$48.70	$73.38

Crew D-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer Foreman (outside)	$55.70	$445.60	$83.90	$671.20	$53.64	$80.55
1 Bricklayer	53.70	429.60	80.90	647.20		
1 Bricklayer Helper	43.70	349.60	65.85	526.80		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 12 Ton		432.65		475.92	13.52	14.87
32 L.H., Daily Totals		$2149.05		$3053.51	$67.16	$95.42

Crew D-11	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer Foreman (outside)	$55.70	$445.60	$83.90	$671.20	$51.03	$76.88
1 Bricklayer	53.70	429.60	80.90	647.20		
1 Bricklayer Helper	43.70	349.60	65.85	526.80		
24 L.H., Daily Totals		$1224.80		$1845.20	$51.03	$76.88

Crew D-12	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer Foreman (outside)	$55.70	$445.60	$83.90	$671.20	$49.20	$74.13
1 Bricklayer	53.70	429.60	80.90	647.20		
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
32 L.H., Daily Totals		$1574.40		$2372.00	$49.20	$74.13

Crew D-13	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Bricklayer Foreman (outside)	$55.70	$445.60	$83.90	$671.20	$52.16	$78.28
1 Bricklayer	53.70	429.60	80.90	647.20		
2 Bricklayer Helpers	43.70	699.20	65.85	1053.60		
1 Carpenter	54.70	437.60	81.65	653.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 12 Ton		432.65		475.92	9.01	9.91
48 L.H., Daily Totals		$2936.25		$4233.52	$61.17	$88.20

Crew D-14	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Bricklayers	$53.70	$1288.80	$80.90	$1941.60	$51.20	$77.14
1 Bricklayer Helper	43.70	349.60	65.85	526.80		
32 L.H., Daily Totals		$1638.40		$2468.40	$51.20	$77.14

Crew E-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.37	$90.80
1 Welder	60.30	482.40	93.30	746.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Welder, Gas Engine, 300 amp		148.75		163.63	6.20	6.82
24 L.H., Daily Totals		$1573.55		$2342.82	$65.56	$97.62

Crew E-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.64	$91.34
4 Struc. Steel Workers	60.30	1929.60	93.30	2985.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30	30.59	33.65
56 L.H., Daily Totals		$5052.60		$6999.50	$90.22	$124.99

Crew E-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.97	$94.33
1 Struc. Steel Worker	60.30	482.40	93.30	746.40		
1 Welder	60.30	482.40	93.30	746.40		
1 Welder, Gas Engine, 300 amp		148.75		163.63	6.20	6.82
24 L.H., Daily Totals		$1611.95		$2427.63	$67.16	$101.15

Crew E-3A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.97	$94.33
1 Struc. Steel Worker	60.30	482.40	93.30	746.40		
1 Welder	60.30	482.40	93.30	746.40		
1 Welder, Gas Engine, 300 amp		148.75		163.63		
1 Telescoping Boom Lift, to 40'		281.90		310.09	17.94	19.74
24 L.H., Daily Totals		$1893.85		$2737.72	$78.91	$114.07

Crew E-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.80	$94.08
3 Struc. Steel Workers	60.30	1447.20	93.30	2239.20		
1 Welder, Gas Engine, 300 amp		148.75		163.63	4.65	5.11
32 L.H., Daily Totals		$2094.35		$3174.03	$65.45	$99.19

Crew E-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Struc. Steel Foremen (outside)	$62.30	$996.80	$96.40	$1542.40	$60.03	$92.24
5 Struc. Steel Workers	60.30	2412.00	93.30	3732.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Welder	60.30	482.40	93.30	746.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30		
1 Welder, Gas Engine, 300 amp		148.75		163.63	23.27	25.60
80 L.H., Daily Totals		$6664.55		$9427.13	$83.31	$117.84

Crew E-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Struc. Steel Foremen (outside)	$62.30	$1495.20	$96.40	$2313.60	$59.96	$92.17
9 Struc. Steel Workers	60.30	4341.60	93.30	6717.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Welder	60.30	482.40	93.30	746.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30		
1 Welder, Gas Engine, 300 amp		148.75		163.63		
1 Air Compressor, 160 cfm		212.30		233.53		
2 Impact Wrenches		90.30		99.33	16.91	18.60
128 L.H., Daily Totals		$9839.15		$14178.39	$76.87	$110.77

Crew E-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.03	$92.24
4 Struc. Steel Workers	60.30	1929.60	93.30	2985.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Welder Foreman (outside)	62.30	498.40	96.40	771.20		
2 Welders	60.30	964.80	93.30	1492.80		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30		
2 Welder, Gas Engine, 300 amp		297.50		327.25	25.13	27.64
80 L.H., Daily Totals		$6813.30		$9590.75	$85.17	$119.88

Crew E-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.73	$91.67
4 Struc. Steel Workers	60.30	1929.60	93.30	2985.60		
1 Welder Foreman (outside)	62.30	498.40	96.40	771.20		
4 Welders	60.30	1929.60	93.30	2985.60		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30		
4 Welder, Gas Engine, 300 amp		595.00		654.50	22.19	24.41
104 L.H., Daily Totals		$8519.60		$12072.40	$81.92	$116.08

Crews - Standard

Crew E-9	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
2 Struc. Steel Foremen (outside)	$62.30	$996.80	$96.40	$1542.40	$59.96	$92.17
5 Struc. Steel Workers	60.30	2412.00	93.30	3732.00		
1 Welder Foreman (outside)	62.30	498.40	96.40	771.20		
5 Welders	60.30	2412.00	93.30	3732.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Lattice Boom Crane, 90 Ton		1713.00		1884.30		
5 Welder, Gas Engine, 300 amp		743.75		818.13	19.19	21.11
128 L.H., Daily Totals		$10131.55		$14500.03	$79.15	$113.28

Crew E-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.30	$94.85
1 Welder	60.30	482.40	93.30	746.40		
1 Welder, Gas Engine, 300 amp		148.75		163.63		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	62.42	68.67
16 L.H., Daily Totals		$1979.60		$2616.28	$123.72	$163.52

Crew E-11	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Painters, Struc. Steel	$47.20	$755.20	$75.80	$1212.80	$48.58	$75.14
1 Building Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 250 cfm		202.85		223.13		
1 Sandblaster, Portable, 3 C.F.		83.85		92.23		
1 Set Sand Blasting Accessories		15.55		17.11	9.45	10.39
32 L.H., Daily Totals		$1856.65		$2736.88	$58.02	$85.53

Crew E-11A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Painters, Struc. Steel	$47.20	$755.20	$75.80	$1212.80	$48.58	$75.14
1 Building Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 250 cfm		202.85		223.13		
1 Sandblaster, Portable, 3 C.F.		83.85		92.23		
1 Set Sand Blasting Accessories		15.55		17.11		
1 Telescoping Boom Lift, to 60'		292.45		321.69	18.58	20.44
32 L.H., Daily Totals		$2149.10		$3058.57	$67.16	$95.58

Crew E-11B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Painters, Struc. Steel	$47.20	$755.20	$75.80	$1212.80	$46.27	$72.62
1 Building Laborer	44.40	355.20	66.25	530.00		
2 Paint Sprayer, 8 C.F.M.		88.40		97.24		
1 Telescoping Boom Lift, to 60'		292.45		321.69	15.87	17.46
24 L.H., Daily Totals		$1491.25		$2161.74	$62.14	$90.07

Crew E-12	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$58.90	$89.55
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Welder, Gas Engine, 300 amp		148.75		163.63	9.30	10.23
16 L.H., Daily Totals		$1091.15		$1596.43	$68.20	$99.78

Crew E-13	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.03	$91.83
.5 Equip. Oper. (light)	55.50	222.00	82.70	330.80		
1 Welder, Gas Engine, 300 amp		148.75		163.63	12.40	13.64
12 L.H., Daily Totals		$869.15		$1265.63	$72.43	$105.47

Crew E-14	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$62.30	$96.40
1 Welder, Gas Engine, 300 amp		148.75		163.63	18.59	20.45
8 L.H., Daily Totals		$647.15		$934.83	$80.89	$116.85

Crew E-16	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.30	$94.85
1 Welder	60.30	482.40	93.30	746.40		
1 Welder, Gas Engine, 300 amp		148.75		163.63	9.30	10.23
16 L.H., Daily Totals		$1129.55		$1681.22	$70.60	$105.08

Crew E-17	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.30	$94.85
1 Structural Steel Worker	60.30	482.40	93.30	746.40		
16 L.H., Daily Totals		$980.80		$1517.60	$61.30	$94.85

Crew E-18	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.44	$92.84
3 Structural Steel Workers	60.30	1447.20	93.30	2239.20		
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Lattice Boom Crane, 20 Ton		1526.00		1678.60	38.15	41.97
40 L.H., Daily Totals		$3943.60		$5392.20	$98.59	$134.81

Crew E-19	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.37	$90.80
1 Structural Steel Worker	60.30	482.40	93.30	746.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Lattice Boom Crane, 20 Ton		1526.00		1678.60	63.58	69.94
24 L.H., Daily Totals		$2950.80		$3857.80	$122.95	$160.74

Crew E-20	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.72	$91.59
5 Structural Steel Workers	60.30	2412.00	93.30	3732.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Lattice Boom Crane, 40 Ton		2127.00		2339.70	33.23	36.56
64 L.H., Daily Totals		$5949.00		$8201.30	$92.95	$128.15

Crew E-22	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Skilled Worker Foreman (out)	$59.10	$472.80	$88.90	$711.20	$57.77	$86.90
2 Skilled Workers	57.10	913.60	85.90	1374.40		
24 L.H., Daily Totals		$1386.40		$2085.60	$57.77	$86.90

Crew E-24	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Structural Steel Workers	$60.30	$1447.20	$93.30	$2239.20	$59.98	$91.95
1 Equipment Operator (med.)	59.00	472.00	87.90	703.20		
1 Hyd. Crane, 25 Ton		586.70		645.37	18.33	20.17
32 L.H., Daily Totals		$2505.90		$3587.77	$78.31	$112.12

Crew E-25	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Welder Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$62.30	$96.40
1 Cutting Torch		12.95		14.24	1.62	1.78
8 L.H., Daily Totals		$511.35		$785.45	$63.92	$98.18

Crew E-26	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.64	$94.84
1 Struc. Steel Worker	60.30	482.40	93.30	746.40		
1 Welder	60.30	482.40	93.30	746.40		
.25 Electrician	63.70	127.40	94.65	189.30		
.25 Plumber	67.70	135.40	101.05	202.10		
1 Welder, Gas Engine, 300 amp		148.75		163.63	5.31	5.84
28 L.H., Daily Totals		$1874.75		$2819.03	$66.96	$100.68

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew E-27	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$59.72	$91.59
5 Struc. Steel Workers	60.30	2412.00	93.30	3732.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 12 Ton		475.80		523.38		
1 Hyd. Crane, 80 Ton		1458.00		1603.80	30.22	33.24
64 L.H., Daily Totals		$5755.80		$7988.78	$89.93	$124.82
Crew F-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Carpenters	$54.70	$1750.40	$81.65	$2612.80	$56.05	$83.63
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	11.90	13.08
40 L.H., Daily Totals		$2717.80		$3868.58	$67.94	$96.71
Crew F-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
4 Carpenters	$54.70	$1750.40	$81.65	$2612.80	$55.46	$82.73
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 55 Ton		990.15		1089.17	20.63	22.69
48 L.H., Daily Totals		$3652.15		$5060.36	$76.09	$105.42
Crew F-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$55.20	$82.39
3 Carpenters	54.70	1312.80	81.65	1959.60		
32 L.H., Daily Totals		$1766.40		$2636.40	$55.20	$82.39
Crew F-6	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$51.93	$77.47
2 Building Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	11.90	13.08
40 L.H., Daily Totals		$2553.00		$3622.18	$63.83	$90.55
Crew F-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$49.55	$73.95
2 Building Laborers	44.40	710.40	66.25	1060.00		
32 L.H., Daily Totals		$1585.60		$2366.40	$49.55	$73.95
Crew G-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer Foreman (outside)	$50.20	$401.60	$81.35	$650.80	$44.99	$72.92
4 Roofers Composition	48.20	1542.40	78.15	2500.80		
2 Roofer Helpers	35.95	575.20	58.25	932.00		
1 Application Equipment		194.80		214.28		
1 Tar Kettle/Pot		209.95		230.94		
1 Crew Truck		168.15		184.97	10.23	11.25
56 L.H., Daily Totals		$3092.10		$4713.79	$55.22	$84.17
Crew G-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Plasterer	$49.85	$398.80	$74.25	$594.00	$46.27	$68.95
1 Plasterer Helper	44.55	356.40	66.35	530.80		
1 Building Laborer	44.40	355.20	66.25	530.00		
1 Grout Pump, 50 C.F./hr.		190.35		209.38	7.93	8.72
24 L.H., Daily Totals		$1300.75		$1864.18	$54.20	$77.67

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew G-2A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer Composition	$48.20	$385.60	$78.15	$625.20	$42.85	$67.55
1 Roofer Helper	35.95	287.60	58.25	466.00		
1 Building Laborer	44.40	355.20	66.25	530.00		
1 Foam Spray Rig, Trailer-Mtd.		530.15		583.16		
1 Pickup Truck, 3/4 Ton		112.20		123.42	26.76	29.44
24 L.H., Daily Totals		$1670.75		$2327.78	$69.61	$96.99
Crew G-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Sheet Metal Workers	$65.45	$1047.20	$98.70	$1579.20	$54.92	$82.47
2 Building Laborers	44.40	710.40	66.25	1060.00		
32 L.H., Daily Totals		$1757.60		$2639.20	$54.92	$82.47
Crew G-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Labor Foreman (outside)	$46.40	$371.20	$69.25	$554.00	$45.07	$67.25
2 Building Laborers	44.40	710.40	66.25	1060.00		
1 Flatbed Truck, Gas, 1.5 Ton		198.50		218.35		
1 Air Compressor, 160 cfm		212.30		233.53	17.12	18.83
24 L.H., Daily Totals		$1492.40		$2065.88	$62.18	$86.08
Crew G-5	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Roofer Foreman (outside)	$50.20	$401.60	$81.35	$650.80	$43.70	$70.83
2 Roofers Composition	48.20	771.20	78.15	1250.40		
2 Roofer Helpers	35.95	575.20	58.25	932.00		
1 Application Equipment		194.80		214.28	4.87	5.36
40 L.H., Daily Totals		$1942.80		$3047.48	$48.57	$76.19
Crew G-6A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Roofers Composition	$48.20	$771.20	$78.15	$1250.40	$48.20	$78.15
1 Small Compressor, Electric		39.30		43.23		
2 Pneumatic Nailers		55.40		60.94	5.92	6.51
16 L.H., Daily Totals		$865.90		$1354.57	$54.12	$84.66
Crew G-7	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$54.70	$437.60	$81.65	$653.20	$54.70	$81.65
1 Small Compressor, Electric		39.30		43.23		
1 Pneumatic Nailer		27.70		30.47	8.38	9.21
8 L.H., Daily Totals		$504.60		$726.90	$63.08	$90.86
Crew H-1	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Glaziers	$52.65	$842.40	$78.40	$1254.40	$56.48	$85.85
2 Struc. Steel Workers	60.30	964.80	93.30	1492.80		
32 L.H., Daily Totals		$1807.20		$2747.20	$56.48	$85.85
Crew H-2	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
2 Glaziers	$52.65	$842.40	$78.40	$1254.40	$49.90	$74.35
1 Building Laborer	44.40	355.20	66.25	530.00		
24 L.H., Daily Totals		$1197.60		$1784.40	$49.90	$74.35
Crew H-3	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Glazier	$52.65	$421.20	$78.40	$627.20	$47.35	$71.03
1 Helper	42.05	336.40	63.65	509.20		
16 L.H., Daily Totals		$757.60		$1136.40	$47.35	$71.03
Crew H-4	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter	$54.70	$437.60	$81.65	$653.20	$51.44	$77.05
1 Carpenter Helper	42.05	336.40	63.65	509.20		
.5 Electrician	63.70	254.80	94.65	378.60		
20 L.H., Daily Totals		$1028.80		$1541.00	$51.44	$77.05

Crews - Standard

Crew J-1	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
3 Plasterers	$49.85	$1196.40	$74.25	$1782.00	$47.73	$71.09
2 Plasterer Helpers	44.55	712.80	66.35	1061.60		
1 Mixing Machine, 6 C.F.		113.35		124.69	2.83	3.12
40 L.H., Daily Totals		$2022.55		$2968.28	$50.56	$74.21

Crew J-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Plasterers	$49.85	$1196.40	$74.25	$1782.00	$48.79	$72.41
2 Plasterer Helpers	44.55	712.80	66.35	1061.60		
1 Lather	54.10	432.80	79.00	632.00		
1 Mixing Machine, 6 C.F.		113.35		124.69	2.36	2.60
48 L.H., Daily Totals		$2455.35		$3600.28	$51.15	$75.01

Crew J-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Terrazzo Worker	$51.75	$414.00	$75.60	$604.80	$47.65	$69.63
1 Terrazzo Helper	43.55	348.40	63.65	509.20		
1 Floor Grinder, 22" Path		96.05		105.66		
1 Terrazzo Mixer		162.90		179.19	16.18	17.80
16 L.H., Daily Totals		$1021.35		$1398.85	$63.83	$87.43

Crew J-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Cement Finishers	$51.80	$828.80	$75.90	$1214.40	$49.33	$72.68
1 Laborer	44.40	355.20	66.25	530.00		
1 Floor Grinder, 22" Path		96.05		105.66		
1 Floor Edger, 7" Path		44.05		48.45		
1 Vacuum Pick-Up System		74.95		82.44	8.96	9.86
24 L.H., Daily Totals		$1399.05		$1980.95	$58.29	$82.54

Crew J-4A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Cement Finishers	$51.80	$828.80	$75.90	$1214.40	$48.10	$71.08
2 Laborers	44.40	710.40	66.25	1060.00		
1 Floor Grinder, 22" Path		96.05		105.66		
1 Floor Edger, 7" Path		44.05		48.45		
1 Vacuum Pick-Up System		74.95		82.44		
1 Floor Auto Scrubber		179.55		197.51	12.33	13.56
32 L.H., Daily Totals		$1933.80		$2708.46	$60.43	$84.64

Crew J-4B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Laborer	$44.40	$355.20	$66.25	$530.00	$44.40	$66.25
1 Floor Auto Scrubber		179.55		197.51	22.44	24.69
8 L.H., Daily Totals		$534.75		$727.51	$66.84	$90.94

Crew J-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Painters	$46.45	$743.20	$68.90	$1102.40	$48.20	$71.69
1 Building Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Air Compressor, 250 cfm		202.85		223.13		
1 Sandblaster, Portable, 3 C.F.		83.85		92.23		
1 Set Sand Blasting Accessories		15.55		17.11	9.45	10.39
32 L.H., Daily Totals		$1844.65		$2626.47	$57.65	$82.08

Crew J-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Painters	$46.45	$743.20	$68.90	$1102.40	$46.45	$68.90
1 Floor Belt Sander		50.20		55.22		
1 Floor Sanding Edger		25.20		27.72	4.71	5.18
16 L.H., Daily Totals		$818.60		$1185.34	$51.16	$74.08

Crew K-1	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Carpenter	$54.70	$437.60	$81.65	$653.20	$51.75	$77.33
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	53.13	58.44
16 L.H., Daily Totals		$1678.05		$2172.26	$104.88	$135.77

Crew K-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$57.13	$87.57
1 Struc. Steel Worker	60.30	482.40	93.30	746.40		
1 Truck Driver (light)	48.80	390.40	73.00	584.00		
1 Flatbed Truck, Gas, 3 Ton		850.05		935.05	35.42	38.96
24 L.H., Daily Totals		$2221.25		$3036.66	$92.55	$126.53

Crew L-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician	$63.70	$509.60	$94.65	$757.20	$65.70	$97.85
1 Plumber	67.70	541.60	101.05	808.40		
16 L.H., Daily Totals		$1051.20		$1565.60	$65.70	$97.85

Crew L-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter	$54.70	$437.60	$81.65	$653.20	$48.38	$72.65
1 Carpenter Helper	42.05	336.40	63.65	509.20		
16 L.H., Daily Totals		$774.00		$1162.40	$48.38	$72.65

Crew L-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter	$54.70	$437.60	$81.65	$653.20	$59.64	$89.16
.5 Electrician	63.70	254.80	94.65	378.60		
.5 Sheet Metal Worker	65.45	261.80	98.70	394.80		
16 L.H., Daily Totals		$954.20		$1426.60	$59.64	$89.16

Crew L-3A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Carpenter Foreman (outside)	$56.70	$453.60	$84.60	$676.80	$59.62	$89.30
.5 Sheet Metal Worker	65.45	261.80	98.70	394.80		
12 L.H., Daily Totals		$715.40		$1071.60	$59.62	$89.30

Crew L-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Skilled Workers	$57.10	$913.60	$85.90	$1374.40	$52.08	$78.48
1 Helper	42.05	336.40	63.65	509.20		
24 L.H., Daily Totals		$1250.00		$1883.60	$52.08	$78.48

Crew L-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$60.75	$93.49
5 Struc. Steel Workers	60.30	2412.00	93.30	3732.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 25 Ton		586.70		645.37	10.48	11.52
56 L.H., Daily Totals		$3988.70		$5880.97	$71.23	$105.02

Crew L-5A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.09	$93.64
2 Structural Steel Workers	60.30	964.80	93.30	1492.80		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 25 Ton		1155.00		1270.50	36.09	39.70
32 L.H., Daily Totals		$3109.80		$4266.90	$97.18	$133.34

Crews - Standard

Crew L-5B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$62.33	$94.01
2 Structural Steel Workers	60.30	964.80	93.30	1492.80		
2 Electricians	63.70	1019.20	94.65	1514.40		
2 Steamfitters/Pipefitters	68.35	1093.60	102.00	1632.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (oiler)	52.50	420.00	78.25	626.00		
1 Hyd. Crane, 80 Ton		1458.00		1603.80	20.25	22.27
72 L.H., Daily Totals		$5945.60		$8372.60	$82.58	$116.29

Crew L-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$66.37	$98.92
.5 Electrician	63.70	254.80	94.65	378.60		
12 L.H., Daily Totals		$796.40		$1187.00	$66.37	$98.92

Crew L-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$53.04	$79.11
1 Building Laborer	44.40	355.20	66.25	530.00		
.5 Electrician	63.70	254.80	94.65	378.60		
28 L.H., Daily Totals		$1485.20		$2215.00	$53.04	$79.11

Crew L-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Carpenters	$54.70	$875.20	$81.65	$1306.40	$57.30	$85.53
.5 Plumber	67.70	270.80	101.05	404.20		
20 L.H., Daily Totals		$1146.00		$1710.60	$57.30	$85.53

Crew L-9	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Labor Foreman (inside)	$44.90	$359.20	$67.00	$536.00	$50.19	$75.58
2 Building Laborers	44.40	710.40	66.25	1060.00		
1 Struc. Steel Worker	60.30	482.40	93.30	746.40		
.5 Electrician	63.70	254.80	94.65	378.60		
36 L.H., Daily Totals		$1806.80		$2721.00	$50.19	$75.58

Crew L-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.35	$93.75
1 Structural Steel Worker	60.30	482.40	93.30	746.40		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	19.82	21.81
24 L.H., Daily Totals		$1948.20		$2773.38	$81.17	$115.56

Crew L-11	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Wreckers	$44.40	$710.40	$67.40	$1078.40	$51.44	$77.26
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Hyd. Excavator, 2.5 C.Y.		1567.00		1723.70		
1 Loader, Skid Steer, 78 H.P.		446.30		490.93	62.92	69.21
32 L.H., Daily Totals		$3659.30		$4687.03	$114.35	$146.47

Crew M-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
3 Elevator Constructors	$90.30	$2167.20	$133.80	$3211.20	$85.79	$127.11
1 Elevator Apprentice	72.25	578.00	107.05	856.40		
5 Hand Tools		50.50		55.55	1.58	1.74
32 L.H., Daily Totals		$2795.70		$4123.15	$87.37	$128.85

Crew M-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman (outside)	$65.70	$525.60	$97.65	$781.20	$67.62	$100.41
1 Common Laborer	44.40	355.20	66.25	530.00		
.25 Equipment Operator (med.)	59.00	118.00	87.90	175.80		
1 Elevator Constructor	90.30	722.40	133.80	1070.40		
1 Elevator Apprentice	72.25	578.00	107.05	856.40		
.25 S.P. Crane, 4x4, 20 Ton		143.59		157.95	4.22	4.65
34 L.H., Daily Totals		$2442.79		$3571.75	$71.85	$105.05

Crew M-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman (outside)	$65.70	$525.60	$97.65	$781.20	$66.92	$99.38
1 Common Laborer	44.40	355.20	66.25	530.00		
.25 Equipment Operator, Crane	61.45	122.90	91.55	183.10		
.25 Equip. Oper. (oiler)	52.50	105.00	78.25	156.50		
1 Elevator Constructor	90.30	722.40	133.80	1070.40		
1 Elevator Apprentice	72.25	578.00	107.05	856.40		
.25 S.P. Crane, 4x4, 40 Ton		190.45		209.50	5.29	5.82
36 L.H., Daily Totals		$2599.55		$3787.09	$72.21	$105.20

Crew Q-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$60.92	$90.92
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
16 L.H., Daily Totals		$974.80		$1454.80	$60.92	$90.92

Crew Q-1A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
.25 Plumber Foreman (outside)	$69.70	$139.40	$104.00	$208.00	$68.10	$101.64
1 Plumber	67.70	541.60	101.05	808.40		
10 L.H., Daily Totals		$681.00		$1016.40	$68.10	$101.64

Crew Q-1C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$60.28	$89.92
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Trencher, Chain Type, 8' D		1894.00		2083.40	78.92	86.81
24 L.H., Daily Totals		$3340.80		$4241.40	$139.20	$176.72

Crew Q-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Plumbers	$67.70	$1083.20	$101.05	$1616.80	$63.18	$94.30
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
24 L.H., Daily Totals		$1516.40		$2263.20	$63.18	$94.30

Crew Q-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber Foreman (inside)	$68.20	$545.60	$101.80	$814.40	$64.44	$96.17
2 Plumbers	67.70	1083.20	101.05	1616.80		
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
32 L.H., Daily Totals		$2062.00		$3077.60	$64.44	$96.17

Crew Q-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber Foreman (inside)	$68.20	$545.60	$101.80	$814.40	$64.44	$96.17
1 Plumber	67.70	541.60	101.05	808.40		
1 Welder (plumber)	67.70	541.60	101.05	808.40		
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Welder, Electric, 300 amp		107.55		118.31	3.36	3.70
32 L.H., Daily Totals		$2169.55		$3195.91	$67.80	$99.87

Crew Q-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter	$68.35	$546.80	$102.00	$816.00	$61.52	$91.83
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
16 L.H., Daily Totals		$984.40		$1469.20	$61.52	$91.83

Crews - Standard

Crew Q-6	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
2 Steamfitters	$68.35	$1093.60	$102.00	$1632.00	$63.80	$95.22
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
24 L.H., Daily Totals		$1531.20		$2285.20	$63.80	$95.22

Crew Q-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter Foreman (inside)	$68.85	$550.80	$102.75	$822.00	$65.06	$97.10
2 Steamfitters	68.35	1093.60	102.00	1632.00		
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
32 L.H., Daily Totals		$2082.00		$3107.20	$65.06	$97.10

Crew Q-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter Foreman (inside)	$68.85	$550.80	$102.75	$822.00	$65.06	$97.10
1 Steamfitter	68.35	546.80	102.00	816.00		
1 Welder (steamfitter)	68.35	546.80	102.00	816.00		
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Welder, Electric, 300 amp		107.55		118.31	3.36	3.70
32 L.H., Daily Totals		$2189.55		$3225.51	$68.42	$100.80

Crew Q-9	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Sheet Metal Worker	$65.45	$523.60	$98.70	$789.60	$58.90	$88.83
1 Sheet Metal Apprentice	52.35	418.80	78.95	631.60		
16 L.H., Daily Totals		$942.40		$1421.20	$58.90	$88.83

Crew Q-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Sheet Metal Workers	$65.45	$1047.20	$98.70	$1579.20	$61.08	$92.12
1 Sheet Metal Apprentice	52.35	418.80	78.95	631.60		
24 L.H., Daily Totals		$1466.00		$2210.80	$61.08	$92.12

Crew Q-11	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Sheet Metal Foreman (inside)	$65.95	$527.60	$99.50	$796.00	$62.30	$93.96
2 Sheet Metal Workers	65.45	1047.20	98.70	1579.20		
1 Sheet Metal Apprentice	52.35	418.80	78.95	631.60		
32 L.H., Daily Totals		$1993.60		$3006.80	$62.30	$93.96

Crew Q-12	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Sprinkler Installer	$66.50	$532.00	$99.35	$794.80	$59.85	$89.42
1 Sprinkler Apprentice	53.20	425.60	79.50	636.00		
16 L.H., Daily Totals		$957.60		$1430.80	$59.85	$89.42

Crew Q-13	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Sprinkler Foreman (inside)	$67.00	$536.00	$100.10	$800.80	$63.30	$94.58
2 Sprinkler Installers	66.50	1064.00	99.35	1589.60		
1 Sprinkler Apprentice	53.20	425.60	79.50	636.00		
32 L.H., Daily Totals		$2025.60		$3026.40	$63.30	$94.58

Crew Q-14	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Asbestos Worker	$60.95	$487.60	$93.25	$746.00	$54.85	$83.90
1 Asbestos Apprentice	48.75	390.00	74.55	596.40		
16 L.H., Daily Totals		$877.60		$1342.40	$54.85	$83.90

Crew Q-15	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$60.92	$90.92
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Welder, Electric, 300 amp		107.55		118.31	6.72	7.39
16 L.H., Daily Totals		$1082.35		$1573.11	$67.65	$98.32

Crew Q-16	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Plumbers	$67.70	$1083.20	$101.05	$1616.80	$63.18	$94.30
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Welder, Electric, 300 amp		107.55		118.31	4.48	4.93
24 L.H., Daily Totals		$1623.95		$2381.51	$67.66	$99.23

Crew Q-17	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter	$68.35	$546.80	$102.00	$816.00	$61.52	$91.83
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Welder, Electric, 300 amp		107.55		118.31	6.72	7.39
16 L.H., Daily Totals		$1091.95		$1587.51	$68.25	$99.22

Crew Q-17A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter	$68.35	$546.80	$102.00	$816.00	$61.50	$91.73
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38		
1 Welder, Electric, 300 amp		107.55		118.31	24.31	26.74
24 L.H., Daily Totals		$2059.35		$2843.28	$85.81	$118.47

Crew Q-18	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Steamfitters	$68.35	$1093.60	$102.00	$1632.00	$63.80	$95.22
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Welder, Electric, 300 amp		107.55		118.31	4.48	4.93
24 L.H., Daily Totals		$1638.75		$2403.51	$68.28	$100.15

Crew Q-19	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Steamfitter	$68.35	$546.80	$102.00	$816.00	$62.25	$92.77
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Electrician	63.70	509.60	94.65	757.20		
24 L.H., Daily Totals		$1494.00		$2226.40	$62.25	$92.77

Crew Q-20	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Sheet Metal Worker	$65.45	$523.60	$98.70	$789.60	$59.86	$89.99
1 Sheet Metal Apprentice	52.35	418.80	78.95	631.60		
.5 Electrician	63.70	254.80	94.65	378.60		
20 L.H., Daily Totals		$1197.20		$1799.80	$59.86	$89.99

Crew Q-21	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Steamfitters	$68.35	$1093.60	$102.00	$1632.00	$63.77	$95.08
1 Steamfitter Apprentice	54.70	437.60	81.65	653.20		
1 Electrician	63.70	509.60	94.65	757.20		
32 L.H., Daily Totals		$2040.80		$3042.40	$63.77	$95.08

Crew Q-22	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$60.92	$90.92
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	29.74	32.71
16 L.H., Daily Totals		$1450.60		$1978.18	$90.66	$123.64

Crew Q-22A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Plumber	$67.70	$541.60	$101.05	$808.40	$56.92	$84.91
1 Plumber Apprentice	54.15	433.20	80.80	646.40		
1 Laborer	44.40	355.20	66.25	530.00		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Hyd. Crane, 12 Ton		475.80		523.38	14.87	16.36
32 L.H., Daily Totals		$2297.40		$3240.58	$71.79	$101.27

Crews - Standard

Crew Q-23	Bare Costs Hr.	Bare Costs Daily	Incl. Subs O&P Hr.	Incl. Subs O&P Daily	Cost Per Labor-Hour Bare Costs	Cost Per Labor-Hour Incl. O&P
1 Plumber Foreman (outside)	$69.70	$557.60	$104.00	$832.00	$65.47	$97.65
1 Plumber	67.70	541.60	101.05	808.40		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Lattice Boom Crane, 20 Ton		1526.00		1678.60	63.58	69.94
24 L.H., Daily Totals		$3097.20		$4022.20	$129.05	$167.59

Crew R-1	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$59.53	$88.46
3 Electricians	63.70	1528.80	94.65	2271.60		
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
48 L.H., Daily Totals		$2857.60		$4246.00	$59.53	$88.46

Crew R-1A	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician	$63.70	$509.60	$94.65	$757.20	$57.33	$85.17
1 Electrician Apprentice	50.95	407.60	75.70	605.60		
16 L.H., Daily Totals		$917.20		$1362.80	$57.33	$85.17

Crew R-1B	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician	$63.70	$509.60	$94.65	$757.20	$55.20	$82.02
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
24 L.H., Daily Totals		$1324.80		$1968.40	$55.20	$82.02

Crew R-1C	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
2 Electricians	$63.70	$1019.20	$94.65	$1514.40	$57.33	$85.17
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
1 Portable cable puller, 8000 lb.		102.65		112.92	3.21	3.53
32 L.H., Daily Totals		$1937.05		$2838.51	$60.53	$88.70

Crew R-2	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$59.81	$88.90
3 Electricians	63.70	1528.80	94.65	2271.60		
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 S.P. Crane, 4x4, 5 Ton		381.95		420.14	6.82	7.50
56 L.H., Daily Totals		$3731.15		$5398.55	$66.63	$96.40

Crew R-3	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$63.45	$94.33
1 Electrician	63.70	509.60	94.65	757.20		
.5 Equip. Oper. (crane)	61.45	245.80	91.55	366.20		
.5 S.P. Crane, 4x4, 5 Ton		190.97		210.07	9.55	10.50
20 L.H., Daily Totals		$1459.97		$2096.67	$73.00	$104.83

Crew R-4	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Struc. Steel Foreman (outside)	$62.30	$498.40	$96.40	$771.20	$61.38	$94.19
3 Struc. Steel Workers	60.30	1447.20	93.30	2239.20		
1 Electrician	63.70	509.60	94.65	757.20		
1 Welder, Gas Engine, 300 amp		148.75		163.63	3.72	4.09
40 L.H., Daily Totals		$2603.95		$3931.22	$65.10	$98.28

Crew R-5	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$55.87	$83.45
4 Electrician Linemen	63.70	2038.40	94.65	3028.80		
2 Electrician Operators	63.70	1019.20	94.65	1514.40		
4 Electrician Groundmen	42.05	1345.60	63.65	2036.80		
1 Crew Truck		168.15		184.97		
1 Flatbed Truck, 20,000 GVW		204.05		224.46		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
.2 Hyd. Crane, 55 Ton		198.03		217.83		
.2 Hyd. Crane, 12 Ton		95.16		104.68		
.2 Earth Auger, Truck-Mtd.		40.51		44.56		
1 Tractor w/Winch		377.65		415.42	13.59	14.95
88 L.H., Daily Totals		$6112.55		$8658.52	$69.46	$98.39

Crew R-6	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$55.87	$83.45
4 Electrician Linemen	63.70	2038.40	94.65	3028.80		
2 Electrician Operators	63.70	1019.20	94.65	1514.40		
4 Electrician Groundmen	42.05	1345.60	63.65	2036.80		
1 Crew Truck		168.15		184.97		
1 Flatbed Truck, 20,000 GVW		204.05		224.46		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
.2 Hyd. Crane, 55 Ton		198.03		217.83		
.2 Hyd. Crane, 12 Ton		95.16		104.68		
.2 Earth Auger, Truck-Mtd.		40.51		44.56		
1 Tractor w/Winch		377.65		415.42		
3 Cable Trailers		194.25		213.68		
.5 Tensioning Rig		55.75		61.33		
.5 Cable Pulling Rig		306.65		337.32	19.91	21.91
88 L.H., Daily Totals		$6669.20		$9270.84	$75.79	$105.35

Crew R-7	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$45.74	$68.94
5 Electrician Groundmen	42.05	1682.00	63.65	2546.00		
1 Crew Truck		168.15		184.97	3.50	3.85
48 L.H., Daily Totals		$2363.75		$3494.17	$49.24	$72.80

Crew R-8	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$56.57	$84.44
3 Electrician Linemen	63.70	1528.80	94.65	2271.60		
2 Electrician Groundmen	42.05	672.80	63.65	1018.40		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
1 Crew Truck		168.15		184.97	5.84	6.42
48 L.H., Daily Totals		$2995.55		$4361.59	$62.41	$90.87

Crew R-9	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$52.94	$79.24
1 Electrician Lineman	63.70	509.60	94.65	757.20		
2 Electrician Operators	63.70	1019.20	94.65	1514.40		
4 Electrician Groundmen	42.05	1345.60	63.65	2036.80		
1 Pickup Truck, 3/4 Ton		112.20		123.42		
1 Crew Truck		168.15		184.97	4.38	4.82
64 L.H., Daily Totals		$3668.35		$5379.98	$57.32	$84.06

Crew R-10	Hr.	Daily	Hr.	Daily	Bare Costs	Incl. O&P
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$60.17	$89.61
4 Electrician Linemen	63.70	2038.40	94.65	3028.80		
1 Electrician Groundman	42.05	336.40	63.65	509.20		
1 Crew Truck		168.15		184.97		
3 Tram Cars		219.60		241.56	8.08	8.89
48 L.H., Daily Totals		$3276.15		$4727.73	$68.25	$98.49

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew R-11	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$60.69	$90.26
4 Electricians	63.70	2038.40	94.65	3028.80		
1 Equip. Oper. (crane)	61.45	491.60	91.55	732.40		
1 Common Laborer	44.40	355.20	66.25	530.00		
1 Crew Truck		168.15		184.97		
1 Hyd. Crane, 12 Ton		475.80		523.38	11.50	12.65
56 L.H., Daily Totals		$4042.75		$5762.74	$72.19	$102.91
Crew R-12	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Carpenter Foreman (inside)	$55.20	$441.60	$82.40	$659.20	$51.90	$77.75
4 Carpenters	54.70	1750.40	81.65	2612.80		
4 Common Laborers	44.40	1420.80	66.25	2120.00		
1 Equip. Oper. (medium)	59.00	472.00	87.90	703.20		
1 Steel Worker	60.30	482.40	93.30	746.40		
1 Dozer, 200 H.P.		1520.00		1672.00		
1 Pickup Truck, 3/4 Ton		112.20		123.42	18.55	20.40
88 L.H., Daily Totals		$6199.40		$8637.02	$70.45	$98.15
Crew R-13	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$61.55	$91.52
3 Electricians	63.70	1528.80	94.65	2271.60		
.25 Equip. Oper. (crane)	61.45	122.90	91.55	183.10		
1 Equipment Oiler	52.50	420.00	78.25	626.00		
.25 Hydraulic Crane, 33 Ton		245.79		270.37	5.85	6.44
42 L.H., Daily Totals		$2831.09		$4114.27	$67.41	$97.96
Crew R-15	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$62.42	$92.78
4 Electricians	63.70	2038.40	94.65	3028.80		
1 Equipment Oper. (light)	55.50	444.00	82.70	661.60		
1 Telescoping Boom Lift, to 40'		281.90		310.09	5.87	6.46
48 L.H., Daily Totals		$3277.90		$4763.69	$68.29	$99.24
Crew R-15A	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$55.98	$83.32
2 Electricians	63.70	1019.20	94.65	1514.40		
2 Common Laborers	44.40	710.40	66.25	1060.00		
1 Equip. Oper. (light)	55.50	444.00	82.70	661.60		
1 Telescoping Boom Lift, to 40'		281.90		310.09	5.87	6.46
48 L.H., Daily Totals		$2969.10		$4309.29	$61.86	$89.78
Crew R-18	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Electrician Foreman	$64.20	$128.40	$95.40	$190.80	$55.89	$83.05
1 Electrician	63.70	509.60	94.65	757.20		
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
26 L.H., Daily Totals		$1453.20		$2159.20	$55.89	$83.05
Crew R-19	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Electrician Foreman	$64.20	$256.80	$95.40	$381.60	$63.80	$94.80
2 Electricians	63.70	1019.20	94.65	1514.40		
20 L.H., Daily Totals		$1276.00		$1896.00	$63.80	$94.80
Crew R-21	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician Foreman	$64.20	$513.60	$95.40	$763.20	$63.71	$94.67
3 Electricians	63.70	1528.80	94.65	2271.60		
.1 Equip. Oper. (medium)	59.00	47.20	87.90	70.32		
.1 S.P. Crane, 4x4, 25 Ton		115.50		127.05	3.52	3.87
32.8 L.H., Daily Totals		$2205.10		$3232.17	$67.23	$98.54

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew R-22	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.66 Electrician Foreman	$64.20	$338.98	$95.40	$503.71	$58.30	$86.62
2 Electricians	63.70	1019.20	94.65	1514.40		
2 Electrician Apprentices	50.95	815.20	75.70	1211.20		
37.28 L.H., Daily Totals		$2173.38		$3229.31	$58.30	$86.62
Crew R-30	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.25 Electrician Foreman (outside)	$65.70	$131.40	$97.65	$195.30	$51.98	$77.40
1 Electrician	63.70	509.60	94.65	757.20		
2 Laborers (Semi-Skilled)	44.40	710.40	66.25	1060.00		
26 L.H., Daily Totals		$1351.40		$2012.50	$51.98	$77.40
Crew R-31	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Electrician	$63.70	$509.60	$94.65	$757.20	$63.70	$94.65
1 Core Drill, Electric, 2.5 H.P.		62.65		68.92	7.83	8.61
8 L.H., Daily Totals		$572.25		$826.12	$71.53	$103.26
Crew W-41E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
.5 Plumber Foreman (outside)	$69.70	$278.80	$104.00	$416.00	$58.78	$87.72
1 Plumber	67.70	541.60	101.05	808.40		
1 Laborer	44.40	355.20	66.25	530.00		
20 L.H., Daily Totals		$1175.60		$1754.40	$58.78	$87.72

Appendix D.4 (continued)

Caterpillar Handbook Pages

Caterpillar Performance Handbook

Edition 29

CATERPILLAR®

CONSTRUCTION & MINING TRUCKS
CONSTRUCTION & MINING TRACTORS

CONTENTS

Features:

- **Caterpillar four-stroke-cycle diesels** … turbocharged, aftercooled, adjustment-free fuel system (direct injection).
- **Electronically-controlled automatic transmission** … speed sensing device automatically shifts transmission between 1st and gear selected by operator.
- **Truck Production Management System (TPMS)** utilizes strut pressure sensors and an on-board microprocessor to determine payload weight, cycle segment times, delay times, actual clock time and date of each cycle.
- **Vital Information Management System (VIMS)** Monitors all vital machine functions. Keeps operator informed of current machine operating conditions, helps reduce downtime and allows service personnel easy access to data for fast accurate diagnosis. VIMS includes Production Management System.
- **Electronic Unit Injection (EUI)** in the 776D-793C and **Hydraulic Electronic Unit Injection (HEUI)** on 769D-775D electronically maintains fuel settings, provides automatic altitude and air filter restriction compensation, automatic variable timing, improved diagnostics and increased fuel efficiency.
- **Oil cooled disc brakes** provide retarding, service, parking, and secondary braking in one sealed, fade-resistant, maintenance-free unit. 769D-777D front brakes are caliper disc, can be switched out of the service system when not needed but activate as part of the secondary system. (Front oil-cooled brakes optional on 777D.) 784C-793C front brakes are oil-cooled disc.
- **Automatic Retarder Control (ARC)** electronically controls braking on grade to maintain faster downhill speeds and consistently higher engine speed.
- **Full hydraulic steering,** with front suspension cylinders serving as kingpins.
- **Four independent,** self-contained, oil-pneumatic suspension cylinders absorb loading and road shocks. Wide spacing for stability.
- **Dual slope body** has V-bottom for load balance and retention. Low loading height and center of gravity.
- **Quarry trucks** have single-slope flat floor for smooth, metered dumping into crushers or hoppers. Optional flat floor body available for 769D, 773D.
- **Integral Roll Over Protective Structure (ROPS)** cab standard on all models.
- **Separate hydraulic systems** prevents cross contamination.

Tractor Features:

- **Yoke type hitch** oscillates four ways to reduce frame stresses. Rugged turn stops prevent excessive wagon rotation either direction.
- **Rear platform** functions as a power train guard and provides safe, stable work area. Fenders and mud flaps protect from material thrown by tires.

NOTE: Listed features may be standard on some models. Optional on others. Contact your Caterpillar Dealer for specific information.



MODEL	769D		769D		771D	
Body Type	**Flat Floor**		**Dual Slope**		**Quarry**	
Gross Vehicle Weight	68 180 kg	**150,000 lb**	68 180 kg	**150,000 lb**	73 970 kg	**163,100 lb**
Chassis Weight*	22 950 kg	**50,600 lb**	22 950 kg	**50,600 lb**	22 950 kg	**50,600 lb**
Body Weight	7800 kg	**17,200 lb**	7330 kg	**16,170 lb**	10 350 kg	**22,820 lb**
Maximum Payload**	37 430 kg	**82,533 lb**	37 900 kg	**83,570 lb**	40 670 kg	**89,680 lb**
Standard Liner Weight	3300 kg	**7280 lb**	3160 kg	**6970 lb**	—	
Payload with Standard Liner	34 130 kg	**75,250 lb**	34 740 kg	**76,600 lb**	—	
Capacity:						
Struck (SAE)	16.5 m^3	**21.6 yd^3**	17 m^3	**22.2 yd^3**	20.2 m^3	**26.4 yd^3**
Heaped (2:1) (SAE)	24.2 m^3	**31.7 yd^3**	24.2 m^3	**31.7 yd^3**	27.5 m^3	**36 yd^3**
Distribution Empty:						
Front	**49.7%**		**49.8%**		**46.3%**	
Rear	**50.3%**		**50.2%**		**53.7%**	
Distribution Loaded:						
Front	**33.2%**		**33.3%**		**32.9%**	
Rear	**66.8%**		**66.7%**		**67.1%**	
Engine Model	**3408E**		**3408E**		**3408E**	
Number of Cylinders	**8**		**8**		**8**	
Bore	137 mm	**5.4"**	137 mm	**5.4"**	137 mm	**5.4"**
Stroke	152 mm	**6"**	152 mm	**6"**	152 mm	**6"**
Displacement	18 L	**1099 in^3**	18 L	**1099 in^3**	18 L	**1099 in^3**
Flywheel Power	362 kW	**485 hp**	362 kW	**485 hp**	362 kW	**485 hp**
Gross Power	380 kW	**510 hp**	380 kW	**510 hp**	380 kW	**510 hp**
Standard Tires	**18.00R33(E-4)**		**18.00R33(E-4)**		**18.00R33(E-4)**	
Machine Clearance Turning Circle	19.8 m	**65'0"**	19.8 m	**65'0"**	19.8 m	**65'0"**
Fuel Tank Refill Capacity	530 L	**140 U.S. gal**	530 L	**140 U.S. gal**	530 L	**140 U.S. gal**
Top Speed (Loaded)	75 km/h	**47 mph**	75 km/h	**47 mph**	56 km/h	**35 mph**
GENERAL DIMENSIONS (Empty):						
Height to Canopy Rock Guard Rail	4.07 m	**13'4"**	4.03 m	**13'3"**	4.02 m	**13'2"**
Wheelbase	3.71 m	**12'2"**	3.71 m	**12'2"**	3.71 m	**12'2"**
Overall Length	8.73 m	**28'7"**	8.57 m	**28'1"**	8.73 m	**28'7"**
Loading Height (Empty)	3.19 m	**10'6"**	3.14 m	**10'4"**	3.40 m	**11'2"**
Height at Full Dump	7.75 m	**25'5"**	7.71 m	**25'3"**	7.74 m	**25'5"**
Body Length (Target Length)	5.43 m	**17'10"**	5.28 m	**17'4"**	5.52 m	**18'1"**
Width (Operating)	5.01 m	**16'5"**	5.01 m	**16'5"**	5.01 m	**16'5"**
Width (Shipping)***	3.95 m	**12'11"**	3.95 m	**12'11"**	3.95 m	**12'11"**
Front Tire Tread	3.10 m	**10'2"**	3.10 m	**10'2"**	3.10 m	**10'2"**

*Weights include lubricants, coolants, and 10% fuel.
**Maximum rating requires selection of proper tires and is dependent on selection of optional equipment. Gross vehicle weight should not be exceeded.
***Disassembled.

Caterpillar Performance Handbook

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CAT®

CATERPILLAR PERFORMANCE HANDBOOK

a publication by Caterpillar Inc., Peoria, Illinois, U.S.A.

JANUARY 2011

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Performance information in this booklet is intended for estimating purposes only. Because of the many variables peculiar to individual jobs (including material characteristics, operator efficiency, underfoot conditions, altitude, etc.), neither Caterpillar Inc. nor its dealers warrant that the machines described will perform as estimated.

NOTE: Always refer to the appropriate Operation and Maintenance Manual for specific product information.

Materials and specifications are subject to change without notice.

Printed in U.S.A.

SEBD0351-41

WHEEL TRACTOR-SCRAPERS
TOWED SCRAPERS

CONTENTS

WHEEL TRACTOR-SCRAPERS

TOWED SCRAPERS

8

Specifications
- Tandem Powered
- Push-Pull



MODEL	627G		637G		657G	
Flywheel Power: Tractor	246/272 kW	**330/365 hp**	345/373 kW	**462/500 hp**	421/447 kW	**564/600 hp**
Scraper	178/198 kW	**239/266 hp**	198/211 kW	**266/283 hp**	306/337 kW	**410/451 hp**
Approx. Operating Weight (Empty)◀	37 922 kg	**83,604 lb**	51 963 kg	**114,559 lb**	68 384 kg	**150,760 lb**
Scraper Capacity: Struck	12 m^3	**15.7 yd^3**	18.3 m^3	**24 yd^3**	24.5 m^3	**32 yd^3**
Heaped	17 m^3	**22 yd^3**	26 m^3	**34 yd^3**	33.6 m^3	**44 yd^3**
Rated Load	23 950 kg	**52,800 lb**	37 013 kg	**81,600 lb**	47 174 kg	**104,000 lb**
Weight Distribution — Empty: Front	**59%**		**59%**		**58%**	
Rear	**41%**		**41%**		**42%**	
Weight Distribution — Loaded: Front	**50%**		**50%**		**50%**	
Rear	**50%**		**50%**		**50%**	
Engine Model: Tractor	**C15 ACERT**		**C18 ACERT**		**C18 ACERT**	
Scraper	**C9 ACERT**		**C9 ACERT**		**C15 ACERT**	
Rated Engine RPM: Tractor	**1800**		**1800**		**1800**	
Scraper	**2000**		**2000**		**1800**	
Displacement: Tractor	15.2 L	**928 in^3**	18.1 L	**1105 in^3**	18.1 L	**1105 in^3**
Scraper	8.8 L	**538 in^3**	8.8 L	**538 in^3**	15.2 L	**928 in^3**
Top Speed (Loaded)	51 km/h	**32 mph**	53 km/h	**33 mph**	53 km/h	**33 mph**
180° Curb-to-Curb Turning Width	11.7 m	**38'5"**	12.2 m	**40'1"**	14.2 m	**46'7"**
Tires — Tractor Drive	**33.25R29★★E3**		**37.25R35★★E3**		**40.5/75R39★★E3**	
Scraper	**33.25R29★★E3**		**37.25R35★★E3**		**40.5/75R39★★E3**	
Width of Cut	3.02 m	**9'11"**	3.51 m	**11'6"**	3.85 m	**12'8"**
Maximum Depth of Cut	333 mm	**13.1"**	437 mm	**17"**	440 mm	**17.3"**
Maximum Depth of Spread	522 mm	**20.6"**	480 mm	**18.9"**	660 mm	**26"**
Fuel Tank Refill Capacity: Tractor	—		—		—	
Scraper	1105 L	**292 U.S. gal**	1268 L	**335 U.S. gal**	1597 L	**424 U.S. gal**
GENERAL DIMENSIONS:						
Height to Top of Scraper	3.81 m	**12'6"**	4.18 m	**13'9"**	4.62 m	**15'2"**
Wheelbase	7.72 m	**25'4"**	8.77 m	**28'9"**	9.96 m	**32'8"**
Overall Length	12.88 m	**42'3"**	14.71 m	**48'3"**	16.2 m	**53'1"**
Overall Width	3.58 m	**11'9"**	3.94 m **	**12'11"**	4.35 m	**14'4"**
Shipping Width (Draft Arm on Inside of Bowl)	—		3.63 m *	**11'11"**	3.91 m **	**12'10"**
Scraper Tread	2.23 m	**7'4"**	2.46 m	**8'1"**	2.81 m	**9'3"**
Tractor Tread	2.20 m	**7'3"**	2.46 m	**8'1"**	2.63 m	**8'8"**
PUSH-PULL GENERAL DIMENSIONS:						
Operating Weight (Empty)◀	39 443 kg	**86,957 lb**	54 057 kg	**119,175 lb**	72 804 kg	**160,505 lb**
Overall Length	15.2 m	**49'7"**	16.64 m	**54'7"**	18.01 m	**59'1"**
Weight Distribution — Empty: Front	**59%**		**60%**		**58%**	
Rear	**41%**		**40%**		**42%**	
Weight Distribution — Loaded: Front	**51%**		**51%**		**51%**	
Rear	**49%**		**49%**		**49%**	

*Optional Shipping Configuration.
**Standard Shipping Configuration.
◀ Operating weight includes standard machine, coolant, lubricants, full fuel tank, and operator.

MODEL	637G 			657G 		
Flywheel Power: Tractor	345/373 kW		**462/500 hp**	421/447 kW		**564/600 hp**
Scraper	198/211 kW		**266/283 hp**	306/337 kW		**410/451 hp**
Approx. Operating Weight (Empty)	54 050 kg		**118,909 lb**	72 190 kg		**158,817 lb**
Scraper Capacity: Struck	31 m^3		**41 yd^3**	45 m^3		**59 yd^3**
Heaped	38 m^3		**50 yd^3**	56 m^3		**73 yd^3**
Rated Load	34 473 kg		**76,000 lb**	49 895 kg		**110,000 lb**
Approx. Operating Weight (Loaded)	88 409 kg		**194,909 lb**	121 933 kg		**268,817 lb**
Top Speed (Loaded)	53 km/h		**33 mph**	53 km/h		**33 mph**
180° Curb-to-Curb Turning Width	13.7 m		**44'10"**	15.6 m		**51'3"**
GENERAL DIMENSIONS:						
Height to Top of Scraper	4.18 m		**13'9"**	4.62 m		**15'2"**
Wheelbase	9.53 m		**31'3"**	11.01 m		**36'1"**
Overall Length	15.47 m		**50'9"**	17.21 m		**56'5"**
Overall Width	3.94 m	**	**12'11"**	4.35 m		**14'4"**
Shipping Width (Draft Arm on Inside of Bowl)	3.63 m	*	**11'11"**	3.91 m	**	**12'10"**
Scraper Tread	2.46 m		**8'1"**	2.81 m		**9'3"**
Tractor Tread	2.46 m		**8'1"**	2.63 m		**8'8"**

*Optional Shipping Configuration.
**Standard Shipping Configuration.

Coal Bowl

Coal Bowl Wheel Tractor-Scrapers are typically used for building and maintaining coal stockpiles and hauling coal to the supply system at coal power plants. The self-loading capability, large capacity, coal pile compaction, and high speed of Coal Bowl Wheel Tractor-Scrapers make them the tool of choice for moving coal both short and long distances. Coal Bowl Wheel Tractor-Scrapers are available in the 637G and 657G tandem engine models.

Coal Bowl Advantages:

- Load hoppers
- Manage coal stockpiles
- Compaction reduces risk of spontaneous combustion in coal stockpile
- Exclusively designed large capacity coal bowls

Notes:

- The 637G Coal Scraper is 736 mm **(29.0")** longer, the bowl sides are 476 mm **(18.7")** taller, and the apron is 499 mm **(19.6")** taller than its earthmoving counterpart.
- The 657G Coal Scraper is 1072 mm **(42.2")** longer, the bowl sides are 1010 mm **(39.8")** taller, the apron is 677 mm **(26.7")** taller, and the ejector is 944 mm **(37.2")** taller than its earthmoving counterpart.

WHEEL LOADERS
INTEGRATED TOOLCARRIERS

CONTENTS

WHEEL LOADERS

Features:

- **Cat heavy duty diesel engine.**
- **Productive operator environment. Excellent visibility.**
- **Automatic lift and bucket controls.**
- **Adjustable suspension seat and steering column.**
- **Four wheel enclosed wet disc brakes.**
- **Automatic power shift transmissions.** Allows operator to select automatic or manual mode.
- **Hydrostatic drive on 906H, 908H and 914G.**
- **Transmission neutralizer switch (924H, 924Hz, 928Hz, 930H, 938H-980H).**
- **Computerized machine function monitoring.**
- **Command control steering** with integrated transmission controls and electro-hydraulic controls … 950H-980H.
- **Lock up clutch on 990H and 994F (optional on 988H).**
- **Impeller clutch on 988H, 990H, 992K, 993K and 994F.**
- **Tilting hood … 938H-980H.**
- **Brake wear indicator.**
- **Limited slip differentials.**
- **Differential locks … 938H.**
- **Automatic Ride Control suspension system.** Operator select "on", "off" or "automatic".
- **Payload control system.**
- **Optional Fusion™ coupler system** for work tool interchangeability with pin-on performance. Work tools can interchange across the entire SWL/MWL/IT line.

Listed features may be standard on some models, optional or unavailable on others. Contact your Cat dealer for specific information.

   

MODEL	**972H**		**980H**		**988H**		**990H**	
Flywheel Power: Net	214 kW	**287 hp**	260 kW	**349 hp**	373 kW	**501 hp**	468 kW	**627 hp**
Gross	229 kW	**307 hp**	293 kW	**392 hp**	414 kW	**555 hp**	512 kW	**687 hp**
Rated Payload*	—		—		11.4 t	**12.5 T**	15 t	**16.5 T**
Gross Rated Bucket Payload*	—		—		16 300 kg	**36,000 lb**	22 700 kg	**50,000 lb**
Engine Model	**C13 ATAAC**		**C15 ATAAC**		**C18 ACERT**		**C27 ACERT**	
Rated Engine RPM	**1800**		**1800**		**1800**		**2000**	
Bore	130 mm	**5.1"**	137 mm	**5.4"**	145 mm	**5.7"**	137 mm	**5.4"**
Stroke	157 mm	**6.2"**	171 mm	**6.75"**	183 mm	**7.2"**	152 mm	**6"**
No. Cylinders	**6**		**6**		**6**		**12**	
Displacement	12.5 L	**763 in^3**	15.2 L	**928 in^3**	18.1 L	**1104.5 in^3**	27.1 L	**1666 in^3**
Speeds Forward	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	7.2	**4.5**	6.6	**4.1**	6.7	**4.2**	7.0	**4.3**
2nd	12.6	**7.8**	11.8	**7.3**	11.8	**7.3**	12.1	**7.5**
3rd	21.4	**13.3**	20.7	**12.9**	20.8	**12.9**	20.8	**13.0**
4th	36.9	**22.9**	36.3	**22.6**	36.0	**22.3**	—	
Speeds Reverse								
1st	8.2	**5.1**	7.6	**4.7**	7.6	**4.7**	7.7	**4.8**
2nd	14.2	**8.8**	13.5	**8.4**	13.5	**8.4**	13.4	**8.3**
3rd	24.3	**15.1**	23.6	**14.7**	23.7	**14.7**	22.9	**14.2**
4th	38.8	**24.0**	41.5	**25.8**	—		—	
Hydraulic Cycle Time, Rated Load in Bucket:	**Seconds**		**Seconds**		**Seconds**		**Seconds**	
Raise	**5.9**		**6.0**		**9.4**		**9.2**	
Dump	**2.1**		**2.1**		**2.4**		**2.9**	
Lower (Empty, Float Down)	**2.4**		**3.4**		**3.8**		**3.8**	
Total	**10.4**		**11.5**		**15.6**		**15.9**	
Tread Width	2.23 m	**7'4"**	2.44 m	**8'0"**	2.59 m	**8'6"**	3.1 m	**10'2"**
Width Over Tires	3.00 m	**9'10"**	3.23 m	**10'7"**	3.54 m	**11'7"**	4.1 m	**13'5"**
Ground Clearance	494 mm	**20"**	442 mm	**17.4"**	549 mm	**22"**	478 mm	**18.8"**
Fuel Tank Capacity	380 L	**100 U.S. gal**	479 L	**127 U.S. gal**	712 L	**188 U.S. gal**	1074 L	**284 U.S. gal**
Hydraulic Tank Capacity	110 L	**29 U.S. gal**	125 L	**33 U.S. gal**	267 L	**70 U.S. gal**	174 L†	**46 U.S. gal**
Hydraulic System Capacity (includes tank)	200 L	**52 U.S. gal**	250 L	**66 U.S. gal**	470 L	**124 U.S. gal**	435 L†	**115 U.S. gal**

*Changes in bucket weight, including field installed wear iron, can impact rated payload. Consult your Cat dealer for assistance in selecting and configuring the proper bucket for the application. The Cat Large Wheel Loader Payload Policy is a guideline intended to maximize wheel loader structural and component life. The Cat Payload Policy is that the "Gross Bucket plus Payload Capacity" is the MAXIMUM weight that should be carried on the end of the Lift Arm/Boom.

†990H has a separate hydraulic system for steering and engine cooling fan. System (including tank) 194 L **(51 U.S. gal)**, tank only 132 L **(35 U.S. gal)**.

Wheel Loaders (cont'd)

Model	Product Ident. No. Prefix	Years Built	Flywheel Horse-power	Approx. Shipping Wt. kg (lb)	Rated Capacity m^3 (yd^3)	Breakout Force kg (lb)	Width Over Tires m (ft)	Ground Clearance mm (in)	Max. Reach at max. height mm (ft)	Dump Clearance at max. height m (ft)	Maximum Speeds km/h (mph) Fwd.	Rev.	Remarks
988	87A	63-76	325	35 800 **(79,000)**	4.6-5.4 **(6.0-7.0)**	21 380 **(47,130)**	3.20 **(10'7")**	570 **(22.5")**	1450 **(4'9")**	3.33 **(10'11")**	30.6 **(19.0)**	30.6 **(19.0)**	
988B	50W	76-93	375	43 365 **(95,600)**	5.4-6.3 **(7.0-8.25)**	36 330 **(80,100)**	3.52 **(11'7")**	474 **(18")**	2150 **(7'1")**	3.19 **(10'5")**	36.2 **(22.5)**	41.4 **(25.7)**	3408 Engine Z Bar Linkage
988F	8YG	93-95	400	43 540 **(95,900)**	5.4-6.1 **(7.0-8.0)**	37 363 **(82,371)**	3.52 **(11'7")**	496 **(19")**	1830 **(6'0")**	3.21 **(10'6")**	35.1 **(21.8)**	23.5 **(14.6)**	Bucket/HP increase STIC Steer
988F Series II	2ZR	95-00	475	45 678 **(100,492)**	6.1-6.9 **(8.0-9.0)**	37 400 **(82,282)**	3.52 **(11'7")**	496 **(1'7")**	1611 **(5'3")**	3.22 **(10'7")**	35.1 **(21.8)**	23.5 **(14.6)**	3048E HEUI Engine Axle Shaft Brakes
988G	2TW	01	475	50 040 **(110,320)**	6.3-7.0 **(8.2-9.2)**	46 950 **(103,500)**	3.47 **(11'5")**	549 **(21.6")**	2113 **(6'11")**	4.0 **(13'1")**	38.7 **(24.0)**	22.3 **(13.8)**	6 Bar Linkage "G" Series
988G	BNH	01-05	475	50 040 **(110,320)**	6.3-7.0 **(8.2-9.2)**	46 950 **(103,500)**	3.47 **(11'5")**	549 **(21.6")**	2113 **(6'11")**	4.0 **(13'11")**	38.6 **(24.0)**	25.1 **(15.6)**	6 Bar Linkage "G" Series
988H	BXY	05	501	49 546 **(109,249)**	6.4-7.0 **(8.33-9.2)**	378.4 **(85,068)**	3.47 **(11'5")**	549 **(22")**	5.85 **(19'2")**	3466 **(11'37")**	36 **(22.3)**	23.7 **(14.7)**	3.88 Meter Linkage
990	7HK	93-95	610	72 910 **(160,600)**	8.6 **(11.2)**	59 776 **(131,784)**	4.13 **(13'6")**	552 **(21.7")**	2070 **(6'10")**	3.99 **(13'1")**	22.5 **(14.0)**	25.0 **(15.5)**	ICTC & New Model
990 Series II	4FR	96-05	625	72 200 **(159,170)**	8.4-9.2 **(11-12)**	63 100 **(138,800)**	4.0 **(13'1")**	490 **(19.3")**	1990 **(6'6")**	4.05 **(13'3")**	22.5 **(14.0)**	25.0 **(15.5)**	HEUI Engine
990H	BWX	05	627	77 842 **(171,642)**	8.6-9.2 **(11.25-12)**	602 **(135,429)**	4.16 **(13'3")**	478 **(18'8")**	8.07 **(26'6")**	4220 **(13'10")**	22.4 **(13.92)**	24.8 **(15.41)**	Standard Lift 8.6 m^3/**11.2 yd^3** Bucket
992	25K	68-73	550	47 670 **(105,100)**	7.65 **(10.0)**	36 900 **(81,360)**	3.93 **(12'11")**	530 **(21")**	2820 **(8'3")**	4.52 **(14'10")**	35.6 **(22.1)**	38.5 **(23.8)**	
992B	25K	73-77	550	64 320 **(141,800)**	7.65 **(10.0)**	29 330 **(84,660)**	— **—**	— **—**	1930 **(6'4")**	4.34 **(14'3")**	40.2 **(25.0)**	43.6 **(27.1)**	
992C	42X	77-81	690	85 640 **(188,800)**	9.6 **(12.5)**	66 240 **(146,030)**	4.55 **(14'11")**	533 **(21")**	2310 **(7'7")**	4.17 **(13'8")**	21.1 **(13.1)**	23.3 **(14.5)**	3412 PCT Engine Z Bar Linkage
992C	49Z	81-92	690	88 430 **(194,950)**	10.4 **(13.5)**	66 285 **(146,132)**	4.50 **(14'9")**	544 **(21")**	2310 **(7'7")**	4.17 **(13'8")**	21.0 **(13.0)**	22.9 **(14.2)**	3412 DIT Engine
992D	7MJ	92-97	710	88 690 **(195,125)**	10.7 **(14.0)**	62 670 **(137,870)**	4.50 **(14'9")**	544 **(21")**	2300 **(7'7")**	4.17 **(13'8")**	21.0 **(13.0)**	22.9 **(14.2)**	
992G	7HR	98-00	800	91 540 **(201,810)**	11.5-12.3 **(15-16)**	62 650 **(137,840)**	4.5 **(14'9")**	691 **(27.2")**	2300 **(7'7")**	4.6 **(15'3")**	20.2 **(12.5)**	22.7 **(14.1)**	6 Bar Linkage "G" Series
992K	H4C	07	801	97 294 **(214,535)**	10.7-12.3 **(14-16)**	584.66 **(128,917)**	— **—**	682 **(2'2")**	9313 **(30'6")**	4480 **(14'8")**	20.6 **(12.8)**	22.4 **(13.9)**	10.7 m^3/**14 yd^3** Bucket
993K	Z9K	07	945	133 637 **(294,800)**	12.8-14.5 **(16.7-19)**	709 **(159,500)**	4.93 **(16'2")**	783 **(30'8")**	9313 **(30'7")**	4849 **(15'11")**	20.1 **(22.1)**	12.5 **(13.7)**	12.8 m^3/**16.7 yd^3** Bucket
994	9YF	90-98	1250	177 000 **(390,300)**	10.3 **(13.4)**	103 420 **(228,000)**	5.20 **(17'1")**	662 **(26")**	2692 **(8'10")**	6.20 **(20'4")**	24.7 **(15.0)**	26.6 **(16.5)**	

CATERPILLAR PERFORMANCE HANDBOOK

a publication by Caterpillar, Peoria, Illinois, U.S.A.

JUNE 2018

Performance information in this booklet is intended for estimating purposes only. Because of the many variables peculiar to individual jobs (including material characteristics, operator efficiency, underfoot conditions, altitude, etc.), neither Caterpillar nor its dealers warrant that the machines described will perform as estimated.

NOTE: Always refer to the appropriate Operation and Maintenance Manual for specific product information.

Materials and specifications are subject to change without notice.

SEBD0351-48

ARTICULATED TRUCKS

CONTENTS

Features:

- **Cat® engines with ACERT™ Technology** meet U.S. EPA Tier 4 Final/EU Stage IV/Japan 2014 (Tier 4 Final), or Tier 2/Stage II/Japan 2001 (Tier 2) equivalent emission standards. The four core elements of meeting these standards are:

  I) Common Rail;

  II) Electronics, ADEM™ A4;

  III) Fuel delivery, Mechanical-activated Electronic Unit Injection (MEUI™ A-C);

  IV) Air Management, Wastegate Turbocharging, Air to Air Aftercooling (ATAAC) with the proven technology of a crossflow cylinder head.

- **Cat electronically controlled transmissions** … Transmissions purpose built and designed for articulated trucks and their applications. Advanced Productivity Electronic Control Strategy (APECS) delivering smooth shifting transmissions with improved acceleration and high productivity. Providing complete integration with the engines for efficient power delivery as well as offering advanced diagnostic and troubleshooting capabilities.

- **Articulating and fully oscillating hitch** … Links front and rear frames for exceptional maneuverability and traction on uneven terrain while eliminating damaging twisting of the frames. Bolted hitch design allows optimum material choices for the cast hitch head and the hard-wearing tube. Bolted design allows easier rebuild and repair.

- **Three-point front suspension** … Three-point front suspension with long-stroke, low-pressure suspension cylinders provide unparalleled ride quality for operator comfort and higher average haul speeds. Front and rear suspension together with the hitch provide for excellent traction in all conditions.

- **Wide, long and low dump body design** … For excellent loadability and high fill factors, excellent machine stability and load retention as well as a good match for other Cat loading systems. Diverging flow design also gives excellent material ejection.

- **Standard ROPS/FOPS, low sound level cab** … Two man cab common across the range. Large cab with excellent visibility, ergonomic control layout and plentiful storage.

- **High capacity low pressure tires in single formation** … For superior traction and flotation in poor underfoot conditions.

- **Bare Chassis offerings** … For certain applications the Caterpillar OEM Solutions Group offers non-dumper/Bare Chassis arrangements.

  Bare Chassis arrangements applications could include: water, service (fuel and lube), high capacity body (waste, coal, etc.), open body (log, pipe, etc.), container carrier, hook lift, tow, cable reel, etc. Please refer to specific OEM for additional information.

Specifications
● Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final)

MODEL	725C2		730C2		730C2 EJ	
Gross Power — SAE J1995	239 kW	**320 hp**	280 kW	**375 hp**	280 kW	**375 hp**
Net Power — SAE J1349	234 kW	**314 hp**	274 kW	**367 hp**	274 kW	**367 hp**
Net Power — ISO 14396	236 kW	**316 hp**	276 kW	**370 hp**	276 kW	**370 hp**
Operating Weight (Empty)*	23 040 kg	**50,795 lb**	23 725 kg	**52,305 lb**	26 395 kg	**57,277 lb**
Top Speed (Loaded)	55 km/h	**34 mph**	55 km/h	**34 mph**	55 km/h	**34 mph**
Gross Machine Weight	47 040 kg	**103,707 lb**	51 725 kg	**114,034 lb**	54 515 kg	**119,270 lb**
Distribution Empty:						
Front	**63%**		**62%**		**59%**	
Center	**19%**		**19%**		**21%**	
Rear	**18%**		**19%**		**20%**	
Distribution Loaded:						
Front	**36%**		**34%**		**30%**	
Center	**32%**		**33%**		**35%**	
Rear	**32%**		**33%**		**35%**	
Max. Capacity**	24.0 t	**26.5 T**	28 t	**31 T**	28 t	**31 T**
Struck (SAE)	11 m^3	**14.4 yd^3**	13.3 m^3	**17.4 yd^3**	13.5 m^3	**17.7 yd^3**
Heaped (2:1) (SAE)	15 m^3	**19.6 yd^3**	17.5 m^3	**23 yd^3**	16.9 m^3	**22.1 yd^3**
Tailgate Heaped SAE 2:1	15.6 m^3	**20.4 yd^3**	18.8 m^3	**24.6 yd^3**	—	
Tailgate Struck	11.1 m^3	**14.5 yd^3**	13.9 m^3	**18.2 yd^3**	—	
Engine Model	**C9.3 ACERT**		**C13 ACERT**		**C13 ACERT**	
No. Cylinders	**6**		**6**		**6**	
Bore	115 mm	**4.53"**	130 mm	**5.12"**	130 mm	**5.12"**
Stroke	149 mm	**5.87"**	157 mm	**6.18"**	157 mm	**6.18"**
Displacement	9.3 L	**567 in^3**	12.5 L	**763 in^3**	12.5 L	**763 in^3**
Tires	**23.5R25**		**23.5R25**		**750/65/R26**	
Clearance Radius	8075 mm	**317.9"**	8075 mm	**317.9"**	8075 mm	**317.9"**
Fuel Tank Refill Capacity	412 L	**108.8 U.S. gal**	412 L	**108.8 U.S. gal**	412 L	**108.8 U.S. gal**
DEF Tank Capacity	20 L	**5.3 U.S. gal**	20 L	**5.3 U.S. gal**	20 L	**5.3 U.S. gal**
General Dimensions (Empty):						
Height to Cab Top	3482 mm	**137.1"**	3482 mm	**137.1"**	3461 mm	**136"**
Overall Length	10 547 mm	**415.2"**	10 555 mm	**415.6"**	10 376 mm	**408.5"**
Loading Height (Empty)	2725 mm	**107.3"**	2911 mm	**114.6"**	3025 mm	**119.1"**
Height at Full Dump	6306 mm	**248.3"**	6464 mm	**254.5"**	—	
Body Length	5696 mm	**224.3"**	5783 mm	**227.7"**	5340 mm	**210.2"**
Width (Operating — Over Mirrors)	3704 mm	**145.8"**	3704 mm	**145.8"**	3704 mm	**145.8"**

*Includes coolant, lubricant and full fuel tank.
**Rating dependent on optional equipment. Maximum gross weight (empty weight plus payload) should not be exceeded.

MODEL	725C2		730C2		730C2 EJ	
Gross Power — SAE J1995	239 kW	**320 hp**	280 kW	**375 hp**	280 kW	**375 hp**
Net Power — SAE J1349	234 kW	**314 hp**	274 kW	**367 hp**	274 kW	**367 hp**
Net Power — ISO 14396	236 kW	**316 hp**	276 kW	**370 hp**	276 kW	**370 hp**
Operating Weight (Empty)*	22 775 kg	**50,211 lb**	23 305 kg	**51,378 lb**	25 980 kg	**57,277 lb**
Top Speed (Loaded)	55 km/h	**34 mph**	55 km/h	**34 mph**	55 km/h	**34 mph**
Gross Machine Weight	46 775 kg	**103,121 lb**	51 305 kg	**113,107 lb**	54 100 kg	**119,270 lb**
Distribution Empty:						
Front	**62%**		**62%**		**58%**	
Center	**19%**		**19%**		**21%**	
Rear	**19%**		**19%**		**21%**	
Distribution Loaded:						
Front	**35%**		**34%**		**29%**	
Center	**33%**		**33%**		**36%**	
Rear	**32%**		**33%**		**35%**	
Max. Capacity**	24.0 t	**26.5 T**	28 t	**31 T**	28 t	**31 T**
Struck (SAE)	11 m^3	**14.4 yd^3**	13.3 m^3	**17.4 yd^3**	13.5 m^3	**17.7 yd^3**
Heaped (2:1) (SAE)	15 m^3	**19.6 yd^3**	17.5 m^3	**23 yd^3**	16.9 m^3	**22.1 yd^3**
Tailgate Heaped SAE 2:1	15.6 m^3	**20.4 yd^3**	18.8 m^3	**24.6 yd^3**	—	
Tailgate Struck	11.1 m^3	**14.5 yd^3**	13.9 m^3	**18.2 yd^3**	—	
Engine Model	**C9.3 ACERT**		**C13 ACERT**		**C13 ACERT**	
No. Cylinders	**6**		**6**		**6**	
Bore	115 mm	**4.53"**	130 mm	**5.12"**	130 mm	**5.12"**
Stroke	149 mm	**5.87"**	157 mm	**6.18"**	157 mm	**6.18"**
Displacement	9.3 L	**567 in^3**	12.5 L	**763 in^3**	12.5 L	**763 in^3**
Tires	**23.5R25**		**23.5R25**		**750/65/R26**	
Clearance Radius	8075 mm	**317.9"**	8075 mm	**317.9"**	8075 mm	**317.9"**
Fuel Tank Refill Capacity	412 L	**108.8 U.S. gal**	412 L	**108.8 U.S. gal**	412 L	**108.8 U.S. gal**
General Dimensions (Empty):						
Height to Cab Top	3482 mm	**137.1"**	3482 mm	**137.1"**	3461 mm	**136"**
Overall Length	10 547 mm	**415.2"**	10 555 mm	**415.6"**	10 376 mm	**408.5"**
Loading Height (Empty)	2725 mm	**107.3"**	2911 mm	**114.6"**	3025 mm	**119.1"**
Height at Full Dump	6306 mm	**248.3"**	6464 mm	**254.5"**	—	
Body Length	5696 mm	**224.3"**	5783 mm	**227.7"**	5340 mm	**210.2"**
Width (Operating — Over Mirrors)	3704 mm	**145.8"**	3704 mm	**145.8"**	3704 mm	**145.8"**

*Includes coolant, lubricant and full fuel tank.
**Rating dependent on optional equipment. Maximum gross weight (empty weight plus payload) should not be exceeded.

HYDRAULIC EXCAVATORS

CONTENTS

HYDRAULIC EXCAVATORS

Cycle Time Estimating Chart

Model		308E2 CR SB	311D LRR	312D, 312D L	315D L	319D L, 319D LN	M314F, M315D2	M316F, M317D2, M318F	M320F, M320D2	M322F, M322D2
Bucket Size	L	220	450	520	520	800	610	750	900	1050
	yd^3	**0.30**	**0.59**	**0.68**	**0.68**	**1.05**	**0.80**	**0.98**	**1.18**	**1.37**
Soil Type		Packed Earth					Sand/Gravel			
Digging Depth	m	1.8	1.5	1.8	3.0	3.0	3.0	3.0	3.0	3.0
	ft	**6'0"**	**5'0"**	**6'0"**	**10'0"**	**10'0"**	**10'0"**	**10'0"**	**10'0"**	**10'0"**
Load Bucket	min	0.08	0.07	0.07	0.07	0.09	0.05	0.06	0.06	0.08
Swing Loaded	min	0.03	0.06	0.06	0.08	0.09	0.05	0.05	0.06	0.06
Dump Bucket	min	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Swing Empty	min	0.08	0.05	0.05	0.06	0.07	0.04	0.04	0.05	0.05
Total Cycle Time	min	0.22	0.21	0.21	0.24	0.28	0.17	0.18	0.20	0.23

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Cycle Time Estimating Chart

Model		320D2	320D RR, 321D CR, 323D2	324D	328D LCR	329D	336D	349D2, 349E, 349F	365C L	385C
Bucket Size	L	800	800	1000	N/A	1100	1400	2400	1900	3760
	yd^3	**1.05**	**1.05**	**1.31**		**1.44**	**1.83**	**3.0**	**2.5**	**5.0**
Soil Type		Hard Clay								
Digging Depth	m	2.3	2.3	3.2	N/A	3.2	3.4	4.0	4.2	5.6
	ft	**8**	**8**	**10**		**10**	**11**	**13**	**14**	**18**
Load Bucket	min	0.09	0.09	0.09	N/A	0.09	0.09	0.13	0.10	0.19
Swing Loaded	min	0.06	0.06	0.06	N/A	0.06	0.07	0.07	0.09	0.06
Dump Bucket	min	0.03	0.03	0.04	N/A	0.04	0.04	0.02	0.04	0.03
Swing Empty	min	0.05	0.05	0.06	N/A	0.06	0.07	0.06	0.07	0.07
Total Cycle Time	min	0.23	0.23	0.25	N/A	0.25	0.27	0.28	0.30	0.35

N/A = Not Applicable

MINING & OFF-HIGHWAY TRUCKS

CONTENTS

MODEL	785C		785D		789D	
Body Type	**Dual Slope**		**Dual Slope**		**Dual Slope**	
Target Gross Machine Weight §	249 476 kg	**550,000 lb**	249 476 kg	**550,000 lb**	324 319 kg	**715,000 lb**
Basic Machine Weight*	59 385 kg	**130,922 lb**	46 240 kg	**101,942 lb**	48 554 kg	**107,043 lb**
Attachments**	21 602 kg	**47,624 lb**	35 781 kg	**78,885 lb**	52 249 kg	**115,190 lb**
Body Weight without Liners***	22 997 kg	**50,700 lb**	22 997 kg	**50,700 lb**	26 606 kg	**58,656 lb**
Full Liner	8113 kg	**17,886 lb**	8113 kg	**17,886 lb**	9692 kg	**21,367 lb**
Operating Machine Weight	112 097 kg	**247,132 lb**	113 131 kg	**249,412 lb**	137 101 kg	**302,256 lb**
Debris (3% of Operating Machine Weight)	3363 kg	**7414 lb**	3394 kg	**7482 lb**	4113 kg	**9068 lb**
Empty Operating Weight	115 460 kg	**254,546 lb**	116 525 kg	**256,894 lb**	141 214 kg	**311,324 lb**
Target Payload §	134.0 m tons	**147.7 tons**	133.0 m tons	**146.6 tons**	183.1 m tons	**201.8 tons**
Capacity:						
Heaped (2:1) (SAE) Base Body	78 m^3	**102 yd^3**	78 m^3	**102 yd^3**	108 m^3	**141 yd^3**
Heaped (2:1) (SAE) with Std. Sideboards	91 m^3	**119 yd^3**	91 m^3	**119 yd^3**	125 m^3	**161 yd^3**
Distribution Empty:						
Front	**45%**		**45.5%**		**46%**	
Rear	**55%**		**54.5%**		**54%**	
Distribution Loaded:						
Front	**33.3%**		**33.3%**		**33%**	
Rear	**66.7%**		**66.7%**		**66%**	
Engine Model	**3512B EUI**		**3512C HD-EUI**		**3516C HD**	
Number of Cylinders	**12**		**12**		**16**	
Bore	170 mm	**6.7"**	170 mm	**6.7"**	170 mm	**6.7 in**
Stroke	190 mm	**7.5"**	215 mm	**8.46"**	210 mm	**8.3 in**
Displacement	51.8 L	**3158 in^3**	58.56 L	**3574 in^3**	78.1 L	**4766 in^3**
Net Power	979 kW	**1313 hp**	979 kW	**1313 hp**	1468 kW	**1969 hp**
Gross Power	1082 kW	**1450 hp**	1082 kW	**1450 hp**	1566 kW	**2100 hp**
Standard Tires	**33.00R51**		**33.00R51**		**37.00R57**	
Machine Clearance Turning Circle	30.6 m	**100'5"**	33.2 m	**108'11"**	30.23 m	**99'2"**
Fuel Tank Refill Capacity	1893 L	**500 U.S. gal**	1893 L	**500 U.S. gal**	2082 L	**550 U.S. gal**
Top Speed (Loaded)	56.5 km/h	**35.1 mph**	56.5 km/h	**35.1 mph**	57.2 km/h	**35.5 mph**
GENERAL DIMENSIONS (Empty):						
Height to Canopy Rock Guard Rail	5.77 m	**19'0"**	5.68 m	**18'7"**	6.50 m	**21'4"**
Wheelbase	5.18 m	**17'0"**	5.18 m	**17'0"**	5.70 m	**18'8"**
Overall Length (Base Body)	11.02 m	**36'3"**	11.55 m	**37'9"**	12.72 m	**41'9"**
Loading Height (Base Body)	4.97 m	**16'4"**	4.97 m	**16'4"**	5.60 m	**18'4"**
Height at Full Dump	11.21 m	**36'10"**	11.81 m	**38'9"**	13.20 m	**43'4"**
Body Length (Target Length)	7.65 m	**25'2"**	7.65 m	**25'2"**	8.29 m	**27'3"**
Width (Operating)	6.64 m	**21'10"**	7.06 m	**23'2"**	7.65 m	**25'1"**
Width (Shipping)****	3.91 m	**12'10"**	3.91 m	**12'10"**	3.84 m	**12'7"**
Front Tire Tread	4.85 m	**15'11"**	4.85 m	**15'11"**	5.37 m	**17'8"**

*See Weight Definitions and Relations on page 18 of this section. Note: No mandatory or optional attachments or fuel.
**Typical selection of mandatory and optional attachments.
***Data provided is for a representative body and liner package. Several dual slope, flat floor, and mine specific design (MSD) bodies and liner packages are available. All weights, capacities, and dimensions are dependent on the machine configuration (body type, attachments, tires, and optional equipment selected).
****Disassembled.
§Reference Caterpillar's latest 10/10/20 Payload Policy for information on gross machine operating weight and target payload.
NOTE: Contact Mining Representative to use Caterpillar Weight Configurator for application specific weights.

USE OF BRAKE PERFORMANCE CURVES

The speed that can be maintained when the machine is descending a grade with retarder applied can be determined from the retarder curves in this section when gross machine weight and total effective grade are known.

Select appropriate grade distance chart that covers total downhill haul; don't break haul into individual segments.

To determine brake performance: Read from gross weight down to the percent effective grade. (Effective grade equals actual % grade *minus* 1% for each 10 kg/metric ton (20 lb/U.S. ton) of rolling resistance.) From this weight-effective grade point, read horizontally to the curve with the highest obtainable speed range, then down to maximum descent speed brakes can safely handle without exceeding cooling capacity. When braking, engine RPM should be maintained at the highest possible level without overspeeding. If cooling oil overheats, reduce ground speed to allow transmission to shift to next lower speed range.

Brake Performance Curves are made in compliance with ISO 10268 and applicable to Sea Level and 32° C (90° F) temperature. Contact Factory for Application Specific Performance.

USE OF RIMPULL-SPEED-GRADEABILITY CURVES

For best results, use Caterpillar Fleet Production and Cost Analysis (FPC) to simulate cycle time, fuel burn, and production for Application Specific Performance inquiries. Contact Factory Representative or visit catminer.cat.com/stb for more information.

(See Wheel Tractor Scraper Section)

Total Effective Grade (or Total Resistance) is grade assistance *minus* rolling resistance.

10 kg/metric ton (20 lb/U.S. ton) = 1% adverse grade.

Example —

With a favorable grade of 20% and rolling resistance of 50 kg/metric ton (100 lb/U.S. ton), find Total Effective Grade.

(50 kg/metric ton) = 50 ÷ 10 = 5% Effective Grade
(from Rolling Resistance)
100 lb/ton = 100 ÷ 20 = 5% Effective Grade
20% (grade) – 5% (resistance) =
15% Total Effective Grade

TYPICAL FIXED TIMES FOR HAULING UNITS

Wait time, delays and operator efficiency all impact cycle time. Minimizing truck exchange time can have a significant effect on productivity.

Fixed time for hauling units include:
1. Truck load time (various with loading tool)
2. Truck maneuver in load area (Truck exchange) (Typically 0.6-0.8 min.)
3. Maneuver and dump time at dump point (Typically 1.0-1.2 min.)

Total cycle time is the combination of:
1. The above fixed time
2. Hauling time (Loaded)
3. Return time (Empty)

Example — assume load tool spots hauler with full bucket

		988F	5130B
cycle times		.60	.45
First pass	(dump time)	.10 min.	.05 min.
2 passes	(full cycle)	.70	.50
3 passes	"	1.30	.95
4 passes	"	1.90	1.40
5 passes	"	2.50	1.85
6 passes	"	3.10	2.30
7 passes	"	3.70	2.75
8 passes	"	4.30	3.20
9 passes	"	4.90	3.65
10 passes	"	5.40	4.10

NOTE: Other sizes of loading tools will have different cycle times. See Wheel Loader section for **average** cycle times for truck loading.

MOTOR GRADERS

CONTENTS

INDUSTRIES SERVED

The motor grader is one of the most versatile work tools in the Cat® product line. The M Series machines are used in numerous applications within a wide range of industries. The major industries using Cat motor graders, along with the typical applications within each, are summarized below.

- **Heavy Construction**
  - Highway Construction
  - Paving/Resurfacing
  - Airport Construction
  - Railroad Construction
  - Dam and Levee Construction
  - Haul Road Maintenance
- **Governmental**
  - Road Maintenance
  - Road Construction
  - Ditch Building/Cleaning
  - Snow Removal
- **Building Construction**
  - Residential Construction
  - Commercial Construction
  - Industrial Construction
  - Sewer and Water Systems
- **Industrial**
  - Waste Disposal
  - Pipeline Construction
- **Mining**
  - Haul Road Maintenance
  - Snow Removal
- **Forestry**
  - Access Road Construction
  - Forest Development
  - Snow Removal
  - Haul Road Maintenance
- **Geographic Versions** — Cat motor graders were specifically designed to meet the needs of different geographic regions and regulations. K/K2 Series for less regulated locations and M/M2/M3 Series are available with an assortment of standard features and optional equipment. All motor graders feature advanced electronically controlled Cat engines, power train components, hydraulics and machine structures.

FEATURES, M Series Motor Graders:

Building on the strong heritage of the H Series, the M Series delivers multiple technological breakthroughs, setting the new standard for motor graders. The H Series has been the industry standard in a variety of heavy construction, mining, road building and governmental applications. The M Series continues this tradition, incorporating revolutionary, customer-driven enhancements by:

– Improving ease of operation and operation training time
– Offering best-in-class operator station and unmatched visibility
– Delivering maximum productivity
– Improving availability and decreasing maintenance time

The M Series line includes eleven models: 120, 120 AWD, 140, 140 AWD, 160, 160 AWD, 12, 12 AWD, 14, 16, 24. The 120 through 14 meet construction, road building, and governmental applications. The All Wheel Drive models improve traction in poor underfoot conditions such as snow, mud, and sand. The 16 and 24 meet the specialized needs of large mining customers.

- **Operation Station:** The 120 through 16 models feature a revolutionary cab design that provides unmatched comfort, visibility, storage and ease of use, which can enhance operator confidence and productivity. The interior noise level is maintained between 70 and 74 dB(A) with the doors and windows closed.

  Ease of Operation. The revolutionary joystick controls and exceptional visibility make operating easier without sacrificing control. The intuitive joystick control pattern allows both new and experienced operators to become productive quickly. Logical grouping of hydraulic functions in the joysticks allow any operator to easily control several functions at the same time. This allows the operator to be more productive and remain comfortable throughout the work shift.

  Advanced Joystick Controls. Two electro-hydraulic joysticks reduce hand and wrist movement as much as 78% compared to conventional lever controls for greatly enhanced operator efficiency. The intuitive pattern is easy to learn and provides the precise implement control to allow both new and experienced operators to become productive quickly. Logical grouping of hydraulic functions in the joysticks allow any operator to control several functions at the same time for more productivity.

  Visibility. The 120 through 16 models boast excellent visibility to the work area, made possible with angled cab doors, a tapered engine enclosure and a patented sloped rear window. Ample glass area and carefully placed components provide excellent visibility to enhance operator confidence and productivity in all motor grader applications. The cab design gives the operator an exceptional view forward to the blade, working surface and front tires. The black glare-reducing paint on the front frame and engine enclosure enhances visibility.

- **Drawbar, Circle and Moldboard:** The 120 through 16 models provide a broad range of extended blade positions particularly beneficial in mid-range bank sloping, ditch cutting and ditch cleaning. A long wheel base allows for an aggressive blade angle permitting material to roll more freely, reducing power requirements. Top-accessible drawbar wear inserts and the shimless moldboard retention system make DCM adjustments fast and simple, delivering more precise material control while lowering operating costs.

  Top-Adjust Drawbar Wear Strips. The patented top-adjust wear strips dramatically reduce drawbar/circle adjustment time. By removing the access plates on top of the drawbar, shims and wear strips can easily be added or replaced. This feature reduces service downtime and lowers overall machine operating costs.

  Shimless Moldboard Retention System. The unique shimless moldboard retention system reduces the potential for blade chatter. Adjusting screws keep the moldboard's wear strips aligned for precise blade control and dramatic reductions in service time.

- **Power Train:** Integrated, electronically controlled systems, deliver smooth reliable performance with reduced operating costs.

  Smooth Shifting Transmission. The transmission design combines several key innovations to ensure smooth, powerful shifts throughout the gear range.

  Advanced Productivity Electronics Control Strategy (APECS). APECS utilizes an electronic control strategy to read the input from sensors to shift the transmission at the optimal point. Event based shifting allows operators to experience faster, smoother and more consistent shifts. Note: M Series 3 Only.

  Electronically Controlled Shifting. The full Electronic Clutch Pressure Control (ECPC) system optimizes inching modulation and smoothes shifting between all gears and directional changes. This provides outstanding control and also extends the life of the transmission by reducing stress on gears.

  Load Compensation. This standard feature ensures consistent shift quality regardless of blade or machine load.

  Hydraulic Brakes. The oil bathed, multi-disc service brakes are hydraulically actuated, providing smooth predictable braking and lower operating costs. With brakes located at each tandem wheel, the Cat motor graders offer the largest total brake surface area in the industry, delivering dependable stopping power and longer brake life.

- **Engine:** The Cat motor grader combines power management with ACERT™ Technology to deliver maximum power and efficiency while reducing the environmental impact.

  ACERT Technology. ACERT Technology allows Cat engines to supply more power per unit of displacement without causing premature wear. This breakthrough technology reduces emissions during the combustion process by using advanced technology in the air and fuel systems, in conjunction with integrated electronics. ACERT Technology enhances overall engine performance while dramatically reducing exhaust emissions.

  Power Management. Power Management utilizes Variable Horse Power (VHP) and Variable Horse Power Plus (VHP Plus) to optimize motor grader performance. VHP delivers additional power in the working gear while balancing fuel consumption, traction and horsepower. VHP Plus, delivers additional power in each forward gear 5th through 8th for increased speed on grade and performance.

  Exhaust Emission Standards. The Cat ACERT Technology engines in the M Series Motor Graders meet U.S. EPA Tier 3/EU Stage IIIA equivalent/Japan 2006 (Tier 3) emission standards. The M Series 2 machines meet U.S. EPA Tier 4 Interim/EU Stage IIIB/Japan 2011 (Tier 4 Interim) equivalent emission standards. The M Series 3 machines meet U.S. EPA Tier 4 Final/ EU Stage IV/Japan 2014 (Tier 4 Final) emission standards.

- **Hydraulics:** Electro-hydraulics enable advanced machine controls with precise and predictable movements.

  Advanced Electro-Hydraulic System. The Cat motor grader product line incorporates a state-of-the-art electro-hydraulic system. This technology is the foundation for revolutionary changes of the machine and implement controls. Advanced joystick controls provide unmatched controllability with precise, predictable hydraulic movements and the reliability you expect from Cat products.

  Load Sensing Hydraulics (PPPC). The time proven load-sensing system and the advanced Proportional Priority Pressure-Compensating (PPPC, or "triple-PC") electro-hydraulic valves are designed to provide superior implement control and enhanced machine performance in all applications. Continuous matching of hydraulic flow and pressure to power demands creates less heat and reduces power consumption.

- **Serviceability:**

  Grouped Service Points. Grouped daily service points in the left side service center help ensure proper maintenance and inspection routines.

  Extended Service Intervals. Extended service intervals, such as 500-hour engine oil changes and 4000-hour hydraulic oil changes, reduce machine service time and increase availability.

  Ecology Drains. Conveniently located ecology drains shorten service times and help keep the environment safe by preventing spills.

  Diagnostics and Monitoring. Cat Messenger and Cat Message are offered as standard equipment to enhance diagnostic capabilities by displaying machine system errors and fault codes. Cat Electronic Technician is a two way communication tool that provides easy access to stored diagnostic data and lets technicians configure machine parameters through the Cat Data Link. Product Link™ provides a communication flow of vital machine data and location. Cat motor graders integrate Cat Messenger, Cat Electronic Technician, and S•O•S℠ analysis for easy monitoring and fast troubleshooting, keeping your machine up and running. Note: Cat Messenger is standard on M Series and M Series 2 only. Cat Message is standard on M Series 3 only.

- **Safety.** Safety is an integral part of all machine and system designs. Cat motor graders provide a safe working environment for both the operator and ground personnel. ROPS and FOPS structures meeting current SAE and ISO requirements are standard on all Global machines. Back-up alarms are a standard feature.

  Operator Presence System. The Operator Presence System keeps the parking brake engaged until the operator is seated for safe operation.

  Secondary Steering System. The standard secondary steering system automatically engages in case of a drop in steering pressure, allowing the operator to steer the machine to a stop.

  Speed Sensitive Steering. The steering software automatically provides an infinitely variable ratio between the joystick and the steer tires, resulting in less sensitive steering as the groundspeed increases.

  Hydraulic Lockout. A simple switch located in the cab disables all implement functions while still providing machine steering control. This safety feature is especially useful while the machine is roading.

  Circle Drive Slip Clutch. This standard feature protects the drawbar, circle and moldboard from shock loads when the end of the blade encounters immovable objects. It also reduces the possibility of abrupt directional changes in poor traction conditions, protecting the machine, operator and surroundings.

  Blade Lift Accumulators. This optional feature uses accumulators to help absorb impact loads to the moldboard by allowing vertical blade travel. Blade lift accumulators reduce unnecessary wear and help to avoid unintended machine movement for increased operator safety.

  Drop-Down Rear Lights. Optional drop-down lights fold out from the rear of the machine. This creates a wider, lower profile, to be better aligned with passenger cars.

  Rearview Camera. Visibility is further enhanced with an optional Work Area Vision System (WAVS) LCD color monitor in the cab.

- **Automatic Differential Lock/Unlock.** The Auto Diff-Lock feature automatically unlocks the differential during a turn, re-locks when straight, for easier operation and improved power train protection.

- **Swing Out Cooling Fan.** This standard feature allows for easy access to the cooling cores reducing time required for clean out. The latched door requires no tools for opening and closing. Note: M Series 2 and M Series 3 Only.

APPLICATIONS, Motor Graders:

The broad line of Cat motor graders allows the customer to choose a motor grader that best fits the intended application. Below is a summary of the typical motor grader applications.

Finish Grading

This application involves preparing a roadway or site surface for future paving or other construction activity. The material being moved is usually a hard, dry base material on a solid underfoot. Finish blading is the motor grader application that requires the highest degree of accuracy. Thus, it is primarily done at low operating speeds — usually less than 5 km/h (3 mph) — in gears 1 and 2. To ensure a smooth, even finished surface, one gear is usually maintained for a given pass. Pass lengths during this application are usually less than 600 m (2000 feet) for road construction and 150 m (500 feet) for site development. Most finish blading is performed by contractors in the Heavy Construction and Building Construction industries.

Heavy Blading

This application involves cutting, moving, and mixing material, usually in the initial stages of surface preparation. A variety of material types are moved in this manner, and the blade tip position varies accordingly. Full blade loads are usually experienced during heavy blading, since moving material is the primary goal. Pass lengths within this application vary, but are usually less than 600 m (2000 feet). Unlike finish blading, the speed of the machine is dependent on the load being moved when heavy blading material. Typical operating speeds are from 0-10 km/h (0 to 6 mph). Therefore, gears 2 through 4 are frequently used in this application. Most heavy blading activity is performed by contractors in the Heavy Construction, Governmental, Industrial, and Forestry industries.

Site Preparation

This application involves any material cutting, moving, and mixing necessary to prepare a residential, commercial, or industrial site for construction. A variety of materials are encountered in this application. Blade loads vary depending on the activity being performed. Both heavy blading and finish blading are performed when preparing a site. Pass lengths are typically in the range of 30-300 m (100 to 1000 feet). Typical operating speeds for site preparation vary depending on whether heavy blading or finish blading activities are being performed. Most site preparation activities are performed by contractors in the Building Construction industry.

Road Maintenance

This application involves reshaping dirt or gravel roads to maintain a crown or superelevation, or restoring the surface itself. This generally involves secondary roads maintained by governmental bodies such as townships and counties. Materials being moved in this application vary from extremely hard dirt bases to moist gravel surfaces. The typical blade load falls between that of finish blading and heavy blading. Pass lengths are frequently longer than 600 m (2000 feet) and can extend for miles. The general speed range for this application is 5-16 km/h (3 to 10 mph), corresponding to gears 2 (heavy dirt) through 5 (soft gravel). As with finish blading, accuracy of the graded surface is the primary concern in this application. Thus, frequent shifts should be avoided whenever possible. A gear should be chosen and maintained unless there is a significant change in the material being moved. Most road maintenance activities are performed by the Governmental industry.

Haul Road Maintenance

This application of the motor grader involves reshaping haul roads at mining, construction, or forestry work sites, usually for the purpose of maintaining smooth travel surfaces for equipment. Materials being moved while maintaining haul roads vary widely. Typical blade loads are about one-third to half of full capacity. Haul roads that experience large hauling units travelling on soft material may require heavy blade loads in order to reshape the road surface. Pass lengths vary depending on the application but can extend for miles on remote forestry or large mine haul roads. The general speed range for haul road maintenance is heavily dependent on the material being moved as well as the grade of the haul road. Many mine sites are in mountainous areas, requiring haul roads with steep grades. Generally, haul-road maintenance is performed at speeds similar to those required for general road maintenance 5-16 km/h (3 to 10 mph).

A travel surface that allows for the safe and efficient movement of machinery is the ultimate goal with this motor grader application. Very precise roadway elevations and slopes are desired but less crucial than when finish blading. Most haul road maintenance activities are performed by the Mining, Heavy Construction, and Forestry industries.

Side/Bank Slope Work

This application involves preparing side slopes or bank slopes along roadways by placing the moldboard on a sloped surface. Slopes of up to a 2:1 angle can be cut using a motor grader. Often the motor grader is operated on the level surface adjacent to the slope, and the moldboard is extended outward to the sloped surface. Fine soils are generally encountered in this application of the motor grader. Blade loads are usually less than half of the full blade capacity, and pass lengths are seldom longer than 600 m (2000 feet). A smooth-graded sloped surface is the primary concern in this application so frequent shifts should be avoided. The typical speed range is 0-6 km/h (0 to 4 mph), corresponding to a gear selection of 1 to 3. The nominal speed is heavily dependent on the type of material being moved and on the slope of the surface. Most side/bank slope work is performed by the Heavy Construction and Governmental industries.

Ditch Building/Cleaning

This application involves cutting "V" and flat-bottom ditches for drainage purposes and rebuilding them when necessary. Due to excessive rain and/or poor material, ditches often need cleaning and reshaping. When building ditches, materials with a wide range of densities are encountered. Blade loads vary accordingly, from half to full-blade capacity. Pass lengths are usually less than 600 m (2000 feet). The primary objective is to move material in a manner that yields a ditch with the desired slope. Ditch building often involves cutting and moving material of high density. Therefore, typical speed ranges vary. Most ditch building work, however, is performed in gears 1 through 3, corresponding to a maximum speed of about 8 km/h (5 mph). Ditch cleaning usually involves blading moist materials underneath a sod cover. Blade loads are usually less than half of full blade capacity when cleaning ditches, and pass lengths are similar to those encountered in ditch building. Typical maximum speeds for this activity are similar to that of ditch building, but less of a blade load is experienced. Ditch building and cleaning activities are usually performed by the Heavy Construction and Governmental industries.

Ripping/Scarifying

This application involves conditioning hard, rough soils before they are bladed. Shanks on the ripper and/or scarifier are pushed into the ground, thus breaking up otherwise hard surfaces. Hard materials such as asphalt can also be loosened in order to make grading operations less damaging to the moldboard. Rippers and scarifiers can also be used to mix aggregates together. The materials being ripped/ scarified are usually hard and dry. Rippers generally penetrate 150-300 mm (6 to 12 inches) into the ground, while scarifiers typically penetrate to a depth of 25-200 mm (1 to 8 inches). Pass lengths are generally less than 600 m (2000 feet) for both activities. Since the material being ripped/scarified is generally hard, the typical maximum speed for this application is about 6 km/h (4 mph) gears 1-2. If the ripper/scarifier is used for mixing aggregates, the typical operating range becomes 6-20 km/h (4 to 12 mph) gears 3-6. Most ripping/scarifying activities are performed by the Heavy Construction and Governmental industries.

Snow Removal

Snow removal is the process of cutting and removing snow or ice from the roadway. In addition to the standard motor grader moldboard, other attachments such as a snow wing, V-plow, one-way plow, or reversible plow can be used to remove the snow. The moldboard itself is the most commonly used attachment for snow plowing. It is used in areas where snow depths are low, the terrain is relatively flat, and where excessive drifting does not occur. A snow wing is a moldboard that attaches to the machine's right side. The wing's curvature lifts the snow and "wings" it off the plowed surface. The snow wing is often used in conjunction with the standard moldboard, where the moldboard cuts the material and feeds it onto the wing. V-plows are mounted in front of the motor grader and are designed to dig into and lift packed snow. The typical speed range for snow removal is 10-30 km/h (6 to 18 mph), corresponding to a gear range of 3 to 7. Snow plowing often involves lower speeds than snow removal. The typical operating range for snow plowing is 8-19 km/h (5 to 12 mph) gears 2 to 4. The majority of Snow Removal/Plowing operations are performed by the Governmental, Mining, and Forestry industries.

TRUCK TO MOTOR GRADER MATCH

	740	770	775	777	785	789	793	797
12/140/160								
14								
16								
18								
24								

NOTE: Calculations based on 30 degree blade angle, standard moldboard width.
May not be applicable in all applications depending on haul road damage.
Rule of thumb 2.5 times the truck width.

MODEL	14M3		16M3	
Base Power — Net	178 kW	**238 hp**	216 kW	**290 hp**
VHP Range — Net	178-213 kW	**238-285 hp**	216-259 kW	**290-348 hp**
VHP Plus Range — Net	180-215 kW	**241-289 hp**	—	
Operating Weight*	25 968 kg	**57,250 lb**	32 411 kg	**71,454 lb**
Engine Model	**C13 ACERT**		**C13 ACERT**	
Rated Engine RPM	**1850**		**2000**	
No. of Cylinders	**6**		**6**	
Displacement	12.5 L	**763 in^3**	12.5 L	**763 in^3**
Max. Torque:				
Tier 4 Final[1]	1542 N·m	**1137 lb-ft**	1771 N·m	**1306 lb-ft**
Tier 2 and Tier 3 Equivalent[2]	1542 N·m	**1137 lb-ft**	1721 N·m	**1270 lb-ft**
No. of Speeds Forward/Reverse	**8/6**		**8/6**	
Top Speed: Forward	50.5 km/h	**31.4 mph**	51.7 km/h	**32.1 mph**
Reverse	39.9 km/h	**24.8 mph**	40.8 km/h	**25.3 mph**
Std. Tires — Front and Rear	**20.5R25**		**23.5R25**	
Front Axle/Steering:				
Oscillation Angle	**32°**		**35°**	
Wheel Lean Angle — Left/Right	**17.1°/17.1°**		**18°/17°**	
Steering Angle	**50°**		**47.5°**	
Articulation Angle	**20°**		**20°**	
Minimum Turning Radius**	7.9 m	**25'11"**	9.3 m	**30'6"**
No. Circle Support Shoes	**6**		**6**	
Hydraulics:				
Pump Type	**Variable Piston**		**Variable Piston**	
Max. Pump Flow	257 L/min	**68 gpm**	280 L/min	**74 gpm**
Tank Capacity	64 L	**16.9 U.S. gal**	70 L	**18.5 U.S. gal**
Implement Pressure: Max.	24 100 kPa	**3495 psi**	24 750 kPa	**3590 psi**
Min.	3400 kPa	**493 psi**	3400 kPa	**493 psi**
Interior Sound Level/SAE J919:				
Tier 4 Final/EU Certified[1]	**73 dB(A)**		**71 dB(A)**	
Tier 2 and Tier 3 Equivalent[2]	**73 dB(A)**		**72 dB(A)**	
Electrical:				
System Size	**24V**		**24V**	
Std. Battery CCA @ 0° F	**1125**		**1400**	
Std. Alternator	**150**		**150**	
GENERAL DIMENSIONS:				
Height (to top of ROPS)	3566 mm	**140.4"**	3719 mm	**146.4"**
Overall Length	9677 mm	**381"**	10 593 mm	**417"**
With Ripper and Pushplate	10 899 mm	**429.1"**	12 051 mm	**474.4"**
Wheelbase	6616 mm	**260.5"**	7365 mm	**290"**
Blade Base	2880 mm	**113.4"**	3066 mm	**120.7"**
Overall Width (at top of front tires)	3050 mm	**120.1"**	3411 mm	**134.3"**
Standard Blade: Length	4267 mm	**14'0"**	4877 mm	**16'0"**
Height	585 mm	**23.0"**	787 mm	**31.0"**
Thickness	25.4 mm	**1.0"**	25 mm	**1.0"**
Lift Above Ground	438 mm	**17.2"**	400 mm	**15.7"**
Max. Shoulder Reach:***				
Frame Straight — Left	3460 mm	**136.2"**	2311 mm	**91"**
Frame Straight — Right	3350 mm	**131.9"**	2311 mm	**91"**
Fuel Tank Capacity	416 L	**109.9 U.S. gal**	496 L	**131 U.S. gal**

***Operating Weight** — based on standard machine configuration with full fuel tank, coolant, lubricants and operator.
****Minimum Turning Radius** — combining the use of articulated frame steering, front wheel steer and unlocked differential.
***Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.
[1] Meets Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.
[2] Meets Tier 2/Stage II/Japan 2001 (Tier 2) equivalent and Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.

TRAVEL SPEEDS @ MAXIMUM RPM WITH STD. TIRES (M/M2/M3 SERIES)

Gear		1		2		3		4		5		6		7		8	
		km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
120M	Forward	4.1	**2.6**	5.6	**3.5**	8.2	**5.1**	11.2	**7.0**	17.5	**10.8**	23.7	**14.8**	32.7	**20.3**	47.5	**29.5**
	Reverse	3.3	**2.0**	6.1	**3.8**	8.9	**5.5**	13.8	**8.6**	25.8	**16.0**	37.5	**23.3**	—	—	—	—
120M2	Forward	4.0	**2.5**	5.4	**3.4**	7.8	**4.8**	10.8	**6.7**	16.8	**10.4**	22.8	**14.2**	31.4	**19.5**	45.7	**28.4**
	Reverse	3.1	**1.9**	5.9	**3.9**	8.5	**5.3**	13.2	**8.2**	24.8	**15.4**	36.1	**22.4**	—	—	—	—
12M	Forward	4.0	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.8**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**22.9**	—	—	—	—
12M2	Forward	4.1	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.9**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**22.9**	—	—	—	—
12M3	Forward	4.1	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.9**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**23.0**	—	—	—	—
140M	Forward	4.0	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.9**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**22.9**	—	—	—	—
140M2	Forward	4.1	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.9**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**22.9**	—	—	—	—
140M3	Forward	4.1	**2.5**	5.5	**3.4**	8.0	**5.0**	11.0	**6.9**	17.1	**10.6**	23.3	**14.5**	32.0	**19.9**	46.6	**29.0**
	Reverse	3.2	**2.0**	6.0	**3.7**	8.7	**5.4**	13.5	**8.4**	25.3	**15.7**	36.8	**23.0**	—	—	—	—
160M	Forward	4.1	**2.5**	5.6	**3.5**	8.1	**5.0**	11.2	**7.0**	17.4	**10.8**	23.7	**14.7**	32.6	**20.3**	47.4	**29.5**
	Reverse	3.3	**2.0**	6.1	**3.8**	8.8	**5.5**	13.7	**8.5**	25.7	**16.0**	37.4	**23.3**	—	—	—	—
160M2	Forward	4.1	**2.6**	5.6	**3.5**	8.1	**5.1**	11.2	**7.0**	17.4	**10.8**	23.7	**14.7**	32.6	**20.3**	47.4	**29.5**
	Reverse	3.3	**2.0**	6.1	**3.8**	8.9	**5.5**	13.7	**8.5**	25.7	**16.0**	37.4	**23.3**	—	—	—	—
160M3	Forward	4.1	**2.6**	5.6	**3.5**	8.1	**5.1**	11.2	**7.0**	17.4	**10.8**	23.7	**14.7**	32.6	**20.3**	47.4	**29.5**
	Reverse	3.3	**2.0**	6.1	**3.8**	8.8	**5.5**	13.7	**8.5**	25.7	**16.0**	37.4	**23.3**	—	—	—	—
14M3	Forward	4.4	**2.7**	5.9	**3.7**	8.6	**5.3**	11.8	**7.4**	18.4	**11.4**	24.9	**15.5**	34.3	**21.3**	49.9	**31.0**
	Reverse	3.4	**2.1**	6.4	**4.0**	9.4	**5.8**	14.5	**9.0**	27.0	**16.8**	39.4	**24.5**	—	—	—	—
16M3	Forward	4.5	**2.8**	6.1	**3.8**	8.9	**5.5**	12.3	**7.6**	19.0	**11.8**	25.8	**16.0**	35.5	**22.0**	51.7	**32.1**
	Reverse	3.6	**2.2**	6.6	**4.1**	9.7	**6.0**	15.0	**9.3**	28.0	**17.4**	40.8	**25.3**	—	—	—	—
18M3	Forward	4.5	**2.8**	6.1	**3.8**	8.9	**5.5**	12.3	**7.6**	19.0	**11.8**	25.8	**16.0**	35.5	**22.0**	51.7	**32.1**
	Reverse	3.6	**2.2**	6.6	**4.1**	9.7	**6.0**	15.0	**9.3**	28.0	**17.4**	40.8	**25.3**	—	—	—	—
24M	Forward	3.7	**2.3**	5.7	**3.6**	9.7	**6.0**	15.1	**9.4**	28.0	**17.4**	43.4	**27.0**	—	—	—	—
	Reverse	5.5	**3.4**	14.5	**9.0**	41.6	**25.8**	—	—	—	—	—	—	—	—	—	—

NOTE: 120M speeds were calculated with a 628 mm **(24.7")** tire at 2000 rpm rated speed.
120M2 speeds were calculated with a 620 mm **(24.4")** tire at high idle, 2150 rpm.
12M2-160M2 speeds were calculated with a 655 mm **(25.8")** tire at high idle, 2150 rpm.
12M3-160M3 speeds were calculated with a 655 mm **(25.8")** tire at 2000 rpm rated speed.

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PRODUCTION

The motor grader is used in a variety of applications in a variety of industries. Therefore, there are many ways to measure its operating capacity, or production. One method expresses a motor grader's production in relation to the area covered by the moldboard.

Formula:

$$A = S \times (L_e - L_o) \times 1000 \times E \quad \text{(Metric)}$$
$$A = S \times (L_e - L_o) \times 5280 \times E \quad \text{(English)}$$

where
- A: Hourly operating area (m^2/h or ft^2/h)
- S: Operating speed (km/h or mph)
- L_e: Effective blade length (m or ft)
- L_o: Width of overlap (m or ft)
- E: Job efficiency

Operating Speeds:

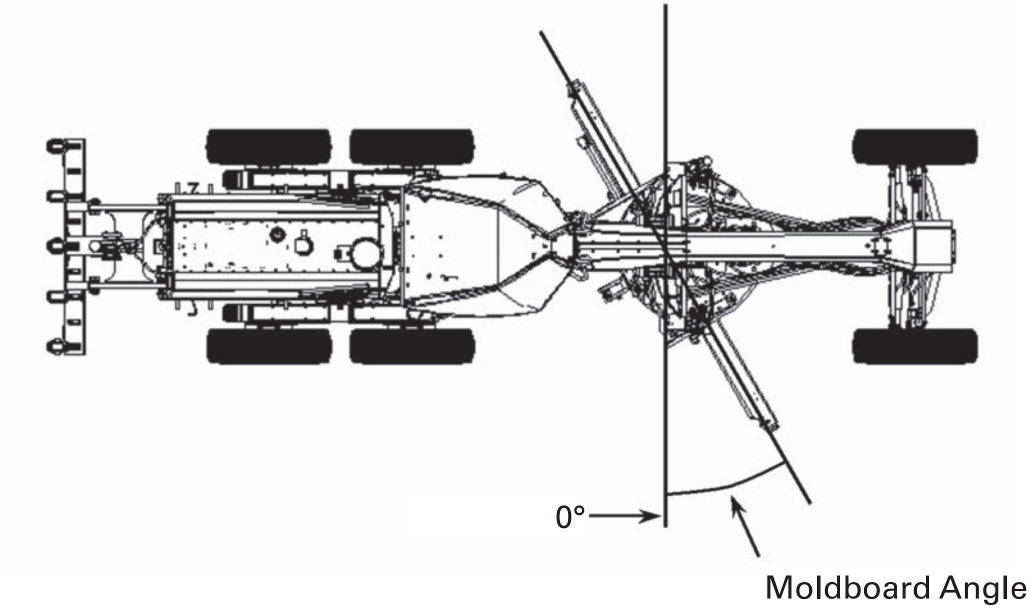
Typical operating speeds by application

Finish Grading:	0-4 km/h	(0-2.5 mph)
Heavy Blading:	0-9 km/h	(0-6 mph)
Ditch Repair:	0-5 km/h	(0-3 mph)
Ripping:	0-5 km/h	(0-3 mph)
Road Maintenance:	5-16 km/h	(3-9.5 mph)
Haul Road Maintenance:	5-16 km/h	(3-9.5 mph)
Snow Plowing:	7-21 km/h	(4-13 mph)
Snow Winging:	15-28 km/h	(9-17 mph)

Effective Blade Length:

Since the moldboard is usually angled when moving material, an effective blade length must be computed to account for this angle. This is the actual width of material swept by the moldboard.

NOTE: Angles are measured as shown below. The effective length becomes shorter as the angle increases.



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Moldboard Length, m (ft)	Effective Length, m (ft) 30 degree blade angle	Effective Length, m (ft) 45 degree blade angle
3.658 **(12)**	3.17 **(10.4)**	2.59 **(8.5)**
4.267 **(14)**	3.70 **(12.1)**	3.02 **(9.9)**
4.877 **(16)**	4.22 **(13.9)**	3.45 **(11.3)**
7.315 **(24)**	6.33 **(20.8)**	5.17 **(17.0)**

For other blade lengths and carry angles:
Effective length = COS [Radians (Blade L)] 3 Blade Length

Width of Overlap:

The width of overlap is generally 0.6 m (2.0 ft). This overlap accounts for the need to keep the tires out of the windrow on the return pass.

Job Efficiency:

Job efficiencies vary based on job conditions, operator skill, etc.

A good estimation for efficiency is approximately 0.70 to 0.85, but actual operating conditions should be used to determine the best value.

Example problem:

A Cat motor grader with a 3.66 m (12 ft) moldboard is performing road maintenance on a township road. The machine is working at an average speed of 13 km/h (8 mph) with a moldboard carry angle of 30 degrees. What is the motor grader's production based on coverage area?

Note: Due to the long passes involved in road maintenance — fewer turnarounds — a higher job efficiency of 0.90 is chosen.

Solution:

From the table, the effective blade length is 3.17 m (10.4 ft).

Metric

Production, A = 13 km/h × (3.17 m − 0.6 m) × 1000 × 0.90
= 30 069 m²/hr (3.07 hectares/hr)

English

Production, A = 8 mph × (10.4 ft − 2.0 ft) × 5280 × 0.90
= 319,334 ft²/hr (7.33 acres/hr)

To pinpoint the theoretical number of motor graders required to properly maintain your haul roads, based on your specific mining applications, please download the haul road maintenance calculator on *https://catminer.cat.com.*

Haul road maintenance impacts cycle time, tire, frame and drive train components, safety and ultimately your cost per ton. To achieve optimal truck productivity, your haul roads must be properly maintained.

Moderate:
- Road Maintenance
- Pad Cleaning
- Rock Clearing
- Shoulder Sweeping

Difficult:
- Ripping
- Spreading Dump Material
- Road Profiling/Reshaping

BLADE PULL

This specification is also known as drawbar pull. This spec can be calculated as follows:

Variables:

Rear weight of machine = Wr

Tire traction coefficient = T (Look up the table entitled "Coefficient of Traction Factors")

$$\mathbf{Wr \times T = Blade\ Pull}$$

Example problem:

Calculate the blade pull for a 140M Global Version version machine operating in a quarry pit...

Metric

RW = 10 501 kg

T = 0.65

$$\mathbf{10\,501 \times 0.65 = 6825.65}$$

English

RW = 23,151 lb

T = 0.65

$$\mathbf{23{,}151 \times 0.65 = 15{,}048.15}$$

BLADE DOWN PRESSURE

This spec can be calculated as follows:

Variables:

Blade to front axle length = BA

Wheel base length = WB

Weight on front wheels = FW

Blade down pressure = BD

$$\mathbf{\frac{WB}{(WB - BA)} \times FW = BD}$$

Example problem:

Calculate the blade down pressure for a 140M Global Version version machine...

Metric

BA = 2565 mm FW = 4223 kg

WB = 6086 mm BD = ?

$$\mathbf{\frac{6086}{(6086 - 2565)} \times 4223 = 7299\ kg}$$

English

BA = 101 in FW = 9310 lb

WB = 240 in BD = ?

$$\mathbf{\frac{240}{(240 - 101)} \times 9310 = 16{,}075\ lb}$$

This specification is only a minor indicator of a motor grader's productivity. It alone gives no measure of overall machine productivity. When considering motor grader production you need an optimum balance between the machine's front and rear weights. If a machine has too much weight on the front axle, it might have a high blade down pressure spec. It will, however, lack the essential rear weight and traction needed to push through the load. Too much weight in the rear and it will not have the necessary weight in the front during heavy cuts to maintain proper steering control.

Cat machines are built with this optimum balance in mind. A Cat motor grader is engineered with the proper weight distribution necessary for maximum productivity.

Effective Blade Length*

	Moldboard							
	3.66 m (12')		4.27 m (14')		4.88 m (16')		7.32 m (24')	
Angle°	m	ft	m	ft	m	ft	m	ft
0°	3.66	**12.00**	4.27	**14.00**	4.88	**16.00**	7.32	**24.00**
5°	3.64	**11.95**	4.25	**13.95**	4.86	**15.94**	7.29	**23.91**
10°	3.60	**11.82**	4.20	**13.79**	4.80	**15.76**	7.21	**23.64**
15°	3.53	**11.59**	4.12	**13.52**	4.71	**15.45**	7.07	**23.18**
20°	3.44	**11.28**	4.01	**13.16**	4.58	**15.04**	6.87	**22.55**
25°	3.32	**10.88**	3.87	**12.69**	4.42	**14.50**	6.63	**21.75**
30°	3.17	**10.39**	3.69	**12.12**	4.22	**13.86**	6.33	**20.78**
35°	3.00	**9.83**	3.50	**11.47**	4.00	**13.11**	5.99	**19.66**
40°	2.80	**9.19**	3.27	**10.72**	3.74	**12.26**	5.61	**18.39**
45°	2.59	**8.49**	3.02	**9.90**	3.45	**11.31**	5.17	**16.97**

*Effective blade length is the amount of blade coverage the machine is capable of when the blade is at a given angle.

EXTREME SLOPE OPERATION

There are two ways of defining slope work. The slope perpendicular to the machine's direction of travel is commonly referred to as "Side Sloping." The slope parallel to the machine's direction of travel — the machines ability to travel up or down terrain, is commonly referred to as "Gradeability."

Side Sloping capability for our Cat graders is somewhat subjective, but general agreement among professional operators is that working on a slope ratio of 2.5:1 (21.8 degrees) is the safe limit … an experienced operator may be able to operate on a 2:1 (28 degrees) slope. Many factors influence this limit such as operator experience, machine configuration, tires and soil conditions, but a 2.5:1 is achievable. Further, a 3:1 slope is the approximate maximum side slope a grader can work on in straight frame configuration. The steeper side slopes all require the machine be articulated to safely navigate the slope.

Gradeability is approximately 22 degrees. This is established by the grader's ability to stop without skidding the tires while moving downhill. The motor grader can, however, *climb* grades steeper than 22 degrees. The traction coefficient is the critical factor in determining whether a grader can safely navigate the slope. Caterpillar recommends that you never climb a slope steeper than you can safely descend.

Maximum lubrication angle: We have measured the graders on a tilt table and pump cavitation occurs around 30 degrees (58% or 1.7:1). This is beyond the grade or slope a motor grader can operate on.

When working side hills and slopes, consideration should be given to the following important points.

- **Speed of Travel** — At higher speeds, inertia forces tend to make the grader less stable.
- **Roughness of Terrain or Surface** — Ample allowance should be made where the terrain or surface is uneven.
- **Mounted Equipment** — Mounted attachments such as front plows, snow wings, rippers and other mounted equipment cause the tractor to balance differently.
- **Nature of Surface** — New earthen fills may give way with the weight of the grader. Rocky surfaces may promote side slipping of grader.
- **Excessive Loads or Side Draft** — This may cause wheel slippage, where the downhill tires "dig in," increasing the angle of grader.
- **Tire Selection and Maintenance** — Consideration should be given to proper tire selection and air pressure. For more information, consult Caterpillar publications — Motor Grader Tire Selection Guide and Operation and Maintenance Manual.
- **Drawbar, Circle and Blade Position** — The position of the blade can affect the stability of the machine.
- **Articulation Angle** — Articulation angle can affect the stability of the machine.
- **Wheel Lean Angle** — Wheel lean angle can affect the stability of the machine.

NOTE: Safe operation on steep slopes may require special machine maintenance as well as excellent operator skill and proper equipment setup for the specific application. Consult Caterpillar publications for further operating tips — Operation & Maintenance Manual, Motor Grader Application Guide, and the Grade Comparison Chart in the Tables section of this Performance Handbook.

Work Tool	120M/ 120M2	12M/ 12M2/ 12M3	140M/ 140M2/ 140M3	160M/ 160M2/ 160M3	16M3/ 18M3	14M3	24M
Lift Group	x	x	x	x	x	x	—
V-Plow	x	x	x	x	—	x	—
One Way Plow	x	x	x	x	—	x	—
Manual Reversible Plow	—	—	—	—	—	x	—
Hydraulic Reversible Plow	x	x	x	x	—	x	—
Snow Wing	x	x	x	x	—	x	—
Mid Mount Scarifier	x	x	x	—	—	—	—
Front Scarifier	x	x	x	x	—	x	—
Manual Angle Blade	x	x	x	x	—	x	—
Hydraulic Angle Blade	x	x	x	x	—	x	—
Straight Blade	x	x	x	x	x	x	—

This list is not all-inclusive.

See Price Lists, Cat Work Tools (Cat WT) Price List, and your Cat dealer for special attachment needs.

Attachments for Cat motor graders require additional hydraulics.

Most front-mounted attachments require a Quick Attach-Detach Parallel Lift Group.

TRACK LOADERS

CONTENTS

Features common to all D Series models (953D-963D-973D):

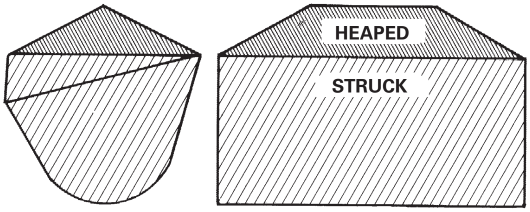
- **Improved serviceability.** All D Series Track-Type Loaders are equipped with a tiltable cab that allows complete service of the hydraulic system. Most daily maintenance checks are performed from the machine's right side, facilitating quick start up. Easy access to major components enhances serviceability and increase uptime.

- **Operator station.** Experience a high level of efficiency, comfort and productivity with the new D Series cab. The cab features a new gauge cluster, a fully air-suspension seat, the new seat mounted controls, an automatic air climate control and provides excellent visibility.

- **Messenger.** Messenger is a new electronic monitoring system with real time, visual feedback on engine and machine operating conditions. It provides information on diagnostic data, maintenance, and allows operating settings such as implement reactions.

- **Hydrostatic drive.** The closed loop hydrostatic drive with electronic control provides precise modulation for quick, smooth operation and superior maneuverability. Shorter cycle times, high efficiency, and excellent maneuverability results in increased productivity.

SAE BUCKET RATING



SAE Bucket Capacities

Struck capacity is that volume contained in a bucket after a load is leveled by drawing a straight edge resting on the cutting edge and the back of the bucket.

Heaped capacity is a struck capacity *plus* that additional material that would heap on the struck load at a 2:1 angle of repose with the struck line parallel to the ground.

SAE J742 (Oct. 79) specifies that the addition of any auxiliary spill guard to protect against spillage of material which might injure the operator will not be included in bucket capacity ratings. Buckets with irregular shaped cutting edges (vee edge) the strike plane should be drawn at one-third the distance of the protruding portion of the cutting edge. Cat rock buckets are built with integral see-through rock guards. Cat light material buckets come standard with bolt-on edges. These features which add to actual bucket capacity are included in published ratings.

Dump Height

SAE J732 JUN92 specifies that dump height is the vertical distance from the ground to the lowest point of the cutting edge with the bucket hinge pin at maximum height and the bucket at a 45° dump angle. Dump angle is the angle in degrees that the longest flat section of the inside bottom of the bucket will rotate below horizontal.

Static Tipping Load

The minimum weight at center of gravity of "SAE Rated" load in bucket which will rotate rear of machine to a point where, on track loaders, front rollers are clear of the track under the following conditions:

a. Loader on hard level surface and stationary.
b. Unit at standard operating weight.
c. Bucket at maximum rollback position.
d. Load at maximum forward position during raising cycle.
e. Unit with standard equipment as described in specifications unless otherwise noted under the heading.

Operating Load

In order to comply with SAE standard J818 MAY87, the operating load for track loaders should not exceed 35% of the Static Tipping load rating. See "Performance Data" of each machine in this handbook for increases to static tipping load by adding cab, counterweights, ripper-scarifier, etc.

SELECTING A MACHINE

Steps in selecting the proper size loader:

1. Determine production required or desired.
2. Determine loader cycle time and cycles per hour. A machine size must be assumed to select a basic cycle time.
3. Determine required payload per cycle in loose cubic yards and pounds (meters and kilograms).
4. Determine bucket size needed.
5. Make machine selection using bucket size and payload as criteria to meet production requirements.
6. Compare the loader cycle time used in calculations to the cycle time of the machine selected. If there is a difference, rework the process beginning at step 2.

1. Production Required

The production required of a track loader should be slightly greater than the production capability of the other critical units in the earth or material moving system. For example, if a hopper can handle 300 tons per hour, a loader capable of slightly more than 300 tons should be used. Required production should be carefully calculated so the proper machine and bucket selections are made.

2. Loader Cycle Times

Material type, pile height, and other factors may improve or reduce production, and should be added to or subtracted from the basic cycle time when applicable.

When hauls are involved, obtain haul and return portions of the cycle from the estimated travel chart (this section). Add the haul and return times to the estimated basic cycle time to obtain total cycle time.

CYCLE TIME FACTORS

A basic cycle time (Load, Dump, Maneuver) of 0.25-0.35 minutes is average for a track loader [the basic cycle for large track loaders, 2 m^3 (2.6 yd^3) and up, can be slightly longer], but variations can be authenticated in the field. The following values for many variable elements are based on normal operations. Adding or subtracting any of the variable times will give the total basic cycle time.

Estimating Cycle Time

Cycle time of a track loader needs to be determined to find loads per hour. Total cycle time includes the following segments:

Load Time + Maneuver Time + Travel Time + Dump Time

Load Time —

Material	Minutes
Uniform aggregates	0.03-0.05
Moist mixed aggregates	0.03-0.06
Moist loam	0.03-0.07
Soil, boulders, roots	0.04-0.20
Cemented materials	0.05-0.20

Maneuver Time — includes basic travel, four changes of direction and turning time, and will be about 0.20 minutes with a competent operator.

Travel Time — in a load and carry operation is comprised of haul and return times which can be determined by the travel charts in this section.

Dump Time — is dictated by the size and strength of the dump target and varies from 0.00 to 0.10 minutes. Typical dump times into highway trucks are from 0.04 to 0.07 minutes.

NOTE: When comparing hydrostatic track loaders with former power shift models (using the production estimating method) two factors must be considered: (1) The hydrostatic track loaders on the average outcycle power shift models by up to 10 percent due to faster machine speed and easier operation. (2) Larger, rear engine hydrostatic track loaders incorporate Z-bar linkage, which provides substantially better bucket fill factors. The degree to which each factor affects estimated production should be left to the user's judgment depending on the particular job application and conditions.

Example: Moist loam is being excavated from a bank and loaded into trucks.

	Minutes
Load — moist loam	0.05
Maneuver Time	0.20
Travel — none required	0.00
Dump	0.05
Total Cycle	0.30 min. or 200 cycles per 60 min. hour

	Minutes added (+) or Subtracted (–) From Basic Cycle
Materials	
— Mixed	+0.02
— Up to 3 mm (1/8 in)	+0.02
— 3 mm (1/8 in) to 20 mm (3/4 in)	–0.02
— 20 mm (3/4 in) to 150 mm (6 in)	0.00
— 150 mm (6 in) and over	+0.03 and Up
— Bank or broken	+0.04 and Up
Pile	
— Conveyor or Dozer piled 3 m (10 ft) and up	0.00
— Conveyor or Dozer piled 3 m (10 ft) or less	+0.01
— Dumped by truck	+0.02
Miscellaneous	
— Common ownership of trucks and loaders	Up to –0.04
— Independently owned trucks	Up to +0.04
— Constant operation	Up to –0.04
— Inconsistent operation	Up to +0.04
— Small target	Up to +0.04
— Fragile target	Up to +0.05

Using actual job conditions and the above factors, total cycle time can be estimated. Convert total cycle time to cycles per hour.

$$\text{Cycles per hour at 100\% Efficiency} = \frac{\text{60 Min}}{\text{Total Cycle Time in Minutes}}$$

Job efficiency is an important factor in machine selection. Efficiency is the actual number of minutes worked during an hour. Job efficiency accounts for operator breaks, and other work interruptions. See "Efficiency Considerations" in this section.

Bucket Fill Factors

The following indicates the approximate amounts of material as a percent of rated bucket capacity which will actually be delivered per bucket per cycle. This is known as "Bucket Fill Factor."

Loose Material	Fill Factor
Mixed Moist Aggregates	95-110%
Uniform Aggregates	
up to 3 mm (1/8 in)	95-110
3 mm-9 mm (1/8 in-3/8 in)	90-110
12 mm-20 mm (1/2 in-3/4 in)	90-110
24 mm and over (1 in)	90-110
Blasted Rock	
Well	80-95%
Average	75-90
Poor	60-75
Other	
Rock Dirt Mixtures	100-120%
Moist Loam	100-120
Soil, Boulders, Roots	80-100
Cemented Materials	85-100

Fill factors on track loaders are affected by bucket penetration, breakout force, rack back angle, bucket profile and ground engaging tools such as bucket teeth and segments or bolt-on replaceable cutting edges.

GENERAL PURPOSE BUCKET W/TEETH & SEGMENTS MAXIMUM OPERATING CAPACITIES

MODEL	GENERAL PURPOSE BUCKET SIZE m^3	GENERAL PURPOSE BUCKET SIZE yd^3	MAXIMUM OPERATING CAPACITY kg	MAXIMUM OPERATING CAPACITY lb
953D/953K	1.85	**2.4**	3182	**7015**
963D/963K	2.45	**3.2**	4214	**9290**
973D	3.21	**4.2**	5521	**12,174**

LOADER PRODUCTION

Loader production equals quantity of material the bucket carries per load × number of bucket loads per hour.

Estimating Bucket Load

The quantity of material in a loader bucket is estimated by two methods, depending on whether the material being loaded is in a loose or bank state.

1. When the material is loose, as in stockpile loading, the bucket load is estimated in loose meters (or cubic yards) by a Bucket Fill Factor (see Tables Section or chart following this discussion). The quantity of material is determined as follows:

   Rated Bucket Capacity × Bucket Fill Factor = Bucket Payload in Loose m^3 (yd^3)

   For example, a 973 with a 3.2 m^3 (4.2 yd^3) General Purpose bucket loading moist loam material will carry:

   3.2 m^3 × 1.15 = 3.68 loose cubic meters
   (4.2 yd^3 × 1.15 = 4.83 loose cubic yards)

   Once the potential bucket load has been determined, check the static tipping load ratings on the specific machine to determine if bucket load is in fact a safe operating load. *(Safe operating load as defined by SAE for track loaders should not exceed 35% of static tipping load.)*

   Productivity in many applications is measured in tons. See Tables Section for material densities if conversion to tons is desired.

2. When material is in the bank state, as in excavation, productivity is measured in bank meters (cubic yards). Bucket load in Bm^3 (BCY) is estimated by applying one of the load factors from the Tables section to convert the excavated material in the bucket from Bm^3 (BCY) to Lm^3 (LCY) to allow for the digging and carrying characteristics of the material. The quantity of excavated material a bucket carries is then determined as follows:

   Rated Bucket Capacity × Load Factor × Bucket Fill Factor = Bucket Payload in Bm^3 (BCY)

   Example: a 953D with a 1.85 m^3 (2.4 yd^3) General Purpose bucket loading wet loam earth from bank:

   1.85 m^3 × 0.79 × 1.15 = 1.68 Bm^3
   (2.4 yd^3 × 0.79 × 1.15 = 2.18 BCY)

Estimating Production

Machine and job considerations include:

- Machine model and bucket size
- Material type, particle size, density and load factor (see Tables Section)
- Bucket fill factor
- Haul distance
- Underfoot conditions
- Altitude
- Dump target size, height, and type

Example:

Conditions —

Machine	953D
Bucket size	1.85 m^3 (2.4 yd^3)
Material	Moist Loam
Bucket fill factor	1.15
Haul length	30 m (100 ft)
Dump target	Pile
Travel in forward speed	
Cycle Time	**Minutes**
Load time	0.15
Maneuver time	0.20
Travel time (from curves)	0.40
Dump time	0.05
Total	0.80

Loads Per Hour —

$$\frac{60 \text{ min/hr}}{0.80 \text{ min/cycle}} = \text{75 cycles per hour @ 100\% efficiency}$$

Load Per Cycle —

1.85 m^3 × 1.15 BFF = 2.13 Lm^3 × 0.81 LF = 1.72 Bm^3

(2.4 yd^3 × 1.15 BFF = 2.76 LCY × 0.81 LF = 2.24 BCY)

Hourly Production —

1.72 Bm^3 × 75 cycles/h = 129 Bm^3/h

(2.24 BCY × 75 cycles/hr = 168 BCY/hr)

More accurate production estimates can be made by recording actual machine cycle times in the same or similar application. Then visually verify the approximate bucket fill factor.

Efficiency Considerations

Loader capacity should always be matched to peak production requirements of the job. Actual "on-the-job" loader productivity will be influenced by factors such as operator skill, personal delays, job layout and other delays. Experience and knowledge of local conditions will be the best indicators of actual job efficiency.

Operation	Working Hour	Efficiency Factor
Day	50 min/Hr	0.83

An Alternative Machine Selection Method

Another method of selecting the right Track Loader and bucket to meet production requirements is by use of the nomographs on the following pages. The method is quicker and easier than the proceding example because it does not require as many calculations, yet the accuracy is about the same within the normal limits of input data.

Be careful when entering and reading data from the nomographs because some scales increase from bottom to top, while others are the reverse. Do not be overly concerned with the precision as affected by pencil line width or reading to the hundredth of a m^3 (yd^3). Remember that bucket fill factor, material density, and cycle time are at best close estimates.

Example problem

A track loader must produce 200 Lm^3 (262 LCY) per hour. Estimated cycle time is 0.5 minutes, working 50 minutes per hour. Bucket fill factor is 110% and the material density is 1600 kg/Lm^3 (2700 lb/LCY).

Determine bucket size, machine model and hourly production in tons and yards.

Solution

At full efficiency, it will cycle 120 times per hour. Since only an average 50 minutes are available, only 100 cycles will be completed per hour.

Starting on Scale A at 100 cycles per hour draw a straight line intersecting 200 m^3/hr (262 yd^3/hr) on Scale B and continuing the line on to Scale C giving 2.0 m^3 (2.62 yd^3) required payload.

Follow steps 1 through 7 on the next two pages.

● ● ●

TRACK-TYPE TRACTORS
Hydraulic Controls
Bulldozers
Rippers and Winches

CONTENTS

TRACK-TYPE TRACTORS

HYDRAULIC CONTROLS

BULLDOZERS

RIPPERS

WINCHES

PACCAR

Allied

TRACK-TYPE TRACTORS

Features:

- **Cat® Diesel Engines** provide the power, high torque rise, reliability and performance you can depend on.
- **HEUI™** on D6R and D7R increases fuel efficiency, reduces smoke, improves cold starting and enhances diagnostic capabilities.
- **Mechanical Electronic Unit Injector (MEUI™)** on D8T, D9T, D10T2 and D11T excels in its ability to control injection pressure over the entire engine operating speed range. It combines the technical advancement of an electronic control system with the simplicity of direct mechanically controlled unit fuel injection. These features allow the engine to have complete control over injection timing, duration, and pressure.
- **Common Rail fuel injection system** on D3K2, D4K2, D5K2, D6K2, D5R2, D6N, D6T and D7E machines; optimizes performance and fuel consumption, minimizes heat rejection, and lowers emissions.

- **Oil cooled steering clutches and brakes** standard on D9R, D10T2 and D11T.
- **Finger Tip Controls (FTC)** of transmission, steering clutches and brakes on D10T2 and D11T.
- **Differential steering** allows infinitely variable turning radius. Standard on the D5R2, D6N, D6R2, D6T, D7R, D7E, D8R, D8T and D9T, allows the tractor to make a "power turn" keeping both tracks working for more traction and higher performance.
- **Electronic Hydrostatic Power Train System** on D3K2 through D6K2 allows power turns, stepless speed range, smooth modulation, dynamic hydrostatic braking, superior maneuverability and excellent controllability.
- **Electric Drive Power Train System** on D7E allows stepless speed range, smooth modulation, and excellent efficiency. When coupled with differential steer it provides superior maneuverability with locked-track pivot turn capability and excellent controllability.
- **Combined hand lever steering** located left of operator provides easier operation on D9R.
- **Standard Tractors** designed for heavy dozing and general grading.
- **XL Tractor D6T** offers higher horsepower and longer roller frames for increased finish grading capability, flotation and productivity.
- **Extra Wide (XW) gauge** on D6T length roller frame provides wider shoes for greater flotation and stability for steep slope grading.
- **Sealed and Lubricated Track** reduces pin and bushing wear for lower undercarriage repair costs. Sealed and lubricated track is standard on the D3K2, D4K2, and D5K2 while heavy duty track chain is available on D5R, D6K2, D6N, D6T, and D7E improves wear life and reduces pin/bore stretching and cracking.
- **SystemOne™ Undercarriage** extends undercarriage system life, improves reliability, and reduces owning and operating costs. Optional on D6T (all sources), D5R2, D6K2, D6N, D6R2, optional on D8T and D8R (all sources), D3K2, D4K2, D5K2.
- **Elevated sprockets** (not on D6K2 or D7E) eliminate final drive stress induced by roller frame movement and ground impact loads. Final drives pull chain only. Seals moved up out of dirt, sand and water for longer life. Blade visibility improved because operator sits higher.
- **Resilient mounted bogie undercarriage** on D8R, D8T, D9T, D10T2 and D11T reduces shock transmitted to tractor. Allows track to conform to rough ground for better traction.
- **Solid mounted undercarriage** standard on D3K2 through D5K2 provides stable platform for low impact, and high abrasion applications. Provides optimum finish grading performance.
- **Oscillating undercarriage** on D6K2 through D7E and optional on the D8R and D8T decreases ground shock to the machine and provides a smoother, more comfortable ride for the operator.
- **Accessible modular design** on D6N XL and up greatly reduces drive train removal and installation time resulting in reduced repair costs.
- **Tag link** on D7R, D8R/D8T and up; L-shaped push arms on D6N, D6T and D7E. Both designs allow closer mounting of dozer blades. This reduces total tractor length, improves maneuverability, balance, blade penetration and pryout.
- **Low ground pressure (LGP)** tractors offer greater flotation in soft, swampy conditions. Available on D3K2 through D8T.

MODEL	D6T		D6T XL	
Emission Standards	**Tier 3/Stage IIIA/ Japan 2006 (Tier 3) equivalent**		**Tier 3/Stage IIIA/ Japan 2006 (Tier 3) equivalent**	
Flywheel Power	149 kW	**200 hp**	149 kW	**200 hp**
Operating Weight:[1]				
Power Shift Differential Steer				
SU Blade	20 580 kg	**45,370 lb**	21 600 kg	**47,620 lb**
Engine Model	**C9 ACERT**		**C9 ACERT**	
Rated Engine RPM: Power Shift	**1850**		**1850**	
No. of Cylinders	**6**		**6**	
Bore	112 mm	**4.4"**	112 mm	**4.4"**
Stroke	149 mm	**5.9"**	149 mm	**5.9"**
Displacement	8.8 L	**537 in^3**	8.8 L	**537 in^3**
Track Rollers (Each Side)	**6**		**7**	
Width of Standard Track Shoe	560 mm	**22"**	560 mm	**22"**
Length of Track on Ground	2.61 m	**8'7"**	2.81 m	**9'3"**
Ground Contact Area (w/Std. Shoe)	2.92 m^2	**4531 in^2**	3.15 m^2	**4878 in^2**
Track Gauge	1.88 m	**74"**	1.88 m	**74"**
GENERAL DIMENSIONS:				
Height[2] (Stripped Top)[3]	2.40 m	**7'11"**	2.40 m	**7'11"**
Height[2] (To Top of ROPS Canopy)	3.11 m	**10'2"**	3.11 m	**10'2"**
Height[2] (To Top of ROPS Cab)	3.11 m	**10'2"**	3.11 m	**10'2"**
Overall Length (without Blade)	3.85 m	**12'7"**	3.85 m	**12'7"**
with SU Blade	5.08 m	**16'8"**	5.33 m	**17'6"**
with Angle Blade	5.00 m	**16'5"**	5.21 m	**17'1"**
Width (over Trunnion)	2.64 m	**8'8"**	2.64 m	**8'8"**
Width (w/o Trunnion — Std. Track)	2.44 m	**8'0"**	2.44 m	**8'0"**
Ground Clearance[2]	384 mm	**1'3"**	384 mm	**1'3"**
Blade Types and Widths:				
Angle Straight	4.16 m	**13'8"**	4.16 m	**13'8"**
Full 25° Angle	3.77 m	**12'5"**	3.77 m	**12'5"**
Semi-U	3.26 m	**10'8"**	3.26 m	**10'8"**
Fuel Tank Refill Capacity	425 L	**112 U.S. gal**	425 L	**112 U.S. gal**

[1] Operating weight includes cab, operator, lubricants, coolant, full fuel tank, standard track, hydraulic controls and fluid, SU blade, drawbar and counterweight.
[2] Dimensions measured from ground line. Add grouser height for total dimension on hard surfaces.
[3] Height (Stripped Top) — without ROPS canopy, exhaust, seat back or other easily removed encumbrances.

Track-Type Tractor Sustainability

Well matched engine and power train systems enhance productivity and fuel efficiency.

MODEL	D6T XL		D6T XW		D6T LGP	
Emission Standards	**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**	
Flywheel Power	151 kW	**202 hp**	151 kW	**202 hp**	151 kW	**202 hp**
Operating Weight:[1]						
Power Shift Differential Steer	20 985 kg	**46,263 lb**	21 788 kg	**48,034 lb**	22 902 kg	**50,490 lb**
VPAT	23 663 kg	**52,167 lb**	24 118 kg	**53,170 lb**	24 336 kg	**53,651 lb**
Engine Model	**C9.3 ACERT**		**C9.3 ACERT**		**C9.3 ACERT**	
Advertised Engine RPM	**2000**		**2000**		**2000**	
No. of Cylinders	**6**		**6**		**6**	
Bore	115 mm	**4.5"**	115 mm	**4.5"**	115 mm	**4.5"**
Stroke	149 mm	**5.9"**	149 mm	**5.9"**	149 mm	**5.9"**
Displacement	9.3 L	**567 in^3**	9.3 L	**567 in^3**	9.3 L	**567 in^3**
Track Rollers (Each Side)	**7**		**7**		**8**	
VPAT	**7**		**8**		**8**	
Width of Standard Track Shoe	560 mm	**22"**	760 mm	**30"**	915 mm	**36"**
VPAT	560 mm	**22"**	710 mm	**28"**	785 mm	**31"**
Length of Track on Ground	2.84 m	**9'5"**	2.84 m	**9'5"**	3.25 m	**10'9"**
VPAT	2.84 m	**9'5"**	3.25 m	**10'9"**	3.25 m	**10'9"**
Ground Contact Area (w/Std. Shoe)	3.54 m^2	**5489 in^2**	4.81 m^2	**7449 in^2**	6.53 m^2	**10,122 in^2**
VPAT	3.54 m^2	**5489 in^2**	5.10 m^2	**7909 in^2**	5.60 m^2	**8684 in^2**
Track Gauge	1.88 m	**74"**	2.03 m	**80"**	2.29 m	**90"**
VPAT	2.13 m	**84"**	2.29 m	**90"**	2.29 m	**90"**
GENERAL DIMENSIONS:						
Height[2] (Stripped Top[3])	2.46 m	**8'1"**	2.46 m	**8'1"**	2.51 m	**8'3"**
VPAT	2.46 m	**8'1"**	2.51 m	**8'3"**	2.51 m	**8'3"**
Height[2] (To Top of ROPS Canopy)	3.11 m	**10'2"**	3.11 m	**10'2"**	3.16 m	**10'4"**
VPAT	3.11 m	**10'2"**	3.16 m	**10'4"**	3.16 m	**10'4"**
Height[2] (To Top of ROPS Cab)	3.15 m	**10'4"**	3.15 m	**10'4"**	3.20 m	**10'6"**
VPAT	3.15 m	**10'4"**	3.20 m	**10'6"**	3.20 m	**10'6"**
Overall Length (without Blade)	3.89 m	**12'9"**	3.89 m	**12'9"**	4.25 m	**13'11"**
VPAT	3.89 m	**12'9"**	4.25 m	**13'11"**	4.25 m	**13'11"**
with S Blade	—		—		5.50 m	**18'1"**
with SU Blade	5.33 m	**17'6"**	5.33 m	**17'6"**	—	
with VPAT Blade	5.39 m	**17'8"**	5.53 m	**18'2"**	5.53 m	**18'2"**
with Angle Blade	5.21 m	**17'1"**	5.29 m	**17'4"**	5.81 m	**19'1"**
Width (over Trunnion)	2.69 m	**8'10"**	2.94 m	**9'8"**	3.48 m	**11'5"**
Width (w/o Trunnion — Std. Track)	2.59 m	**8'6"**	2.79 m	**9'2"**	3.20 m	**10'6"**
VPAT	2.72 m	**8'11"**	3.00 m	**9'10"**	3.14 m	**10'4"**
Ground Clearance[2]	372 mm	**1'3"**	372 mm	**1'3"**	406 mm	**1'4"**
VPAT	372 mm	**1'3"**	406 mm	**1'4"**	406 mm	**1'4"**
Blade Types and Widths:						
Straight	—		—		4.06 m	**13'4"**
Angle Straight	4.16 m	**13'8"**	4.52 m	**14'10"**	5.07 m	**16'8"**
Full 25° Angle	3.77 m	**12'5"**	4.11 m	**13'6"**	4.63 m	**15'2"**
Semi-U	3.26 m	**12'8"**	3.56 m	**11'8"**	—	
VPAT						
Straight	3.88 m	**12'9"**	4.16 m	**13'8"**	4.16 m	**13'8"**
Full 24° Angle	3.54 m	**11'7"**	3.79 m	**12'5"**	3.79 m	**12'5"**
Fuel Tank Refill Capacity	411 L	**109 U.S. gal**	411 L	**109 U.S. gal**	411 L	**109 U.S. gal**
DEF Tank Refill Capacity	17.1 L	**4.5 U.S. gal**	17.1 L	**4.5 U.S. gal**	17.1 L	**4.5 U.S. gal**

[1] Operating weight includes cab, operator, lubricants, coolant, full fuel tank, standard track, hydraulic controls and fluid, SU blade and drawbar.
[2] Dimensions measured from ground line. Add grouser height for total dimension on hard surfaces.
[3] Height (Stripped Top) — without ROPS canopy, exhaust, seat back or other easily removed encumbrances.

MODEL	D9R		D9T		D9T	
Emission Standards	—		**Tier 3/Stage IIIA/ Japan 2006 (Tier 3) equivalent[1]**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**	
Flywheel Power	302 kW	**405 hp**	306 kW	**410 hp**	325 kW	**436 hp**
Operating Weight:[2]						
Power Shift Clutch Brake	48 784 kg	**107,548 lb**	—		—	
Power Shift Differential Steer	—		47 872 kg	**105,539 lb**	48 361 kg	**106,618 lb**
Engine Model	**3408C SCAC**		**C18 ACERT**		**C18 ACERT**	
Rated Engine RPM	**1900**		**1833**		**1800**	
No. of Cylinders	**8**		**6**		**6**	
Bore	137 mm	**5.4"**	145 mm	**5.7"**	145 mm	**5.7"**
Stroke	152 mm	**6"**	183 mm	**7.2"**	183 mm	**7.2"**
Displacement	18 L	**1099 in^3**	18.1 L	**1106 in^3**	18.1 L	**1106 in^3**
Track Rollers (Each Side)	**8**		**8**		**8**	
Width of Standard Track Shoe	610 mm	**24"**	610 mm	**24"**	610 mm	**24"**
Length of Track on Ground	3.47 m	**11'5"**	3.47 m	**11'5"**	3.47 m	**11'5"**
Ground Contact Area (w/Std. Shoe)	4.24 m^2	**6569 in^2**	4.24 m^2	**6569 in^2**	4.24 m^2	**6569 in^2**
Track Gauge	2.25 m	**7'5"**	2.25 m	**7'5"**	2.25 m	**7'5"**
GENERAL DIMENSIONS:						
Height[3] (Stripped Top)[4]	3.69 m	**12'1"**	3.69 m	**12'1"**	3.69 m	**12'1"**
Height[3] (To Top of ROPS Canopy)	4.00 m	**13'1"**	4.00 m	**13'1"**	4.00 m	**13'1"**
Height[3] (To Top of FOPS Cab)	3.82 m	**12'6"**	3.82 m	**12'6"**	3.82 m	**12'6"**
Overall Length (with SU Blade)[5]	6.88 m	**22'6"**	6.88 m	**22'6"**	6.88 m	**22'6"**
(without Blade)	5.18 m	**17'0"**	5.18 m	**17'0"**	5.18 m	**17'0"**
(with SU Blade and Ripper)[5]	8.23 m	**27'0"**	8.23 m	**27'0"**	8.23 m	**27'0"**
(without Blade and Ripper)	4.91 m	**16'1"**	4.91 m	**16'1"**	4.91 m	**16'1"**
Width (over Trunnion)	3.30 m	**10'8"**	3.30 m	**10'8"**	3.30 m	**10'8"**
Width (w/o Trunnion — Std. Shoe)	2.88 m	**9'5"**	2.88 m	**9'5"**	2.88 m	**9'5"**
Ground Clearance[6]	496 mm	**1'7"**	496 mm	**1'7"**	496 mm	**1'7"**
Blade Types and Widths:						
Universal	4.65 m	**15'3"**	4.65 m	**15'3"**	4.65 m	**15'3"**
Semi-U	4.31 m	**14'2"**	4.31 m	**14'2"**	4.31 m	**14'2"**
Fuel Tank Refill Capacity	818 L	**216 U.S. gal**	889 L	**235 U.S. gal**	821 L	**217 U.S. gal**
DEF Tank Refill Capacity	—		—		36 L	**9.5 U.S. gal**

[1] Product available to meet Tier 2/Stage II/Japan 2001 (Tier 2) equivalent OR Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.
[2] Operating weight includes ROPS canopy, operator, lubricants, coolant, full fuel tank, hydraulic controls and fluids, semi universal blade with tilt, back-up alarm, seat belts, lights, and single shank ripper.
— D9R equipped with track guides, ROPS/FOPS cab, single shank ripper and SU blade.
[3] Dimensions measured from ground line. Add grouser height for total dimension on hard surfaces.
[4] Height (Stripped Top) — without ROPS canopy, exhaust, seat back or other easily removed encumbrances.
[5] Includes drawbar.
[6] Per ISO 6746 — Must add grouser height for total dimension on hard surfaces.

MODEL	D10T2		D11T		D11T CD	
Emission Standards	**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)[1]**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)[1]**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)[1]**	
Flywheel Power	447 kW	**600 hp**	634 kW	**850 hp**	634 kW	**850 hp**
Reverse Gears	538 kW	**722 hp**	—		—	
Operating Weight:[2]						
Power Shift Clutch Brake	70 171 kg	**154,700 lb**	104 236 kg	**229,800 lb**	112 718 kg	**248,500 lb**
Engine Model	**C27 ACERT**		**C32 ACERT**		**C32 ACERT**	
Rated Engine RPM	**1800**		**1800**		**1800**	
No. of Cylinders	**12**		**12**		**12**	
Bore	137 mm	**5.4"**	145 mm	**5.71"**	145 mm	**5.71"**
Stroke	152 mm	**6"**	162 mm	**6.38"**	162 mm	**6.38"**
Displacement	27 L	**1648 in^3**	32.1 L	**1959 in^3**	32.1 L	**1959 in^3**
Track Rollers (Each Side)	**8**		**8**		**8**	
Width of Standard Track Shoe	610 mm	**24"**	710 mm	**28"**	915 mm	**36"**
Length of Track on Ground (Idler to Idler)	3.88 m	**12'9"**	4.44 m	**14'7"**	4.44 m	**14'7"**
Ground Contact Area (w/Std. Shoe)	4.74 m^2	**7347 in^2**	6.31 m^2	**9781 in^2**	8.13 m^2	**12,605 in^2**
Track Gauge	2.55 m	**8'4"**	2.89 m	**9'6"**	2.89 m	**9'6"**
GENERAL DIMENSIONS:						
Height (Stripped Top)[3]	3.222 m	**10'7"**	3.64 m	**11'11"**	3.64 m	**11'11"**
Height (To Top of ROPS Canopy)	4.41 m	**14'5"**	4.70 m	**15'5"**	4.70 m	**15'5"**
Height (To Top of FOPS Cab)	4.10 m	**13'5"**	4.39 m	**14'5"**	4.39 m	**14'5"**
Overall Length:						
(with SU Blade and SS Ripper)[4]	9.16 m	**30'1"**	10.59 m	**34'9"**	10.70 m	**35'1"**
(without Blade and Ripper)[5]	5.32 m	**17'5"**	6.16 m	**20'3"**	6.16 m	**20'3"**
Width (over Trunnion)	3.74 m	**12'3"**	4.38 m	**14'4"**	4.38 m	**14'4"**
Width (w/o Trunnion — Std. Shoe)	3.30 m	**10'10"**	3.78 m	**12'5"**	3.81 m	**12'6"**
Ground Clearance[6]	632 mm	**2'1"**	675 mm	**2'3"**	675 mm	**2'3"**
Blade Types and Widths:						
CarryDozer	—		—		6.71 m	**22'0"**
Universal	5.26 m	**17'3"**	6.36 m	**20'10"**	—	
Semi-U	4.94 m	**16'3"**	5.60 m	**18'4"**	—	
Fuel Tank Refill Capacity	1204 L	**314 U.S. gal**	1609 L	**425 U.S. gal**	1609 L	**425 U.S. gal**
Fuel Tank Refill Capacity (Extra Capacity)	—		1987 L	**505 U.S. gal**	1987 L	**505 U.S. gal**

[1] Product available to meet Tier 2/Stage II/Japan 2001 (Tier 2) equivalent OR Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.
[2] Operating weight includes coolant, lubricants, full fuel tank, ROPS, FOPS cab, SU ABR bulldozer (D10T2) or U ABR bulldozer (D11T), dual tilt, single-shank ripper with pin-puller, fast fuel, standard ES shoes, and operator.
D11T CD has 11 Carrydozer and single-shank Carrydozer ripper.
[3] Height (Stripped Top) — without ROPS canopy, cab, exhaust, lift cylinders, seat back or other easily removed encumbrances.
[4] Overall length of D11T CD includes Straight (CarryDozer) Blade and SS Ripper.
[5] Overall length of machine from front tag link trunnion to rigid drawbar and excludes track grouser height.
[6] Per ISO 6746 — Must add grouser height for total dimension on hard surfaces.

All dimensions are approximate.

TRAVEL SPEED

POWER SHIFT MODEL	D3K2[1] All Models		D3K2 All Models		D4K2[1] All Models		D4K2 All Models		D5K2[1] All Models		D5K2 All Models		D6K2 All Models	
HYDROSTATIC	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
FORWARD	9.0	5.6	9.0	5.6	9.0	5.6	9.0	5.6	9.0	5.6	9.0	5.6	10.0	6.2
REVERSE	10.0	6.2	10.0	6.2	10.0	6.2	10.0	6.2	10.0	6.2	10.0	6.2	10.0	6.2

[1] Meets Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.

POWER SHIFT MODEL	D5R2 Powershift with AutoShift		D6R2 Powershift with AutoShift		D6T		D7E		D7E LGP		D7R	
FORWARD	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
1	3.3	2.1	3.8	2.4	3.8	2.3	—	—	—	—	3.52	2.19
1.5	4.2	2.6	4.8	3.0	—	—	—	—	—	—	—	—
2	5.8	3.6	6.5	4.1	6.5	4.0	—	—	—	—	6.10	3.79
2.5	7.3	4.5	8.4	5.2	—	—	—	—	—	—	—	—
3	10.1	6.3	11.5	7.1	11.3	7.0	—	—	—	—	10.54	6.55
REVERSE												
1	4.2	2.6	4.8	3.0	4.7	2.9	—	—	—	—	4.54	2.82
1.5	5.2	3.2	6.2	3.9	—	—	—	—	—	—	—	—
2	7.3	4.5	8.4	5.2	8.3	5.1	—	—	—	—	7.85	4.88
2.5	7.3	4.5	8.4	5.2	—	—	—	—	—	—	—	—
3	12.5	7.8	14.5	9.1	14.6	9.0	—	—	—	—	13.58	8.44
ELECTRIC												
FORWARD	—	—	—	—	—	—	11.3	7.0	11.3	7.0	—	—
REVERSE	—	—	—	—	—	—	11.3	7.0	11.3	7.0	—	—

GEAR	D6N* Powershift with AutoShift		D6N* Powershift with AutoShift — Sound Suppressed	
FORWARD	km/h	mph	km/h	mph
0.5	2.5	1.6	2.4	1.5
0.7	2.8	1.7	2.7	1.6
1.0	3.3	2.1	3.0	1.9
1.5	4.4	2.7	4.4	2.7
1.7	4.9	3.0	4.9	3.0
2.0	5.8	3.6	5.8	3.6
2.5	7.5	4.7	7.5	4.7
2.7	8.3	5.2	8.3	5.2
3.0	9.8	6.1	9.8	6.1
REVERSE				
0.5	3.1	1.9	2.9	1.8
0.7	3.4	2.1	3.1	1.9
1.0	4.1	2.5	3.5	2.2
1.5	5.4	3.4	5.4	3.4
1.7	6.0	3.7	6.0	3.7
2.0	7.1	4.4	7.1	4.4
2.5	9.5	5.9	9.5	5.9
2.7	10.5	6.5	10.5	6.5
	12.2	7.6	12.2	7.6

*Meets Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.

TRAVEL SPEED

POWER SHIFT MODEL	Differential Steer D8R		D8T		D9R		D9T		D10T2		D11T/CD		D11T/CD High Altitude	
FORWARD	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
1	3.5	**2.2**	3.4	**2.1**	3.8	**2.4**	3.9	**2.4**	4.0	**2.5**	3.9	**2.4**	4.0	**2.5**
2	6.2	**3.9**	6.0	**3.7**	6.8	**4.2**	6.8	**4.2**	7.2	**4.5**	6.8	**4.2**	7.0	**4.4**
3	10.8	**6.7**	10.6	**6.6**	11.9	**7.4**	11.7	**7.3**	12.7	**7.9**	11.8	**7.3**	12.0	**7.5**
REVERSE														
1	4.7	**2.9**	4.5	**2.8**	4.7	**2.9**	4.7	**2.9**	5.2	**3.2**	4.7	**2.9**	4.8	**3.0**
2	8.1	**5.0**	7.9	**4.9**	8.4	**5.2**	8.4	**5.2**	9.0	**5.6**	8.2	**5.1**	8.3	**5.2**
3	13.9	**8.6**	14.2	**8.8**	14.7	**9.1**	14.3	**8.9**	15.8	**9.8**	14.0	**8.7**	14.9	**9.0**

GEAR	D6T Powershift with AutoShift		D6T Powershift with AutoShift — Sound Suppressed	
FORWARD	km/h	mph	km/h	mph
0.5	2.7	**1.7**	2.7	**1.7**
0.7	3.3	**2.0**	3.2	**2.0**
1.0	3.7	**2.3**	3.2	**2.0**
1.5	4.7	**2.9**	4.7	**2.9**
1.7	5.7	**3.6**	5.7	**3.6**
2.0	6.5	**4.0**	6.3	**3.9**
2.5	8.2	**5.1**	8.2	**5.1**
2.7	10.0	**6.2**	10.0	**6.2**
3.0	11.3	**7.0**	10.9	**6.8**
REVERSE				
0.5	3.5	**2.2**	3.5	**2.2**
0.7	4.2	**2.6**	3.9	**2.4**
1.0	4.7	**2.9**	3.9	**2.4**
1.5	6.0	**3.7**	6.0	**3.7**
1.7	7.3	**4.5**	7.3	**4.5**
2.0	8.3	**5.1**	8.0	**5.0**
2.5	10.4	**6.5**	10.4	**6.5**
2.7	12.7	**7.9**	12.7	**7.9**
3.0	14.4	**9.0**	13.8	**8.6**

HYDRAULIC CONTROLS

CONTENTS

Features:

- **Designed and built for specific tractor applications.** Valves and components sized for exacting quality and performance.
- **Job requirements matched** through various arrangements.
- **Hydraulic blade and ripper controls:** Mechanical controls on G Series. Electro hydraulic controls on D6N and D6K2. Pilot blade and ripper controls on D6T Tier 3/Stage IIIA, Japan 2006 (Tier 3) equivalent with optional electro hydraulic blade control. Electro hydraulic blade and ripper controls on D6T Tier 4 Interim/ Stage IIIB/Japan 2011 (Tier 4 Interim) equivalent Mechanical controls on D9R. Electro hydraulic blade and ripper controls on D7E, D8T, D9T, D10T2, and D11T.
- **Full flow filters*** … all oil completely filtered.
- **Dual tilt** — standard on D11T and D11T CD, attachment option on D7E, D8R, D8T, D9R, D9T, D10T2.

*Exception — D8R 2-pump.

BULLDOZERS

CONTENTS

Features:

- **Straight Bulldozers** — adjustable tilt angle controls blade penetration.
- **Variable cutting edge Power Angle and Tilt (VPAT)** — blade is available on the D3K2, D4K2, D5K2, D6K2, D6N, and D6T. The blade can be mechanically tipped forward for improved penetration or back for more productivity and easier finish grading.
- **Angling Bulldozers** — 25° right/left angling; C-frame allows mounting other tools.
- **Universal Bulldozers** — 25° wings provide increased capacity, less spillage.
- **Semi-Universal Bulldozers** — combines penetration ability of straight blade with increased load capacity provided by short 25° wings.
- **Wheel Dozer blades** are offered in straight and universal blade design with hydraulic pitch and tilt control.
- **Box-section construction** on blades adds rigidity and strength.
- **Cutting edges** are heat treated and reversible for extra life.

BLADE SELECTION

Properly matching tractor and dozer is a basic requirement for maximizing production. First consider the kind of work the tractor will be doing most of its life. Then evaluate:

- Material to be moved.
- Tractor limitations.

Materials to be moved

Most materials are dozeable. However, dozer performance will vary with material characteristics such as:

Particle Size and Shape — The larger the individual particle size, the harder it is for a cutting edge to penetrate. Particles with sharp edges resist the natural rolling action of a dozer blade. These particles require more horsepower to move than a similar volume of material with rounded edges.

Voids — Few voids or the absence of voids means the individual particles have most or all of their surface area in contact with other particles. This forms a bond which must be broken. A well graded material, which lacks voids, is generally heavy, and will be hard to remove from the bank state.

Water Content — In most materials the lack of moisture increases the bond between particles and makes the material difficult to remove from the bank state. A high moisture content makes dozing difficult because the material is heavy and requires more force to move. Optimum moisture reduces dust and offers the best condition for dozing ease and operator comfort.

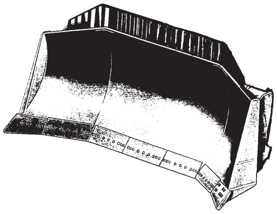
The effect of freezing depends on the moisture content. When frozen, the material's bond strengthens as moisture content increases and temperature decreases. However, freezing a completely dry material does not change its characteristics.

An indication of a blade's ability to penetrate and obtain a blade load is kW per meter (or horsepower per foot) of cutting edge. The higher the kW/meter (HP/foot), the more aggressive the blade. Kilowatt per Lm^3 (horsepower per loose cubic yard) indicates a blade's ability to push material. The higher the kW/Lm^3 (HP/LCY), the greater the blade's potential capability for carrying material at a greater speed.

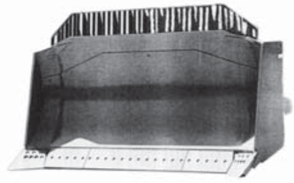
Tractor Limitations

The weight and horsepower of the machine determines its ability to push. No tractor can exert more pounds push than the machine itself weighs and its power train can develop. Various terrain and underfoot conditions on the job limit the tractor's ability to use its weight and horsepower. The "approximate coefficient of traction factors" chart in the Tables Section presents these traction factors for common materials. To use the chart, take the total tractor weight (with attachments) times the factor to arrive at the maximum usable push the dozer can exert.

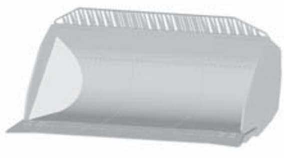
Production Dozing Tools



"U" — Universal blade — the large wings on this blade include one end bit and at least one section of cutting edge which make it efficient for moving big loads over long distances as in land reclamation, stockpile work, charging hoppers and trapping for loaders. As this blade has a lower kW/meter (HP/foot) of cutting edge than an "S" or "SU", penetration should not be a prime objective. With a lower kW/Lm^3 (HP/LCY) than an "S" or "SU", this blade is best for lighter or relatively easily dozed material. If equipped with tilt cylinders the U blade can be used to pry out, level, cut ditches and steer the tractor.

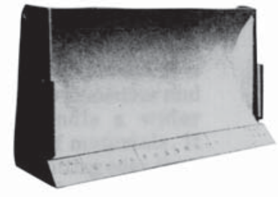


"SU" — The Semi-U blade combines the desirable characteristics of S and U-blades into one package. It has increased capacity by the addition of short wings which include only the dozer end bits. The wings provide improved load retention capabilities while maintaining the blade's ability to penetrate and load quickly in tightly packed materials and to handle a wide variety of materials in production oriented applications. Tilt cylinder(s) increase both the productivity and versatility of this dozer. Equipped with a push plate, it is effectively used for push loading scrapers.



"CD" — The CD or Carry-Dozer Blade is available for the D11T CarryDozer only. It is built to the same high standard of structural integrity as the "U" and "SU" Dozers. The CD Blade has a unique "bucket" shape that allows it to carry several cubic yards or cubic meters of material in the blade. This acts as a disposable counterweight that allows the CarryDozer to push more material per pass than a standard D11T. The CarryDozer will not be as effective as the "U" or "SU" dozer in tightly packed or poorly shot material. It is also more sensitive to the carry-back in sticky materials.

General Purpose Dozing Tools



"S" — The Straight blade provides excellent versatility. Since it is physically smaller than the SU or U-blade, it is easier to maneuver and can handle a wider range of materials. It has a higher kW/ meter (HP/foot) of cutting edge than the SU or U-blade; consequently, the "S" is more aggressive in penetrating and obtaining a blade load. A tilt cylinder increases both the productivity and versatility of this dozer. With a high kW/Lm^3 (HP/LCY), the S-blade can handle heavy material easily.

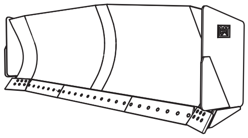
Power Angle and Tilt Blade — Versatility is its key feature with its ability to perform a variety of site development to general dozing work as well as heavy-duty applications. Angle and tilt control is with 2 levers on some machines, 1 lever on others.

Variable Power Angle and Tilt (VPAT) blade can be mechanically tipped forward for improved penetration or shedding sticky material and backward for finish grading and improved productivity.

Special Application Dozing Tools

Caterpillar provides specialty bulldozers for specific applications. The blades are designed to increase production while performing certain tasks. Following are the most popular special applications blades.

Variable Radius (VR) Blades



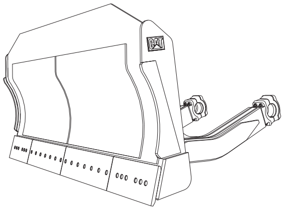
Variable Radius Semi-U Blades are excellent tools for land improvement, soil conservation, site development or general construction. They combine the penetration ability of a Semi-U Blade with the load retention and high capacity of a U-blade.

They provide the aggressive cutting action needed for digging, while having the material retention characteristics needed for moving high volumes over a distance. This is accomplished through a moldboard which varies in radius from the edge to the center. This creates a rolling action in the material being moved, pushing it to the center of the blade for better retention. The extended side wings, angled to thirty degrees, further increase the capacity over a standard blade.

Angle Blade (A-Blade)

"A" — Or Angling blade can be positioned straight or angled 25 degrees to either side. It is designed for side-casting, pioneering roads, backfilling, cutting ditches and other similar tasks. It can reduce the amount of maneuvering required to do these jobs. Its "C" frame can be used for attachments such as pushing, land clearing, or snow removal tools. A-blades are not recommended for rock or severe applications.

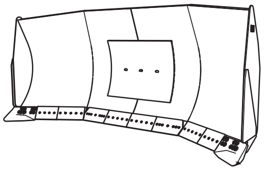
Cushion Dozers



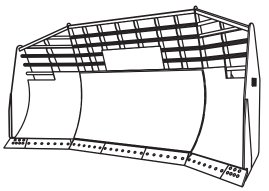
Cushion Dozers are designed to push-load wheel-tractor scrapers, or track-type tractors. The heavy-duty design includes reinforcement to transfer machine power without damaging the blade or the tractor. Blade cylinders are pinned to the C-frame, and the blade height is such that the blade lift cylinders are isolated from damaging forces.

The taller blade allows pushing from a higher position, eliminating blade drag and increasing productivity. The blade curvature is matched to the curve of the Cat Push Block for maximum contact area, preventing the block from riding over the top of the blade. Extended side plates make it easier for operators to "catch" the stinger when repositioning for a new pass. The center of the blade is armored with T-1 plate steel for maximum service life. The narrow width of the cushion blade increases machine maneuverability in congested cuts and reduces the possibility of cutting tires associated with SU and U-blades.

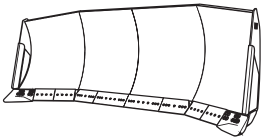
When not push-loading, the dozer can be used for cut maintenance and other general dozing jobs.



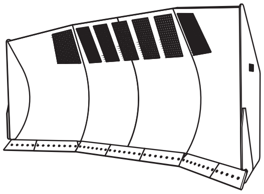
Coal U-Blades are designed specifically to move large volumes of coal in coal piles, at powerplants and transshipment points. The wing angle of thirty degrees crowds material to the center of the blade, maximizing capacity by minimizing side spill. The moldboard is much higher and wider than standard, specifically to match the material density and loading characteristics of coal. The curve of the moldboard rolls the material forward, enhancing the carrying capacity. With this design, coal-moving capacity can be as much as 200 percent greater than a standard U-blade.



Landfill U-Blades provide capacity increases of up to fifty percent over a straight blade. Landfill blades have the height and width to handle large volumes of low-density refuse, but are tough enough to dig and bulldoze ground cover. Vision to the load is provided by areas of screen in the upper blade. Angled wings slice into natural bed earth for trenches or cover material, adding to the versatility in the landfill.

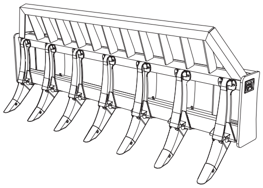


Reclamation U-Blades — are purpose-built for reclamation of mine spoil piles. The blade has a larger capacity than a standard U-blade. The wing angle of 28 degrees provides a good balance between load retention and shearing action, keeping the optimal load in front of the blade, but cutting cleanly through the material when necessary.



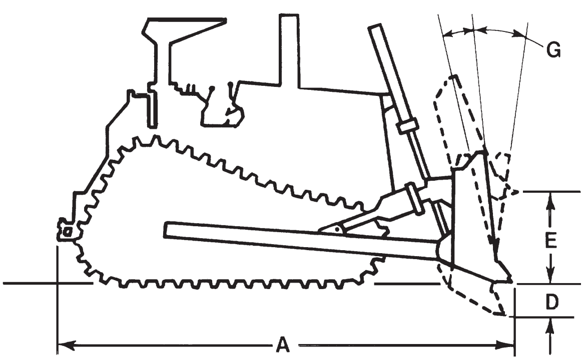
The width of **Woodchip U-Blades** gives operators maximum control and greater confidence, even in steep chip piles. Deep curvature of the moldboard keeps material flowing to liven dead chips and optimize production on long pushes. Blade height and wings angled at thirty degrees combine for excellent material retention – giving better production with every pass. An operator visibility window in the top section is standard.

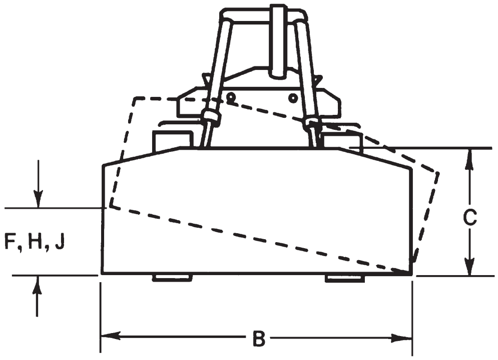
Multi-Application/Rock and Root Rakes



Multi-Application/Rock and Root Rakes are perfectly suited for heavy duty land clearing including removal of stumps, large rocks or large trees and for work in clay and other heavy soils. Frames are constructed of high strength steel for longer life. Cast teeth, with replaceable tips, are designed for maximum ground penetration and resistance to shock loading when prying or pushing trees, stumps and rocks. Brush rack is standard and increases height and capacity by as much as 40%.

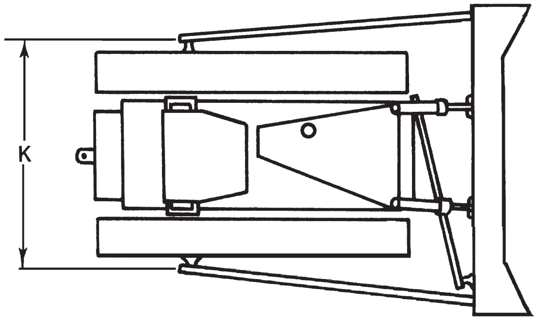
Rake is a direct replacement for existing blade, and utilizes existing push arms and C-frames.





KEY

A Length (Blade Straight)
Blade:
B Width (including standard end bits)
C Height
D Maximum Digging Depth
E Ground Clearance @ Full Lift
F Maximum Tilt (Manual)
G Maximum Pitch Adjustment
H Maximum Hydraulic Tilt
J Hydraulic Tilt (manual brace centered)
K Push Arm Trunnion Width (to Ball Centers)



Blade capacities on the following pages are as determined by SAE recommended practice J1265. Capacities are defined as:

$$Vs = 0.8\ WH^2.$$

$$Vu = ZH\ (W-Z)\tan X.$$

Where: Vs = Capacity of straight or angling blade.
Vu = Capacity of semi-U or full U-blade.
W = Blade width exclusive of end bits.
H = Effective blade height considering tapered top corners, etc.
Z = Wing length measured parallel to blade width @ ground line of cutting edges.
X = Wing angle.

MODEL	D6R2 6S		D6R2 6SU		D6R2 6SU XL		D6R2 6S LGP	
Gauge	—		1880 mm	**74"**	1880 mm	**74"**	2286 mm	**90"**
Type	**Straight**		**Semi-Universal**		**Semi-Universal**		**Straight**	
Blade Capacities*	3.89 m^3	**5.1 yd^3**	5.61 m^3	**7.3 yd^3**	5.55 m^3	**7.26 yd^3**	3.75 m^3	**4.9 yd^3**
Weight, Shipping** (Dozer)	2251 kg	**4963 lb**	2333 kg	**5143 lb**	2570 kg	**5666 lb**	2418 kg	**5331 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	4903 mm	**193.1"**	5095 mm	**200.6"**	5332 mm	**210.0"**	5465 mm	**215.2"**
Blade Dimensions:								
B Width (including std. end bits)	3360 mm	**132.3"**	3260 mm	**128.3"**	3260 mm	**128.3"**	4063 mm	**160"**
C Height	1257 mm	**49.5"**	1412 mm	**55.6"**	1412 mm	**55.6"**	1101 mm	**43.3"**
D Max. Digging Depth	473 mm	**18.6"**	473 mm	**18.6"**	459 mm	**18.1"**	655 mm	**25.8"**
E Ground Clearance @ Full Lift	1104 mm	**43.5"**	1104 mm	**43.5"**	1195 mm	**47.0"**	1083 mm	**42.6"**
G Max. Pitch Adjustment	**+5.3 to 4.8°**		**+5.6 to –5.2°**		**+5.6 to –5.2°**		**+4.4 to –4.4°**	
H Max. Hydraulic Tilt	765 mm	**30.1"**	743 mm	**29.3"**	743 mm	**29.3"**	701 mm	**27.6"**
K Push Arm Trunnion Width (to Ball Centers)	2640 mm	**103.9"**	2640 mm	**103.9"**	2640 mm	**103.9"**	3490 mm	**137.4"**

MODEL	D6R2 6A		D6R2 6A XL		D6T 6A		D6T 6SU	
Gauge	1880 mm	**74"**	1880 mm	**74"**	1880 mm	**74"**	1880 mm	**74"**
Type	**Angling**		**Angling**		**Angling**		**Semi-Universal**	
Blade Capacities*	3.93 m^3	**5.1 yd^3**	3.89 m^3	**5.1 yd^3**	3.64 m^3	**4.75 yd^3**	5.35 m^3	**6.99 yd^3**
Weight, Shipping** (Dozer)	2715 kg	**5986 lb**	2625 kg	**5787 lb**	3138 kg	**6904 lb**	2973 kg	**6540 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	5007 mm	**197.2"**	5209 mm	**205.1"**	5.00 m	**16'5"**	5.08 m	**17'6"**
Length (Blade Angled)	—		—		5.83 m	**19'2"**	—	
Width (Blade Angled)	—		—		3.78 m	**12'5"**	—	
Width (with C-Frame only)	—		—		2.93 m	**9'8"**	—	
Blade Dimensions:								
B Width (including std. end bits)	4166 mm	**164.0"**	4166 mm	**164.0"**	4.16 m	**13'8"**	3.26 m	**10'8"**
C Height	1155 mm	**45.5"**	1155 mm	**45.5"**	1154 mm	**3'10"**	1411 mm	**4'8"**
D Max. Digging Depth	506 mm	**19.9"**	524 mm	**20.6"**	506 mm	**1'8"**	453 mm	**1'6"**
E Ground Clearance @ Full Lift	1142 mm	**45.0"**	1205 mm	**47.4"**	1144 mm	**3'9"**	1204 mm	**3'11"**
G Max. Pitch Adjustment	**25°**		**25°**		—		**+5.6° to –5.2°**	
H Max. Hydraulic Tilt	408 mm	**16.1"**	408 mm	**16.1"**	519 mm	**1'8"**	811 mm	**2'8"**
Blade Angle	—		—		**25°**		—	
J Hydraulic Tilt (Manual Brace Centered)	—		—		—		455 mm	**1'6"**
K Push Arm Trunnion Width (to Ball Centers)	2640 mm	**103.9"**	2625 mm	**103.9"**	2.58 m	**8'6"**	2.58 m	**8'6"**

*Blade capacities as determined by SAE J1265. Tractor and dozer dimensions variations due to SystemOne undercarriage products are negligible. Notice that the capacity of the SU-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the SU-blade. It is intended for **relative comparisons of dozer sizes,** and not for predicting capacities or productivities in actual field conditions.
**Shipping Weight — Total Bulldozer Arrangement includes: Blade, push arms or C-frame, braces, cylinders, lines, trunnions and lift cylinder mountings.

	D6T							
MODEL	**6A XL**		**6SU XL**		**6VPAT XL**		**6A XW**	
Gauge	1.88 m	**74"**	1.88 m	**74"**	2.13 m	**84"**	2.03 m	**80"**
Type	**Angling**		**Semi-Universal**		**VPAT**		**Angling**	
Blade Capacities*	3.94 m^3	**5.15 yd^3**	5.55 m^3	**7.26 yd^3**	4.64 m^3	**6.07 yd^3**	4.35 m^3	**5.69 yd^3**
Weight, Shipping** (Dozer)	3086 kg	**6803 lb**	2831 kg	**6242 lb**	3464 kg	**7637 lb**	3731 kg	**8226 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	5.21 m	**17'1"**	5.33 m	**17'6"**	5.39 m	**17'8"**	5.29 m	**17'4"**
Length (Blade Angled)	6.05 m	**19'10"**	—		3.54 m	**11'7"**	6.20 m	**20'4"**
Width (Blade Angled)	3.77 m	**12'5"**	—		3.49 m	**11'5"**	4.11 m	**13'6"**
Width (with C-Frame only)	2.99 m	**9'10"**	—		—		3.29 m	**10'10"**
Blade Dimensions:								
B Width (including std. end bits)	4.16 m	**13'8"**	3.26 m	**10'8"**	3.88 m	**12'9"**	4.52 m	**14'10"**
C Height	1154 mm	**3'10"**	1407 mm	**4'7"**	1294 mm	**4'3"**	1153 mm	**3'9"**
D Max. Digging Depth	555 mm	**1'10"**	501 mm	**1'7"**	792 mm	**2'7"**	541 mm	**1'9"**
E Ground Clearance @ Full Lift	1112 mm	**3'7"**	1180 mm	**3'10"**	1053 mm	**3'5"**	1139 mm	**3'9"**
G Max. Pitch Adjustment	—		**+4.0° to –4.0°**		**+0.5° to –3.1°**		—	
H Max. Hydraulic Tilt	424 mm	**1'5"**	811 mm	**2'8"**	410 mm	**1'4"**	424 mm	**1'5"**
Blade Angle	**25°**		—		**24°**		**25°**	
J Hydraulic Tilt (Manual Brace Centered)	—		455 mm	**1'6"**	—		—	
K Push Arm Trunnion Width (to Ball Centers)	2.58 m	**8'6"**	2.58 m	**8'6"**	—		2.89 m	**9'8"**

	D6T							
MODEL	**6SU XW**		**6A LGP**		**6S LGP**		**6VPAT LGP/XW**	
Gauge	2.03 m	**80"**	2.29 m	**90"**	2.29 m	**90"**	2.29 m	**90"**
Type	**Semi-Universal**		**Angling**		**Straight**		**VPAT**	
Blade Capacities*	5.64 m^3	**7.38 yd^3**	4.94 m^3	**6.46 yd^3**	3.79 m^3	**4.96 yd^3**	5.02 m^3	**6.57 yd^3**
Weight, Shipping** (Dozer)	2976 kg	**6562 lb**	3745 kg	**8255 lb**	2720 kg	**5997 lb**	3558 kg	**7845 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	5.33 m	**17'6"**	5.81 m	**19'1"**	5.50 m	**18'1"**	5.53 m	**18'2"**
Length (Blade Angled)	—		6.81 m	**22'4"**	—		—	
Width (Blade Angled)	—		4.63 m	**15'2"**	—		3.72 m	**12'2"**
Width (with C-Frame only)	—		3.77 m	**12'5"**	—		—	
Blade Dimensions:								
B Width (including std. end bits)	3.56 m	**11'8"**	5.07 m	**16'8"**	4.06 m	**13'3"**	4.16 m	**13'8"**
C Height	1407 mm	**4'7"**	1150 mm	**3'9"**	1108 mm	**3'8"**	1294 mm	**4'3"**
D Max. Digging Depth	502 mm	**1'7"**	853 mm	**2'10"**	590 mm	**1'11"**	743 mm	**2'5"**
E Ground Clearance @ Full Lift	1180 mm	**3'10"**	1004 mm	**3'3"**	1094 mm	**3'7"**	1102 mm	**3'7"**
G Max. Pitch Adjustment	**+4.0° to –4.0°**		—		**+4.4° to –4.4°**		**+0.5° to –3.1°**	
H Max. Hydraulic Tilt	791 mm	**2'7"**	618 mm	**2'0"**	747 mm	**2'5"**	435 mm	**1'5"**
Blade Angle	—		**24.2°**		—		**24°**	
J Hydraulic Tilt (Manual Brace Centered)	442 mm	**1'5"**	—		399 mm	**1'4"**	—	
K Push Arm Trunnion Width (to Ball Centers)	2.89 m	**9'8"**	3.42 m	**11'5"**	3.42 m	**11'5"**	—	

*Blade capacities as determined by SAE J1265.
Notice that the capacity of the SU-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the SU-blade. It is intended for **relative comparisons of dozer sizes,** and not for predicting capacities or productivities in actual field conditions.
**Shipping Weight — Total Bulldozer Arrangement includes: Blade, push arms or C-frame, braces, cylinders, lines, trunnions and lift cylinder mountings.

MODEL	D9R/D9T			
	9SU		9U	
Type	**Semi-U**		**Universal**	
Blade Capacities*	13.5 m^3	**17.7 yd^3**	16.4 m^3	**21.4 yd^3**
Weight, Shipping** (Dozer)	6863 kg	**15,130 lb**	7388 kg	**16,288 lb**
Tractor and Dozer Dimensions:				
A Length (Blade Straight)	6.60 m	**21'6"**	6.96 m	**22'8"**
Blade Dimensions:				
B Width (including std. end bits)	4.31 m	**14'1"**	4.65 m	**15'2"**
C Height	1934 mm	**6'4.1"**	1934 mm	**6'4.1"**
D Max. Digging Depth	606 mm	**1'11.9"**	606 mm	**1'11.9"**
E Ground Clearance @ Full Lift	1422 mm	**4'8"**	1422 mm	**4'8"**
G Max. Pitch Adjustment	**+3.4° to 2.9°**		**+3.4° to 2.9°**	
H Max. Hydraulic Tilt	940 mm	**3'1"**	1014 mm	**3'3.9"**
J Hydraulic Tilt (Manual Brace Centered)	570 mm	**1'10.4"**	616 mm	**2'0.3"**
K Push Arm Trunnion Width (to Ball Centers)	3.30 m	**10'8"**	3.30 m	**10'8"**
Maximum Track Width Permitted	762 mm	**2'6"**	762 mm	**2'6"**
Dual Tilt Option				
G Dual Pitch Adj.	**+4.8° to 5.2°**		**+4.8° to 4.9°**	
H Dual Max. Hyd. Tilt	1139 mm	**3'8.8"**	1231 mm	**4'0.5"**

*Blade capacities as determined by SAE J1265.
Notice that the capacity of the U-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the U-blade. It is intended for **relative comparisons of dozer sizes**, and not for predicting capacities or productivities in actual field conditions.
Notice that the capacity of the SU-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the SU-blade. It is intended for **relative comparisons of dozer sizes,** and not for predicting capacities or productivities in actual field conditions.
**Shipping Weight — Total Bulldozer Arrangement includes: Blade, push arms or C-frame, braces, cylinders, lines, trunnions and lift cylinder mountings.

MODEL	D11T 11SU		11U		11 CD	
Type	Semi-U		Universal		CarryDozer	
Blade Capacities*	27.2 m³	**35.5 yd³**	34.4 m³	**45.0 yd³**	43.6 m³	**57.0 yd³**
Weight, Shipping**						
Standard Dozer	14 813 kg	**32,658 lb**	17 296 kg	**38,131 lb**	24 085 kg	**53,099 lb**
Abrasion Dozer	16 192 kg	**35,698 lb**	18 823 kg	**41,498 lb**	—	
Tractor and Dozer Dimensions:						
A Length	8.58 m	**28'2"**	8.64 m	**28'4"**	8.77 m	**28'9"**
Width	5.50 m	**18'1"**	6.26 m	**20'7"**	6.43 m	**21'1"**
Blade Dimensions:						
B Width (including std. end bits)	5.58 m	**18'4"**	6.35 m	**20'10"**	6.71 m	**22'0"**
C Height	2.75 m	**9'0"**	2.83 m	**9'3"**	2.96 m***	**9'8"*** **
D Max. Digging Depth	766 mm	**2'6.2"**	766 mm	**2'6.2"**	688 mm	**2'3"**
E Ground Clearance @ Full Lift	1533 mm	**5'0.4"**	1533 mm	**5'0.4"**	1850 mm	**6'1"**
G Max. Pitch Adjustment	**+2.1° to 2.2°**		**+2.1° to 2.2°**		—	
H Max. Hydraulic Tilt	1184 mm	**3'10.6"**	1344 mm	**4'4.9"**	1800 mm	**5'11"**
J Hydraulic Tilt (Manual Brace Centered)	886 mm	**2'10.9"**	1006 mm	**3'3.6"**	—	
K Push Arm Trunnion Width (to Ball Centers)	4.18 m	**13'9"**	4.18 m	**13'9"**	4.18 m	**13'9"**
Maximum Track Width Permitted	914 mm	**3'0"**	914 mm	**3'0"**	914 mm	**3'0"**
Dual Tilt Option	**+7.5° to 7.6°**		**+7.5° to 7.6°**			
	or		or			
G Dual Pitch Adjustment	**+0° to 13°**		**+0° to 13°**		**+47.8° to 10.4°**	
H Dual Max. Hyd. Tilt	1706 mm	**5'7.2"**	1938 mm	**6'4.3"**	—	

*Blade capacities as determined by SAE J1265.
Notice that the capacity of the U-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the U-blade. It is intended for **relative comparisons of dozer sizes,** and not for predicting capacities or productivities in actual field conditions.
Notice that the capacity of the SU-blade is the volume carried by a straight blade of the same dimensions plus the volume included in the "cup" of the SU-blade. It is intended for **relative comparisons of dozer sizes,** and not for predicting capacities or productivities in actual field conditions.
**Shipping Weight — Total Bulldozer Arrangement includes: Blade, push arms or C-frame, braces, cylinders, lines, trunnions and lift cylinder mountings.
***Blade height with cutting edge at 53°.

All dimensions are approximate.

BULLDOZER PRODUCTION OFF-THE-JOB

You can estimate bulldozer production using the production curves that follow and the correction factors that are applicable. Use this formula:

$$\begin{array}{r} \text{Production (Lm}^3\text{/hr)} \\ \text{(LCY/hr)} \end{array} = \begin{array}{c} \text{Maximum} \\ \text{production} \end{array} \times \begin{array}{c} \text{Correction} \\ \text{factors} \end{array}$$

The bulldozer production curves give maximum uncorrected production for universal, semi-universal, and straight blades and are based on the following conditions:

1. 100% efficiency (60 minute hour — level cycle).
2. Power shift machines with 0.05 min. fixed times.
3. Machine cuts for 15 m (50 feet), then drifts blade load to dump over a high wall. (Dump time — 0 sec.)
4. Soil density of 1370 kg/Lm^3 (2300 lb/LCY).
5. Coefficient of traction:*
   a. Track machines — 0.5 or better
   b. Wheel machines — 0.4 or better
6. Hydraulic controlled blades used.
7. Dig 1F**
   Carry 2F**
   Return 2R**

To obtain estimated production in bank cubic meters or bank cubic yards, appropriate load factor from the Tables section should be applied to the corrected production as calculated above.

$$\begin{array}{r} \text{Production Bm}^3\text{/hr} \\ \text{(BCY/h)} \end{array} = \begin{array}{c} \text{Lm}^3\text{/hr} \\ \text{(LCY/h)} \end{array} \begin{array}{l} \times \text{ LF} \\ \times \text{ LF} \end{array}$$

*Coefficient of traction assumed to be at least 0.4. While poor traction affects both track and wheel vehicles, causing them to take smaller blade loads, wheeled units are affected more severely and production falls much more rapidly. While no fixed rules can predict this production loss, a rough rule of thumb is that wheel dozer production falls off 4% for each one-hundredth decrease in coefficient of traction below 0.40. If, for example, coefficient of traction is 0.30, the difference is ten-hundredths (0.10), and production is 60% (10 × 4% = 40% decrease).

**This gear sequence is based on level to downhill terrain, light to medium density material, and no blade extensions such as spill plates, rock guards, etc. Exceeding these conditions may require carry in 1F, but productivity should equal or exceed "standard conditions" due to the larger loads that can be carried in 1F.

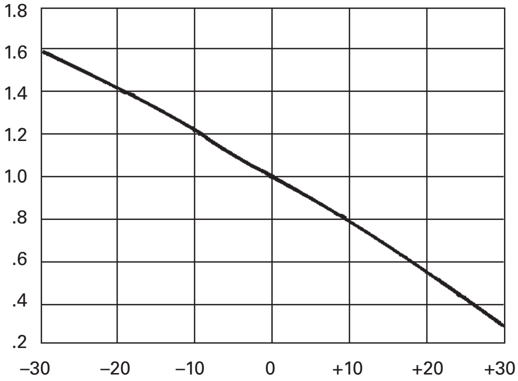
JOB CONDITION CORRECTION FACTORS

	TRACK-TYPE TRACTOR
OPERATOR —	
Excellent	1.00
Average	0.75
Poor	0.60
MATERIAL —	
Loose stockpile	1.20
Hard to cut; frozen —	
with tilt cylinder	0.80
without tilt cylinder	0.70
Hard to drift; "dead" (dry, non-cohesive material) or very sticky material	0.80
Rock, ripped or blasted	0.60-0.80
SLOT DOZING	1.20
SIDE BY SIDE DOZING	1.15-1.25
VISIBILITY —	
Dust, rain, snow, fog or darkness	0.80
JOB EFFICIENCY —	
50 min/hr	0.83
40 min/hr	0.67
BULLDOZER*	
Adjust based on SAE capacity relative to the base blade used in the Estimated Dozing Production graphs.	
GRADES — See following graph.	

***NOTE:** Angling blades and cushion blades are not considered production dozing tools. Depending on job conditions, the A-blade and C-blade will average 50-75% of straight blade production.

% Grade vs. Dozing Factor

(–) Downhill
(+) Uphill



ESTIMATING DOZER PRODUCTION OFF-THE-JOB

Example problem:

Determine average hourly production of a D8T/8SU (with tilt cylinder) moving hard-packed clay an average distance of 45 m (150 feet) down a 15% grade, using a slot dozing technique.

Estimated material weight is 1600 kg/Lm^3 (2650 lb/LCY). Operator is average. Job efficiency is estimated at 50 min/hr.

Uncorrected Maximum Production — 458 Lm^3/h (600 LCY/hr) (example only)

Applicable Correction Factors:

Hard-packed clay is "hard to cut" material . . .–0.80
Grade correction (from graph) . . . .–1.30
Slot dozing . . . .–1.20
Average operator . . . .–0.75
Job efficiency (50 min/hr) . . . .–0.83
Weight correction. . . . . (2300/2650)–0.87

Production = Maximum Production × Correction Factors
= (600 LCY/hr) (0.80) (1.30) (1.20) (0.75) (0.83) (0.87)
= 405.5 LCY/hr

To obtain production in metric units, the same procedure is used substituting maximum uncorrected production in Lm^3.

= 458 Lm^3/h × Factors
= 309.6 Lm^3/h

RIPPERS

CONTENTS

Features:

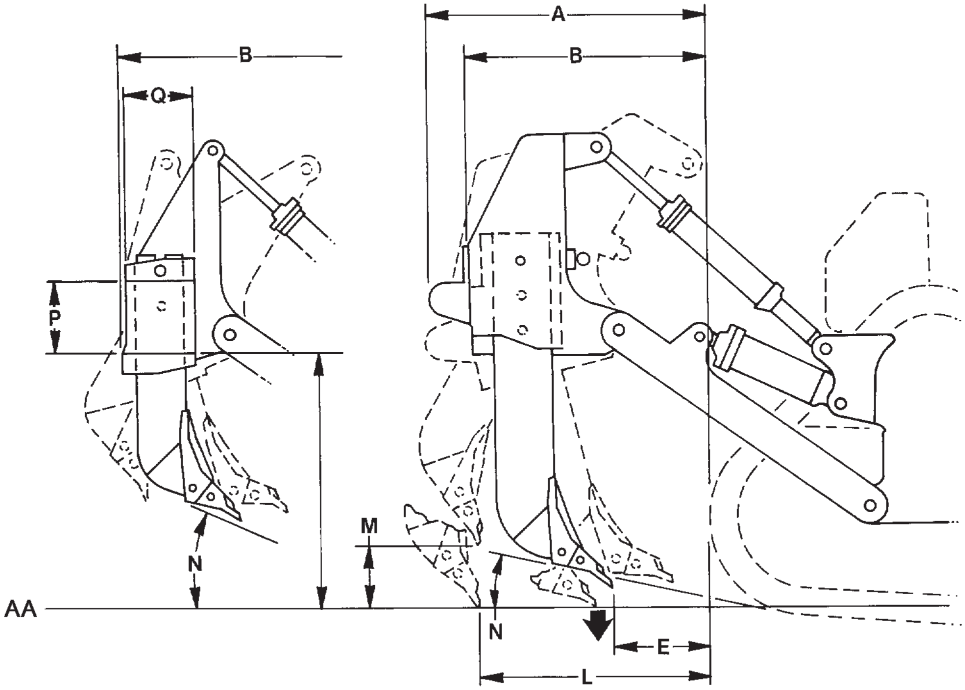
- **Parallelogram linkage with hydraulically variable pitch** on D7E, D7R, D8R/D8T, D9R/D9T, D10T2 and D11T. Operator can adjust angle of ripper tip to the material for penetration at all ripping depths to increase production.
- **Fixed Parallelogram linkage design** used on D3K2, D4K2, D5K2, D6K2, D6N, D6R, D6R XL, D6T and D6T XL. This design holds tooth angle constant at all ripping depths.
- **Adjustable Single shank** arrangements available for D8R/D8T, D9R/D9T, D10T2 and D11T for tough ripping applications and deep ripping requirements.
- **Hydraulically Variable Pitch Multi-shank** arrangements available on D7E, D7R, D8R/D8T, D9R/D9T, D10T2 and D11T allow wide-beam coverage in easier-to-rip materials.
- **Counterweighted CarryDozer Ripper single shank** available for D11T and D11T CD, multi-shank available for D11T CD.

DEFINITION OF FORCES SHOWN IN TABLES THAT FOLLOW

"Pryout," (Breakout) kilonewtons (and pounds) — the maximum sustained upward force, generated by the lift cylinders measured at the ripper tip. Breakout force is measured with the shank in the top hole, shank vertical and ripper full down. Breakout force may be hydraulically or balance limited.

"Penetration force," kilonewtons (and pounds) — the maximum sustained downward force, generated by the ripper lift cylinders measured at the ripper tip, which is required to raise the back end of the vehicle with the tip on ground and the shank (pinned in the top hole) vertical.

Adjustable Parallelogram Ripper

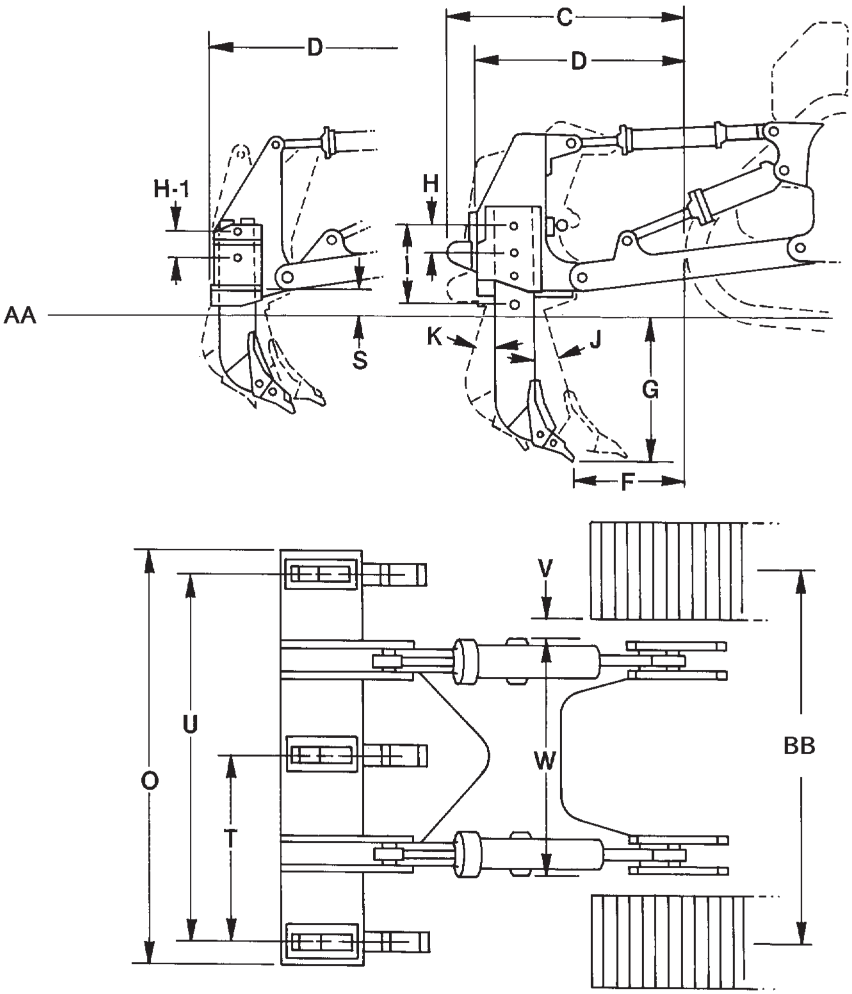


NOTE: Letters correspond to ripper specifications on pages that follow.

KEY

AA — Ground Line

Adjustable Parallelogram Ripper

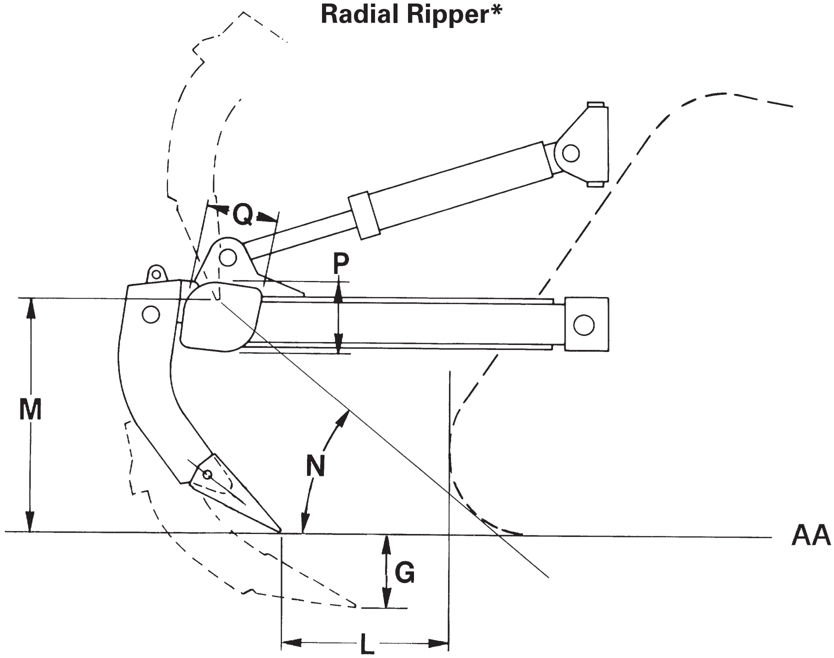


NOTE: Letters correspond to ripper specifications on pages that follow.

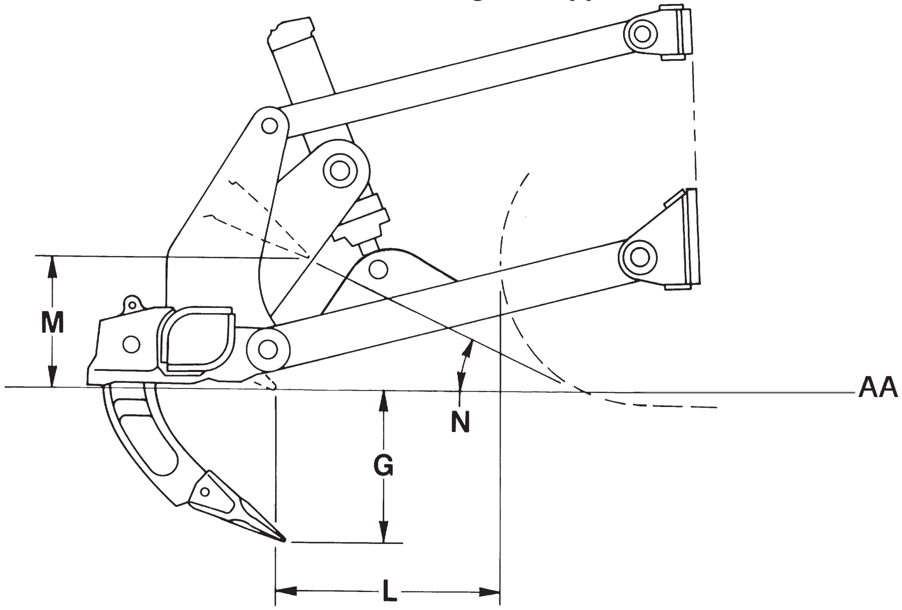
KEY

AA — Ground Line
BB — Track Gauge

Radial Ripper*



Fixed Parallelogram Ripper



NOTE: Letters correspond to ripper specifications on pages that follow.

KEY	
AA	— Ground Line
*	— Tip Standard

TRACTOR/RIPPER	D11T		D11T	
	Adjustable Parallelogram			
Ripper Type	**Multi-shank**		**CD Multi-shank**	
Dimensions:				
Ripper to Track				
Ripper length behind track, shank vertical, ripper up (A)				
A With Pushblock	**N/A**		**N/A**	
B Without Pushblock	1.69 m	**5'6"**	1.71 m	**5'8"**
Ripper length behind track, shank vertical, ripper down (A)				
C With Pushblock	**N/A**		**N/A**	
D Without Pushblock	2.16 m	**7'1"**	2.16 m	**7'1"**
Tip to track distance, shank vertical (A)				
E Ripper Up	0.78 m	**2'7"**	0.78 m	**2'7"**
F Ripper Down	1.95 m	**6'5"**	1.96 m	**6'5"**
Shank*				
G Maximum digging depth	1100 mm	**3'7.3"**	1100 mm	**3'7.3"**
H Dig adjustment per hole	280 mm	**11"**	280 mm	**11"**
I Total dig adjustment	280 mm	**11"**	280 mm	**11"**
Pitch Adjustment, ripper down:				
J Forward	**12.2°**		**12.2°**	
K Backward	**31.8°**		**31.8°**	
L Maximum reach at ground line	1.71 m	**5'7"**	1.71 m	**5'7"**
M Maximum ground clearance under tooth (shank pinned in bottom hole)	1090 mm	**3'6.9"**	1090 mm	**3'6.9"**
N Maximum ramp angle, ripper up (shank pinned in bottom hole)	**36.4°**		**36.4°**	
Shank Section	100 × 400 mm	**3.9" × 15.7"**	100 × 400 mm	**3.9" × 15.7"**
Ripper Beam				
O Overall width	3.33 m	**10'11"**	3.34 m	**10'11.5"**
P Height	560 mm	**22"**	595 mm	**23.4"**
Q Length	560 mm	**22"**	595 mm	**23.4"**
Clearance under beam, shank vertical				
R Ripper Up	2.06 m	**6'9"**	2.03 m	**6'8"**
S Ripper Down	282 mm	**11.1"**	247 mm	**9.7"**
Number of Pockets	**3**		**3**	
T Pocket Spacing	1.5 m	**4'11"**	1.5 m	**4'11"**
U Shank Gauge	3.0 m	**9'10"**	3.0 m	**9'10"**
V Track Clearance with standard shoe	166 mm	**5.6"**	166 mm	**5.6"**
W Width across widest part of lift cylinders	1.9 m	**6'3"**	1.9 m	**6'3"**
Installed Weights:				
Ripper with standard shank	8674 kg	**19,123 lb**	11 790 kg	**25,993 lb**
Each additional tooth group	689 kg	**1519 lb**	689 kg	**1519 lb**
Ripper Forces:**				
Penetration Force, shank vertical	335 kN	**75,311 lb**	365 kN	**82,055 lb**
Pryout Force, shank vertical	632 kN	**142,079 lb**	636 kN	**142,978 lb**

*Hydraulic pin puller is standard with deep ripping shank. Deep Ripping Arrangement maximum digging depth is 2.18 m **(7'2")**.
**Forces are for a ripper on a tractor equipped with an EROPS, U-Dozer and performance track. Forces will vary slightly with other vehicle configurations.

TIP SELECTION FOR THE D8R/D8T, D9R/D9T, D10T2 AND D11T RIPPERS

Three tip configurations (short, intermediate and long) in two styles (centerline and penetration) are available for economical operation in a variety of conditions.

RECOMMENDED TIP USAGE

Short — Use in high impact conditions where breakage problems occur. The shorter the tip, the more it resists breakage.

Intermediate — Most effective in moderate impact conditions where abrasion is not excessive.

Long — Use in loose, abrasive materials where breakage is not a problem. Generally offers the most wear material.

Centerline vs Penetration

The materials being ripped and the tractor doing the ripping will both have an effect on which tip will do the best job. High density material requires a "penetration" tip. High impact material requires a "centerline" tip. The following is a general guide to tip application.

	Tips to use		
Ripping Condition	**D8R/D8T D9R/D9T**	**D10T2**	**D11T**
Tandem Tractors	Short	Short	Short
Single Shank and Multi-shank			
Extreme Duty	Int.	Short	Short
Medium Duty	Long	Int.	Int.
Abrasive Duty	Long	Long	Long

Always use the longest tip that will wear without excessive breakage. Different tips should be tried to determine the most economical.

ESTIMATING RIPPING PRODUCTION

Ripping costs must be compared to other methods of loosening the material — usually drilling and blasting — on a cost per ton or bank cubic yard basis. Thus, an accurate estimation of ripper production is needed to determine unit ripping costs.

There are three general methods of estimating ripping production:

1. The best method is to record the time spent ripping, then remove (using scrapers or loaders and trucks) and weigh the ripped material. The total weight divided by the time spent will give hourly production. If the contractor is paid by volume, then a density must be used and the accuracy is only as good as the density used. For payment by volume removed, method 2 may be desirable. Some care will be needed to assure that only ripped material is removed.
2. Another method is to cross-section the area and then record the time spent ripping. After the material has been removed, cross-section the area again to determine the volume of rock removed. The volume divided by the time spent ripping gives the ripping rate per minute or hour.
3. Timing the ripper over a measured distance is the least accurate method, but valuable for quick estimating on the job. An average cycle time should be determined from a number of timed cycles. Turn-around or back-up time must be included. Measure the average rip distance, rip spacing and depth of penetration. This data will give the volume per cycle from which the production in bank cubic yards can be calculated. Experience has shown results obtained from this method are about 10 to 20% higher than the more accurate method of cross-sectioning.

An example of the measured distance method for calculating ripper production is:

Data — D10T2 — No. 10 with one shank.
910 mm (36 in) between passes.
1.6 km/h (1 mph) average speed (including slippage and stalls).
Every 91 m (300 ft) requires 0.25 min to raise, pivot, turn, and lower again: 91 m (300 ft) = 1 pass.
610 mm (24 in) penetration.
Full time ripping (no pushing or dozing assignment).

Example of Estimating Production (Metric)

Time per pass:

1.6 km/h = 26.7 m/min. Then $\frac{91 \text{ m}}{26.7 \text{ m/min}}$ = 3.41 min;

3.41 min + 0.25 min (turn time) = 3.66 min/pass.

If the operator works an average of 45 min per h, it is possible to make = $\frac{45}{3.66}$ = 12.3 passes per h

Volume ripped: 91 m × 0.9 m × 0.6 m = 49.1 BCM per pass

Production = 49.1 × 12.3 = 604 BCM per h

Remember the results from this method are usually 10 to 20 per cent higher than the actual production that can be expected on the job.

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Example of Estimating Production (English)

Time per pass:

MPH = 88 fpm. Then $\frac{300 \text{ ft}}{88 \text{ fpm}}$ = 3.41 min;

3.41 min + 0.25 min. (turn time) = 3.66 min/pass.

If the operator works an average of 45 min per h, it is possible to make = $\frac{45}{3.66}$ = 12.3 passes per h

Volume ripped: $\frac{300 \times 3 \times 2}{27}$ = 66.7 BCY per pass

Production = 66.7 × 12.3 = 820 BCY per hr

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NOTE: The demands of heavy ripping will increase the normal owning and operating costs of the tractor.

These costs should be increased no less than 30-40% in heavy ripping applications to estimate rock loosening costs.

There is no ready answer or rule-of-thumb solution to predict ripping production. Even if everything is known about the seismic velocity of the material, its composition, job conditions, equipment and operator, only a "guesstimate" can be given. The final answer must come from a production study obtained on the job site.

Sample problem (Metric)

Determine the loosening costs in the following situation:

Machine	— D10T2 Tractor with No. 10 Single Shank Ripper
Rip Spacing	— 915 mm
Ripper Penetration	— 610 mm
Rip Distance	— 91 m
Rip Time	— 3.41 minutes
Maneuver Time	— 0.25 minutes
Seismic Velocity	— 1830 meters per second

Assume 60 min. hour

Solution:

1. Total Cycle Time = 3.41 + 0.25 = 3.66 min

   Cycles/hour = $\frac{60 \text{ min/hr}}{3.66 \text{ min/cycle}}$ = 16.4
2. Production per cycle = 91 m × 0.9 m × 0.6 m = 49.1 BCM/cycle
3. Production = 49.1 BCM/cycle × 16.4 cycles/h = 805 BCM/h
4. Remember results of this method are usually 10 to 20% high.

   Actual Production = 80% of 805 BCM/h
   = 644 BCM/h

   Or 90% of 805 BCM/h = 725 BCM/h
5. Owning and Operating Costs

   A D10T2 (ripping only) could have a \$115.00/h O & O costs including \$30/h operator.
6. Loosening Costs

   \$115.00/hr ÷ 644 BCM/h = \$0.179/BCM
   \$115.00/hr ÷ 725 BCM/h = \$0.159/BCM

   The loosening cost should range from 15.9¢ to 17.9¢/BCM

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Sample problem (English)

Determine the loosening costs in the following situation:

Machine	— D10T2 Tractor with No. 10 Single Shank Ripper
Rip Spacing	— 3 feet
Ripper Penetration	— 2 feet
Rip Distance	— 300 feet
Rip Time	— 3.41 minutes
Maneuver Time	— 0.25 minutes
Seismic Velocity	— 6000 feet per second

Assume 60 min. hour

Solution:

1. Total Cycle Time = 3.41 + 0.25 = 3.66 min

   $$\text{Cycles/hour} = \frac{60 \text{ min/hr}}{3.66 \text{ min/cycle}} = 16.4$$

2. Production per cycle = $\frac{300 \times 3 \times 2}{27}$ = 66.7 BCY/cycle

3. Production = 66.7 BCY/cycle × 16.4 cycles/hr = 1094 BCY/hour

4. Remember results of this method are usually 10 to 20% high.

   Actual Production = 80% × 1094
   = 875 BCY/hr
   or 90% × 1094 = 984 BCY/hr

5. Owning and Operating Costs
   A D10T2 (ripping only) could have a $115.00/hr O & O costs including $30/hr operator

6. Loosening Costs
   $115.00/hr ÷ 875 BCY/hr = $0.131/BCY
   $115.00/hr ÷ 984 BCY/hr = $0.117/BCY
   The loosening cost should range from 11.7¢ to 13.1¢/BCY

●●●

USE OF SEISMIC VELOCITY CHARTS

The charts of ripper performance estimated by seismic wave velocities have been developed from field tests conducted in a variety of materials. Considering the extreme variations among materials and even among rocks of a specific classification, the charts must be recognized as being at best only one indicator of rippability.

Accordingly, consider the following precautions when evaluating the feasibility of ripping a given formation:

— Tooth penetration is often the key to ripping success, regardless of seismic velocity. This is particularly true in homogeneous materials such as mudstones and claystones and the fine-grained caliches. It is also true in tightly cemented formations such as conglomerates, some glacial tills and caliches containing rock fragments.

— Low seismic velocities of sedimentaries can indicate probable rippability. However, if the fractures and bedding joints do not allow tooth penetration, the material may not be ripped effectively.

— Pre-blasting or "popping" may induce sufficient fracturing to permit tooth entry, particularly in the caliches, conglomerates and some other rocks; but the economics should be checked carefully when considering popping in the higher grades of sandstones, limestones and granites.

Ripping is still more art than science, and much will depend on operator skill and experience. Ripping for scraper loading may call for different techniques than if the same material is to be dozed away. Cross-ripping requires a change in approach. The number of shanks used, length and depth of shank, tooth angle, direction, throttle position — all must be adjusted according to field conditions. Ripping success may well depend on the operator finding the proper combination for those conditions.

WHEEL LOADERS
INTEGRATED TOOLCARRIERS

CONTENTS

WHEEL LOADERS

Features:

- **Cat® heavy duty diesel engine.**
- **Productive operator environment. Excellent visibility.**
- **Automatic lift and bucket controls.**
- **Adjustable suspension seat and steering column.**
- **Four wheel enclosed wet disc brakes.**
- **Automatic power shift transmissions.** Allows operator to select automatic or manual mode.
- **Hydrostatic drive on 903C2, 906K/M, 907K/M, 908K/M, 910K/M, 914K/M, 918M, 924K, 926M, 930K/M and 938K/M.**
- **Transmission neutralizer switch (950H-980H, 950K-980K, 950L-980L and 950M-982M).**
- **Advanced power train with continuously variable transmission** available on the 966M XE and 972M XE.
- **Computerized machine function monitoring.**
- **Command control steering** with integrated transmission controls and electro-hydraulic controls … 950H-980H.
- **Electro-Hydraulic (EH) Joystick Steering with Force Feedback (Speed Sensitive) on 966K, 966M, 972K, 972M, 980K, 980M and 982M (optional on 950M and 962M).**
- **Lock up clutch on 950L, 950M, 962L, 962M, 966L, 966M, 972L, 972M, 980L, 980M, 982M, 988K, 990K and 994K (optional on the 980K, 992K and 993K).**
- **Impeller clutch on 988K, 990K, 992K, 993K and 994K.**
- **Tilting hood … 950H-980H, 950K-980K, 950L-980L and 950M-982M.**
- **Brake wear indicator.**
- **Limited slip differentials on 924K, 926M, 930K/M, 938K/M (optional on 950H-980H, 950K-980K, 980L, 980M and 982M).**
- **Differential locks … 903C2, 906K/M, 907K/M, 908K/M, 910K/M, 914K/M, 918M, 924K, 926M, 930K/M, 938K/M, 950M, 962M, 966M and 972M (optional on 950L, 962L, 966L and 972L).**
- **Automatic Ride Control suspension system.** Operator select “on,” “off” or “automatic” (excluding 903C2).
- **Payload control system** (excluding models below 924K).
- **Optional Fusion coupler system** for attachment interchangeability with pin-on performance. Attachments can interchange across the entire SWL/MWL/IT line (excluding models below 924K).
- **Performance Series Buckets** — Reduced dig times and better material retention lead to significant productivity and fuel efficiency improvements (910K/M, 914K/M, 918M, 924K, 926M, 930K/M, 938K/M, 950H-980H, 950K- 980K, 950L-980L and 950M-982M).

Listed features may be standard on some models, optional or unavailable on others. Contact your Cat dealer for specific information.

MODEL	950H		962H		966H	
Emission Standards	**Tier 3 equivalent***		**Tier 3 equivalent***		**Tier 3 equivalent***	
Maximum Engine: Net	147 kW	**197 hp**	156 kW	**209 hp**	195 kW	**262 hp**
Gross	162 kW	**217 hp**	172 kW	**231 hp**	211 kW	**283 hp**
Engine Model	**C7 ACERT**		**C7 ACERT**		**C11 ACERT**	
Maximum Net Power Engine RPM	**1800**		**1800**		**1800**	
Bore	110 mm	**4.3"**	110 mm	**4.3"**	130 mm	**5.1"**
Stroke	127 mm	**5"**	127 mm	**5"**	140 mm	**5.5"**
No. Cylinders	**6**		**6**		**6**	
Displacement	7.2 L	**439 in³**	7.2 L	**439 in³**	11.1 L	**677 in³**
Speeds Forward:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	6.9	**4.3**	7.0	**4.4**	6.7	**4.2**
2nd	12.7	**7.9**	13.0	**8.1**	12.6	**7.8**
3rd	22.3	**13.9**	22.6	**14.0**	22.1	**13.7**
4th	37.0	**23.0**	38.0	**23.6**	37.4	**23.2**
Speeds Reverse:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	7.6	**4.7**	7.6	**4.7**	7.4	**4.6**
2nd	13.9	**8.6**	13.9	**8.6**	13.9	**8.6**
3rd	24.5	**15.2**	24.5	**15.2**	24.3	**15.1**
4th	40.0	**24.9**	40.0	**24.9**	37.4	**23.2**
Hydraulic Cycle Time, Rated Load in Bucket:	**Seconds**		**Seconds**		**Seconds**	
Raise (from Carry Position)	**6.2**		**6.2**		**5.9**	
Dump (at Maximum Raise)	**2.0**		**2.0**		**1.6**	
Lower (Empty, Float Down)	**2.5**		**2.5**		**2.4**	
Total	**10.7**		**10.7**		**9.9**	
Tread Width	2.14 m	**7'0"**	2.14 m	**7'0"**	2.23 m	**7'4"**
Width Over Tires	2.79 m	**9'2"**	2.79 m	**9'2"**	3.06 m	**9'10"**
Ground Clearance	412 mm	**16"**	412 mm	**16"**	434 mm	**17"**
Fuel Tank Capacity	264 L	**70 U.S. gal**	264 L	**70 U.S. gal**	380 L	**100 U.S. gal**
Hydraulic Tank Capacity	110 L	**29 U.S. gal**	110 L	**29 U.S. gal**	110 L	**29 U.S. gal**
Hydraulic System Capacity (includes tank)	186 L	**48.4 U.S. gal**	186 L	**48.4 U.S. gal**	200 L	**52 U.S. gal**

*Meets Tier 3, Stage IIIA, Japan 2006 (Tier 3) equivalent emission standards.

NOTE: Net Engine Power is provided according to SAE J1349 and ISO 9249. Gross Engine Power is provided according to SAE J1995. Machines may only be available in certain regions. Contact your local Cat dealer for product availability.

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MODEL	972H		980H		986H		990K	
Emission Standards	**Tier 3 equivalent***		**Tier 3 equivalent***		**Tier 2 equivalent or Tier 3 equivalent****		**Tier 2 equivalent or Tier 4 Final*****	
Maximum Engine: Net	214 kW	**287 hp**	260 kW	**349 hp**	305 kW	**409 hp**	521 kW	**699 hp**
Gross	232 kW	**311 hp**	293 kW	**392 hp**	335 kW	**449 hp**	561 kW	**752 hp**
Rated Payload†	—		—		10 tonnes	**11 tons**	15.9 tonnes	**17.5 tons**
Gross Rated Bucket Payload†	—		—		—		24 249 kg	**53,460 lb**
Engine Model	**C13 ACERT**		**C15 ACERT**		**C15 ACERT**		**C27 ACERT**	
Maximum Net Power Engine RPM	**1800**		**1800**		**1800**		**1800**	
Bore	130 mm	**5.1"**	137 mm	**5.4"**	137 mm	**5.4"**	137 mm	**5.4"**
Stroke	157 mm	**6.2"**	171 mm	**6.75"**	171 mm	**6.75"**	152 mm	**6"**
No. Cylinders	**6**		**6**		**6**		**12**	
Displacement	12.5 L	**763 in³**	15.2 L	**928 in³**	15.2 L	**928 in³**	27.0 L	**1650 in³**
Speeds Forward:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	7.2	**4.5**	6.6	**4.1**	7.3	**5**	7.3	**4.5**
2nd	12.6	**7.8**	11.8	**7.3**	12.7	**8**	13.3	**8.3**
3rd	21.4	**13.3**	20.7	**12.9**	22	**14**	22.9	**14.2**
4th	36.9	**22.9**	36.3	**22.6**	39	**24**	—	
Speeds Reverse:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	8.2	**5.1**	7.6	**4.7**	7.6	**5**	7.9	**4.9**
2nd	14.2	**8.8**	13.5	**8.4**	14.1	**9**	14.7	**9.1**
3rd	24.3	**15.1**	23.6	**14.7**	25	**12**	24.9	**15.5**
4th	38.8	**24.0**	41.5	**25.8**	—		—	
Hydraulic Cycle Time, Rated Load in Bucket:	**Seconds**		**Seconds**		**Seconds**		**Seconds**	
Raise††	**5.9**		**6.0**		**8.5**		**8.2**	
Dump (at Maximum Raise)	**2.1**		**2.1**		**3**		**2.9**	
Lower (Empty, Float Down)	**2.4**		**3.4**		**4.3**		**3.6**	
Total	**10.4**		**11.5**		**15.8**		**13.8**	
Tread Width	2.23 m	**7'4"**	2.43 m	**8'0"**	2.59 m	**8'6"**	3.1 m	**10'2"**
Width Over Tires	3.00 m	**9'10"**	3.18 m	**10'5"**	3.54 m	**11'7"**	4.1 m	**13'5"**
Ground Clearance	434 mm	**17"**	430 mm	**16.9"**	459 mm	**18"**	596 mm	**23.5"**
Fuel Tank Capacity	380 L	**100 U.S. gal**	453 L	**120 U.S. gal**	600 L	**159 U.S. gal**	1114 L	**294 U.S. gal**
Hydraulic Tank Capacity	110 L	**29 U.S. gal**	125 L	**33 U.S. gal**	130 L	**34 U.S. gal**	—	
Implement and Fan	—		—		—		261 L	**68.9 U.S. gal**
Steering and Braking	—		—		—		132 L	**34.9 U.S. gal**
Hydraulic System Capacity (includes tank)	200 L	**52 U.S. gal**	250 L	**66 U.S. gal**	330 L	**87 U.S. gal**	795 L	**210 U.S. gal**

*Meets Tier 3, Stage IIIA, Japan 2006 (Tier 3) equivalent emission standards.
**Meets Tier 2/Stage II/Japan 2001 (Tier 2) equivalent OR Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.
***Meets Tier 2/Stage II/Japan 2001 (Tier 2) equivalent OR Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.
†Changes in bucket weight, including field installed wear iron, can impact rated payload. Consult your Cat dealer for assistance in selecting and configuring the proper bucket for the application. The Cat Large Wheel Loader Payload Policy is a guideline intended to maximize wheel loader structural and component life. The Cat Payload Policy is that the "Gross Bucket plus Payload Capacity" is the MAXIMUM weight that should be carried on the end of the Lift Arm/Boom.
††Raise is from carry position for the 972H and 980H.
NOTE: 972H and 980H Net Engine Power is provided according to SAE J1349 and ISO 9249. Gross Engine Power is provided according to SAE J1995. The 972H and 980H are not available in all regions. Contact your local Cat dealer for product availability.

MODEL	992K		993K		994K	
Maximum Engine: Net	607 kW	**814 hp**	764 kW	**1024 hp**	1297 kW	**1739 hp**
Gross	671 kW	**900 hp**	773 kW	**1036 hp**	1377 kW	**1847 hp**
Rated Payload:*						
STD	21.8 tonnes	**24 tons**	22.7 tonnes	**30 tons**	40.8 tonnes	**45 tons**
HL, EHL, SHL	19 tonnes	**21 tons**	24.9 tonnes	**27.5 tons**	38.1 tonnes	**42 tons**
Gross Rated Bucket Payload:*						
STD	33 687 kg	**74,265 lb**	42 912 kg	**94,603 lb**	64 791 kg	**142,838 lb**
HL	30 138 kg	**66,441 lb**	40 459 kg	**89,195 lb**	61 458 kg	**135,489 lb**
Engine Model	**C32 ACERT****		**C32 ACERT****		**3516E**	
Emission Level						
Rated Engine RPM	**1750**		**1900**		**1600**	
Bore	145 mm	**5.7"**	145 mm	**5.7"**	170 mm	**6.7"**
Stroke	162 mm	**6.4"**	162 mm	**6.4"**	215 mm	**8.5"**
No. Cylinders	**12**		**12**		**16**	
Displacement	32.1 L	**1959 in³**	32.1 L	**1959 in³**	78 L	**4766 in³**
Speeds Forward:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	7.1	**4.4**	6.8	**4.2**	7.4	**4.6**
2nd	12.2	**7.6**	11.9	**7.4**	12.9	**8.0**
3rd	20.6	**12.8**	20.5	**12.7**	24.0	**14.9**
Speeds Reverse:	**km/h**	**mph**	**km/h**	**mph**	**km/h**	**mph**
1st	7.4	**4.6**	7.5	**4.7**	8.1	**5.0**
2nd	13.0	**8.1**	13.1	**8.1**	14.1	**8.8**
3rd	22.4	**13.9**	22.5	**13.9**	24.0	**14.9**
Hydraulic Cycle Time, Rated Load in Bucket:	**Seconds**		**Seconds**		**Seconds**	
Raise	**9.4**		**9.2**		**12.6**	
Dump	**1.8**		**1.8**		**3.1**	
Lower (Empty, Float Down)	**3.7**		**3.1**		**4.2**	
Total	**14.9**		**14.1**		**19.9**	
Tread Width	3.3 m	**10'10"**	3.54 m	**11'6"**	4.3 m	**14'1"**
Width Over Tires	4.5 m	**14'9"**	4.93 m	**16'2"**	5.49 m	**18'10"**
Ground Clearance	682 mm	**26.8"**	721 mm	**2'5"**	898 mm	**33"**
Fuel Tank Capacity	1610 L	**425 U.S. gal**	2170 L	**573 U.S. gal**	3445 L	**910 U.S. gal**
Hydraulic Systems:						
Lift, Tilt	646 L	**171 U.S. gal**	755 L	**199 U.S. gal**	1022 L	**270 U.S. gal**
Tank Only	326 L	**86 U.S. gal**	553 L	**146 U.S. gal**	756 L	**200 U.S. gal**
Steering and Brakes	231 L	**61 U.S. gal**	227 L	**60 U.S. gal**	379 L	**100 U.S. gal**
Tank Only	159 L	**42 U.S. gal**	185 L	**48.9 U.S. gal**	340 L	**90 U.S. gal**

*Changes in bucket weight, including field installed wear iron, can impact rated payload. Consult your Cat dealer for assistance in selecting and configuring the proper bucket for the application. The Cat Large Wheel Loader Payload Policy is a guideline intended to maximize wheel loader structural and component life. The Cat Payload Policy is that the "Gross Bucket plus Payload Capacity" is the MAXIMUM weight that should be carried on the end of the Lift Arm/Boom.
**Products available to meet Tier 2/Stage II/Japan 2001 (Tier 2) equivalent OR Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.
NOTE: The 994K meets Tier 1 equivalent emission standards.

Bucket Type		**General Purpose — Pin On**								
Edge Type		**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**High Lift Delta**
Capacity — rated	**m³**	3.80	3.80	4.00	4.00	4.20	4.20	4.60	4.60	—
	yd³	**4.97**	**4.97**	**5.23**	**5.23**	**5.49**	**5.49**	**6.02**	**6.02**	**—**
Capacity — 110%	**m³**	4.18	4.18	4.40	4.40	4.62	4.62	5.06	5.06	—
	yd³	**5.47**	**5.47**	**5.75**	**5.75**	**6.04**	**6.04**	**6.62**	**6.62**	**—**
Width	**mm**	3220	3271	3220	3271	3220	3271	3220	3271	—
	ft/in	**10'6"**	**10'8"**	**10'6"**	**10'8"**	**10'6"**	**10'8"**	**10'6"**	**10'8"**	**—**
Dump clearance at maximum lift and 45° discharge	**mm**	3067	2915	3058	2905	2991	2837	2977	2823	558
	ft/in	**10'0"**	**9'6"**	**10'0"**	**9'6"**	**9'9"**	**9'3"**	**9'9"**	**9'3"**	**1'9"**
Reach at maximum lift and 45° discharge	**mm**	1327	1467	1334	1473	1388	1525	1400	1537	–25
	ft/in	**4'4"**	**4'9"**	**4'4"**	**4'10"**	**4'6"**	**5'0"**	**4'7"**	**5'0"**	**–1"**
Reach at level lift arm and bucket level	**mm**	2739	2943	2750	2955	2838	3043	2857	3062	404
	ft/in	**8'11"**	**9'7"**	**9'0"**	**9'8"**	**9'3"**	**9'11"**	**9'4"**	**10'0"**	**1'3"**
Digging depth	**mm**	124	124	124	124	124	124	124	124	–25
	in	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**–1"**
Overall length	**mm**	8681	8906	8693	8918	8780	9005	8799	9024	697
	ft/in	**28'6"**	**29'3"**	**28'7"**	**29'4"**	**28'10"**	**29'7"**	**28'11"**	**29'8"**	**2'3"**
Overall height with bucket at maximum lift	**mm**	5788	5788	5902	5902	5902	5902	5874	5874	558
	ft/in	**19'0"**	**19'0"**	**19'5"**	**19'5"**	**19'5"**	**19'5"**	**19'4"**	**19'4"**	**1'9"**
Loader clearance circle with bucket at carry position	**mm**	14 727	14 899	14 733	14 905	14 778	14 951	14 787	14 961	481
	ft/in	**48'4"**	**48'11"**	**48'5"**	**48'11"**	**48'6"**	**49'1"**	**48'7"**	**49'1"**	**1'6"**
Static tipping load, straight (ISO)*	**kg**	16 045	15 863	16 024	15 842	15 831	15 648	15 822	15 636	372
	lb	**35,364**	**34,963**	**35,319**	**34,915**	**34,893**	**34,488**	**34,872**	**34,463**	**821**
Static tipping load, straight (rigid tire)*	**kg**	17 316	17 131	17 305	17 120	17 104	16 917	17 120	16 931	299
	lb	**38,164**	**37,757**	**38,141**	**37,733**	**37,697**	**37,287**	**37,732**	**37,318**	**658**
Static tipping load, articulated (ISO)*	**kg**	14 052	13 869	14 028	13 845	13 848	13 664	13 829	13 643	166
	lb	**30,971**	**30,569**	**30,918**	**30,514**	**30,522**	**30,117**	**30,479**	**30,070**	**366**
Static tipping load, articulated (rigid tire)*	**kg**	15 312	15 128	15 298	15 113	15 111	14 925	15 116	14 928	112
	lb	**33,749**	**33,342**	**33,718**	**33,309**	**33,304**	**32,894**	**33,316**	**32,901**	**248**
Breakout force**	**kN**	187	185	185	183	173	171	170	168	–14
	lbf	**42,151**	**41,781**	**41,695**	**41,326**	**38,984**	**38,618**	**38,277**	**37,912**	**–3170**
Operating weight*	**kg**	23 073	23 211	23 125	23 263	23 181	23 319	23 221	23 359	1763
	lb	**50,853**	**51,157**	**50,968**	**51,272**	**51,091**	**51,395**	**51,179**	**51,483**	**3888**

*Static tipping loads and operating weights shown are based on standard machine configuration with 26.5R25 L3 Michelin XHA2 radial tires, power train guard, full fuel tank, coolants, lubricants, air conditioner and operator.
Static tipping loads conform to the international standard as defined in ISO 14397-1 (SEPT2007).
Measured 100 mm **(4") behind tip of cutting edge with bucket hinge pin as pivot point in accordance with SAE J732 (APR2007).

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society of Automotive Engineers, including SAE Standard J732 (APR2007) which governs loader ratings.

NOTE: Bucket availability varies by region. Consult your local dealer for availability.

Bucket Type		Rock — Pin On		Material Handling/Standard — Pin On				
Edge Type		Bolt-on Cutting Edges	Teeth & Segments	Bolt-on Cutting Edges	Teeth & Segments	Bolt-on Cutting Edges	Teeth & Segments	High Lift Delta
Capacity — rated	m^3	3.40	3.40	4.00	4.00	4.60	4.60	—
	yd^3	**4.45**	**4.45**	**5.23**	**5.23**	**6.02**	**6.02**	**—**
Capacity — 110%	m^3	3.74	3.74	4.40	4.40	5.06	5.06	—
	yd^3	**4.89**	**4.89**	**5.75**	**5.75**	**6.62**	**6.62**	**—**
Width	mm	3252	3252	3220	3271	3220	3271	—
	ft/in	**10'8"**	**10'8"**	**10'6"**	**10'8"**	**10'6"**	**10'8"**	**—**
Dump clearance at maximum lift and 45° discharge	mm	3124	3026	2978	2815	2893	2730	558
	ft/in	**10'2"**	**9'11"**	**9'9"**	**9'2"**	**9'5"**	**8'11"**	**1'9"**
Reach at maximum lift and 45° discharge	mm	1454	1576	1252	1379	1337	1464	–25
	ft/in	**4'9"**	**5'2"**	**4'1"**	**4'6"**	**4'4"**	**4'9"**	**–1"**
Reach at level lift arm and bucket level	mm	2818	2974	2769	2973	2889	3093	404
	ft/in	**9'2"**	**9'9"**	**9'1"**	**9'9"**	**9'5"**	**10'1"**	**1'3"**
Digging depth	mm	68	68	124	124	124	124	–25
	in	**2.7**	**2.7**	**4.9**	**4.9**	**4.9**	**4.9**	**–1"**
Overall length	mm	8745	8906	8711	8936	8831	9056	697
	ft/in	**28'9"**	**29'3"**	**28'7"**	**29'4"**	**29'0"**	**29'9"**	**2'3"**
Overall height with bucket at maximum lift	mm	5845	5845	5858	5858	5982	5982	558
	ft/in	**19'3"**	**19'3"**	**19'3"**	**19'3"**	**19'8"**	**19'8"**	**1'9"**
Loader clearance circle with bucket at carry position	mm	14 813	14 901	14 742	14 914	14 804	14 978	481
	ft/in	**48'8"**	**48'11"**	**48'5"**	**49'0"**	**48'7"**	**49'2"**	**1'6"**
Static tipping load, straight (ISO)*	kg	16 255	16 185	15 834	15 653	15 622	15 438	372
	lb	**35,826**	**35,672**	**34,899**	**34,499**	**34,431**	**34,026**	**821**
Static tipping load, straight (rigid tire)*	kg	17 542	17 471	17 078	16 894	16 885	16 699	299
	lb	**38,663**	**38,507**	**37,640**	**37,235**	**37,216**	**36,805**	**658**
Static tipping load, articulated (ISO)*	kg	14 217	14 147	13 861	13 680	13 655	13 471	166
	lb	**31,334**	**31,180**	**30,551**	**30,151**	**30,096**	**29,690**	**366**
Static tipping load, articulated (rigid tire)*	kg	15 496	15 425	15 097	14 913	14 909	14 723	112
	lb	**34,153**	**33,998**	**33,274**	**32,870**	**32,861**	**32,450**	**248**
Breakout force**	kN	186	185	182	181	166	165	–14
	lbf	**41,828**	**41,704**	**41,111**	**40,742**	**37,481**	**37,117**	**–3170**
Operating weight*	kg	24 004	24 056	23 134	23 272	23 267	23 404	1763
	lb	**52,905**	**53,019**	**50,987**	**51,291**	**51,279**	**51,583**	**3888**

*Static tipping loads and operating weights shown are based on standard machine configuration with 26.5R25 L3 Michelin XHA2 radial tires, power train guard, full fuel tank, coolants, lubricants, air conditioner and operator.
Static tipping loads conform to the international standard as defined in ISO 14397-1 (SEPT2007).
Measured 100 mm **(4") behind tip of cutting edge with bucket hinge pin as pivot point in accordance with SAE J732 (APR2007).

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society of Automotive Engineers, including SAE Standard J732 (APR2007) which governs loader ratings.

NOTE: Bucket availability varies by region. Consult your local dealer for availability.

Bucket Type		**General Purpose — Pin On**						**High Lift Delta**
Edge Type		**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	
Capacity — rated	**m³**	5.40	5.40	5.70	5.70	6.00	6.00	—
	yd³	**7.06**	**7.06**	**7.46**	**7.46**	**7.85**	**7.85**	**—**
Capacity — 110%	**m³**	5.94	5.94	6.27	6.27	6.60	6.60	—
	yd³	**7.77**	**7.77**	**8.20**	**8.20**	**8.63**	**8.63**	**—**
Width	**mm**	3447	3535	3447	3535	3447	3535	—
	ft/in	**11'3"**	**11'7"**	**11'3"**	**11'7"**	**11'3"**	**11'7"**	**—**
Dump clearance at maximum lift and 45° discharge	**mm**	3242	3077	3174	3007	3156	2989	220
	ft/in	**10'7"**	**10'1"**	**10'4"**	**9'10"**	**10'4"**	**9'9"**	**8"**
Reach at maximum lift and 45° discharge	**mm**	1580	1717	1628	1762	1649	1784	2
	ft/in	**5'2"**	**5'7"**	**5'4"**	**5'9"**	**5'4"**	**5'10"**	**0"**
Reach at level lift arm and bucket level	**mm**	3064	3276	3148	3360	3176	3388	160
	ft/in	**10'0"**	**10'8"**	**10'3"**	**11'0"**	**10'5"**	**11'1"**	**6"**
Digging depth	**mm**	133	133	133	133	133	133	–1
	in	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**–0**
Overall length	**mm**	9637	9878	9721	9962	9749	9990	200
	ft/in	**31'8"**	**32'5"**	**31'11"**	**32'9"**	**32'0"**	**32'10"**	**8"**
Overall height with bucket at maximum lift	**mm**	6391	6391	6213	6213	6239	6239	221
	ft/in	**21'0"**	**21'0"**	**20'5"**	**20'5"**	**20'6"**	**20'6"**	**9"**
Loader clearance circle with bucket at carry position	**mm**	15 857	16 080	15 902	16 125	15 917	16 141	175
	ft/in	**52'1"**	**52'10"**	**52'3"**	**52'11"**	**52'3"**	**53'0"**	**7"**
Static tipping load, straight (ISO)*	**kg**	20 504	20 322	20 272	20 089	20 136	19 952	–1720
	lb	**45,192**	**44,790**	**44,681**	**44,277**	**44,379**	**43,974**	**–3792**
Static tipping load, straight (rigid tire)*	**kg**	22 086	21 900	21 855	21 667	21 719	21 531	–1950
	lb	**48,678**	**48,268**	**48,168**	**47,755**	**47,870**	**47,456**	**–4299**
Static tipping load, articulated (ISO)*	**kg**	17 895	17 710	17 677	17 492	17 544	17 358	–1550
	lb	**39,441**	**39,035**	**38,961**	**38,552**	**38,667**	**38,257**	**–3416**
Static tipping load, articulated (rigid tire)*	**kg**	19 764	19 578	19 546	19 358	19 414	19 226	–1787
	lb	**43,561**	**43,150**	**43,079**	**42,666**	**42,789**	**42,375**	**–3939**
Breakout force**	**kN**	201	199	190	188	186	184	3
	lbf	**45,379**	**44,838**	**42,792**	**42,264**	**41,931**	**41,407**	**719**
Operating weight*	**kg**	29 945	30 084	30 028	30 167	30 124	30 263	115
	lb	**65,999**	**66,304**	**66,182**	**66,487**	**66,393**	**66,698**	**253**

*Static tipping loads and operating weights shown are based on standard machine configuration with 29.5R25, L3 Michelin XHA2 radial tires, power train guard, full fuel tank, coolant, lubricants, air conditioner and operator.
Static tipping loads conform to the international standard as defined in ISO 14397-1 (SEPT2007).
Measured 100 mm **(4") behind tip of cutting edge with bucket hinge pin as pivot point in accordance with SAE J732 (APR2007).

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society of Automotive Engineers, including SAE Standard J732 (APR2007) which governs loader ratings.

NOTE: Bucket availability varies by region. Consult your local dealer for availability.

Bucket Type		Material Handling — Pin On		Rock — Pin On		Coal — Pin On	General Purpose/ Heavy Duty — Pin On		
Edge Type		**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**Bolt-on Cutting Edges**	**Bolt-on Cutting Edges**	**Teeth & Segments**	**High Lift Delta**
Capacity — rated	**m³**	5.70	5.70	4.40	4.40	8.20	5.70	5.70	—
	yd³	**7.46**	**7.46**	**5.75**	**5.75**	**10.73**	**7.46**	**7.46**	**—**
Capacity — 110%	**m³**	6.27	6.27	4.84	4.84	9.02	6.27	6.27	—
	yd³	**8.20**	**8.20**	**6.33**	**6.33**	**11.80**	**8.20**	**8.20**	**—**
Width	**mm**	3447	3535	3504	3504	3638	3447	3535	—
	ft/in	**11'3"**	**11'7"**	**11'5"**	**11'5"**	**11'11"**	**11'3"**	**11'7"**	**—**
Dump clearance at maximum lift and 45° discharge	**mm**	3075	2898	3101	3101	2887	3174	3007	220
	ft/in	**10'1"**	**9'6"**	**10'2"**	**10'2"**	**9'5"**	**10'4"**	**9'10"**	**8"**
Reach at maximum lift and 45° discharge	**mm**	1543	1665	1844	1844	1724	1628	1762	2
	ft/in	**5'0"**	**5'5"**	**6'0"**	**6'0"**	**5'7"**	**5'4"**	**5'9"**	**0"**
Reach at level lift arm and bucket level	**mm**	3173	3385	3360	3360	3435	3148	3360	160
	ft/in	**10'4"**	**11'1"**	**11'0"**	**11'0"**	**11'3"**	**10'3"**	**11'0"**	**6"**
Digging depth	**mm**	133	133	106	106	138	133	133	–1
	in	**5.2**	**5.2**	**4.1**	**4.1**	**5.4**	**5.2**	**5.2**	**–0**
Overall length	**mm**	9746	9987	9949	9949	10 011	9721	9962	200
	ft/in	**32'0"**	**32'10"**	**32'8"**	**32'8"**	**32'11"**	**31'11"**	**32'9"**	**8"**
Overall height with bucket at maximum lift	**mm**	6212	6212	6184	6184	6506	6213	6213	221
	ft/in	**20'5"**	**20'5"**	**20'4"**	**20'4"**	**21'5"**	**20'5"**	**20'5"**	**9"**
Loader clearance circle with bucket at carry position	**mm**	15 916	16 139	16 094	16 093	16 236	15 902	16 125	175
	ft/in	**52'3"**	**53'0"**	**52'10"**	**52'10"**	**53'4"**	**52'3"**	**52'11"**	**7"**
Static tipping load, straight (ISO)*	**kg**	19 825	19 643	21 253	21 285	19 512	20 116	19 932	–1720
	lb	**43,694**	**43,295**	**46,843**	**46,913**	**43,006**	**44,336**	**43,932**	**–3792**
Static tipping load, straight (rigid tire)*	**kg**	21 360	21 175	22 897	22 940	21 151	21 694	21 507	–1950
	lb	**47,078**	**46,670**	**50,466**	**50,560**	**46,616**	**47,815**	**47,402**	**–4299**
Static tipping load, articulated (ISO)*	**kg**	17 271	17 088	18 537	18 550	16 932	17 519	17 334	–1550
	lb	**38,067**	**37,663**	**40,857**	**40,884**	**37,318**	**38,613**	**38,204**	**–3416**
Static tipping load, articulated (rigid tire)*	**kg**	19 091	18 906	20 482	20 509	18 854	19 385	19 198	–1787
	lb	**42,078**	**41,670**	**45,144**	**45,202**	**41,556**	**42,726**	**42,313**	**–3939**
Breakout force**	**kN**	187	184	190	189	157	189	187	3
	lbf	**42,029**	**41,504**	**42,739**	**42,551**	**35,358**	**42,665**	**42,136**	**719**
Operating weight*	**kg**	30 153	30 292	31 109	31 184	30 532	30 175	30 313	115
	lb	**66,457**	**66,762**	**68,564**	**68,730**	**67,293**	**66,504**	**66,809**	**253**

*Static tipping loads and operating weights shown are based on standard machine configuration with 29.5R25, L3 Michelin XHA2 radial tires, power train guard, full fuel tank, coolant, lubricants, air conditioner and operator.
Static tipping loads conform to the international standard as defined in ISO 14397-1 (SEPT2007).
Measured 100 mm **(4") behind tip of cutting edge with bucket hinge pin as pivot point in accordance with SAE J732 (APR2007).

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society of Automotive Engineers, including SAE Standard J732 (APR2007) which governs loader ratings.

NOTE: Bucket availability varies by region. Consult your local dealer for availability.

Bucket Type		**Rock — Pin On**					**Rock/ Heavy Duty/Extra Wide Bucket — Pin On**	
Edge Type		**Teeth & Segments + Side Protector**	**Teeth + Side Protector**	**Teeth & Segments + Side Protector**	**Teeth + Side Protector**	**Teeth + Side Protector**	**Teeth & Segments + Side Protector**	**High Lift Delta**
Capacity — rated	**m³**	4.48	4.31	5.66	5.38	5.38	5.41	—
	yd³	**5.86**	**5.64**	**7.40**	**7.03**	**7.03**	**7.07**	**—**
Capacity — 110%	**m³**	4.93	4.75	6.22	5.91	5.91	5.95	—
	yd³	**6.45**	**6.21**	**8.14**	**7.74**	**7.74**	**7.78**	**—**
Width	**mm**	3504	3504	3504	3504	3510	3645	—
	ft/in	**11'5"**	**11'5"**	**11'5"**	**11'5"**	**11'6"**	**11'11"**	**—**
Dump clearance at maximum lift and 45° discharge	**mm**	3051	3051	2890	2890	2983	2941	220
	ft/in	**10'0"**	**10'0"**	**9'5"**	**9'5"**	**9'9"**	**9'7"**	**8"**
Reach at maximum lift and 45° discharge	**mm**	1788	1788	1979	1979	1930	1965	2
	ft/in	**5'10"**	**5'10"**	**6'5"**	**6'5"**	**6'4"**	**6'5"**	**0"**
Reach at level lift arm and bucket level	**mm**	3359	3359	3608	3608	3512	3561	160
	ft/in	**11'0"**	**11'0"**	**11'10"**	**11'10"**	**11'6"**	**11'8"**	**6"**
Digging depth	**mm**	106	71	106	71	77	77	–1
	in	**4.1**	**2.8**	**4.1**	**2.8**	**3.0**	**3.0**	**–0**
Overall length	**mm**	9948	9948	10 197	10 197	10 069	10 156	200
	ft/in	**32'8"**	**32'8"**	**33'6"**	**33'6"**	**33'1"**	**33'4"**	**8"**
Overall height with bucket at maximum lift	**mm**	6204	6204	6378	6378	6378	6378	221
	ft/in	**20'5"**	**20'5"**	**21'0"**	**21'0"**	**21'0"**	**21'0"**	**9"**
Loader clearance circle with bucket at carry position	**mm**	16 093	16 093	16 235	16 235	16 156	16 340	175
	ft/in	**52'10"**	**52'10"**	**53'4"**	**53'4"**	**53'1"**	**53'8"**	**7"**
Static tipping load, straight (ISO)*	**kg**	20 998	21 519	20 119	20 693	20 705	19 813	–1720
	lb	**46,279**	**47,428**	**44,343**	**45,607**	**45,635**	**43,669**	**–3792**
Static tipping load, straight (rigid tire)*	**kg**	22 649	23 190	21 764	22 361	22 374	21 461	–1950
	lb	**49,918**	**51,112**	**47,968**	**49,285**	**49,313**	**47,301**	**–4299**
Static tipping load, articulated (ISO)*	**kg**	18 265	18 775	17 439	17 995	18 008	17 091	–1550
	lb	**40,257**	**41,381**	**38,436**	**39,663**	**39,690**	**37,669**	**–3416**
Static tipping load, articulated (rigid tire)*	**kg**	20 223	20 750	19 387	19 965	19 977	19 053	–1787
	lb	**44,572**	**45,733**	**42,730**	**44,003**	**44,031**	**41,993**	**–3939**
Breakout force**	**kN**	188	204	159	172	184	173	3
	lbf	**42,289**	**45,879**	**35,932**	**38,725**	**41,402**	**38,896**	**719**
Operating weight*	**kg**	31 475	31 175	31 821	31 521	31 517	32 239	115
	lb	**69,370**	**68,709**	**70,132**	**69,471**	**69,463**	**71,055**	**253**

*Static tipping loads and operating weights shown are based on standard machine configuration with 29.5R25, L3 Michelin XHA2 radial tires, power train guard, full fuel tank, coolant, lubricants, air conditioner and operator.
Static tipping loads conform to the international standard as defined in ISO 14397-1 (SEPT2007).
Measured 100 mm **(4") behind tip of cutting edge with bucket hinge pin as pivot point in accordance with SAE J732 (APR2007).

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society of Automotive Engineers, including SAE Standard J732 (APR2007) which governs loader ratings.

NOTE: Bucket availability varies by region. Consult your local dealer for availability.

			Standard Lift						
Bucket Type			**Rock**			**Heavy Duty Rock**		**High Abrasion Rock**	
Ground Engaging Tools			**Teeth & Segments**	**Teeth & Segments**	**Teeth & Segments**	**Teeth & Segments**	**Teeth & Segments**	**Teeth & Segments**	**Teeth & Segments**
Cutting Edge Type			**Spade**	**Spade**	**Spade**	**Spade**	**Spade**	**Spade**	**Spade**
Rated bucket capacity (§)		**m³**	10.7	11.5	12.3	10.7	11.5	10.7	10.7
		yd³	**14.0**	**15.0**	**16.0**	**14.0**	**15.0**	**14.0**	**14.0**
Operating load at rated capacity		**kg**	21 773	21 773	21 773	21 773	21 773	21 773	21 773
		lb	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**
Struck capacity (§)		**m³**	8.9	9.5	10.2	8.9	9.5	8.9	8.9
		yd³	**11.6**	**12.4**	**13.3**	**11.6**	**12.4**	**11.6**	**11.6**
Bucket width (§)		**mm**	4824	4884	4824	5068	4824	5165	5068
		ft/in	**15'10"**	**16'0"**	**15'10"**	**16'7"**	**15'10"**	**16'11"**	**16'7"**
Dump clearance at full lift SAE 45° discharge (§)		**mm**	4849	4785	4741	4849	4788	4935	4935
		ft/in	**15'11"**	**15'8"**	**15'7"**	**15'11"**	**15'8"**	**16'2"**	**16'2"**
	Tooth tip	**mm**	4607	4548	4495	4612	4545	4699	4699
		ft/in	**15'1"**	**14'11"**	**14'8"**	**15'1"**	**14'11"**	**15'5"**	**15'5"**
Reach at full lift SAE 45° discharge (§)		**mm**	2092	2149	2194	2092	2151	2036	2036
		ft/in	**6'11"**	**7'0"**	**7'2"**	**6'11"**	**7'11"**	**6'10"**	**6'10"**
	Tooth tip	**mm**	2326	2378	2427	2322	2385	2292	2292
		ft/in	**7'7"**	**7'10"**	**8'0"**	**7'7'**	**7'10"**	**7'6"**	**7'6"**
Reach with boom horizontal and bucket level		**mm**	5114	5193	5265	5108	5200	5025	5025
		ft/in	**16'10"**	**17'0"**	**17'4"**	**16'10"**	**17'1"**	**16'6"**	**16'6"**
Digging depth (segment) (§)		**mm**	196	201	201	196	198	175	175
		in	**7.7**	**7.9**	**7.9**	**7.7**	**7.8**	**6.9**	**6.9**
Overall length — bucket level ground (§)		**mm**	15 736	15 818	15 890	15 729	15 823	15 632	15 632
		ft/in	**51'7"**	**51'11"**	**51'1"**	**51'7"**	**51'11"**	**51'4"**	**51'4"**
Overall height with bucket at full raise (§)		**mm**	9313	9313	9492	9313	9313	9392	9313
		ft/in	**30'7"**	**30'7"**	**31'1"**	**30'7"**	**30'7"**	**30'10"**	**30'7"**
Loader clearance radius with bucket in carry position (§)		**mm**	11 097	11 121	11 131	11 096	11 122	11 085	11 085
		ft/in	**36'5"**	**36'6"**	**36'6"**	**36'5"**	**36'6"**	**36'5"**	**36'5"**
Tipping load straight* (§)		**kg**	55 216	54 526	54 184	53 745	54 784	51 692	53 325
		lb	**121,730**	**120,209**	**119,455**	**118,487**	**120,778**	**113,961**	**117,561**
Static tipping load full 35° turn* (§)		**kg**	48 361	47 695	47 341	46 893	47 953	44 839	46 474
		lb	**106,618**	**105,149**	**104,369**	**103,381**	**105,718**	**98,853**	**102,458**
Static tipping load full 40° turn* (§)		**kg**	46 440	45 780	45 422	44 972	46 037	42 919	44 554
		lb	**102,383**	**100,928**	**100,138**	**99,146**	**101,494**	**94,620**	**98,225**
Static tipping load full 43° turn* (§)		**kg**	45 201	44 546	44 185	43 735	44 803	41 681	43 316
		lb	**99,651**	**98,207**	**97,411**	**96,419**	**98,774**	**91,891**	**95,495**
Tipping load straight** (§)		**kg**	57 096	56 402	56 093	55 615	56 662	53 564	55 194
		lb	**125,874**	**124,344**	**123,663**	**122,610**	**124,918**	**118,088**	**121,681**
Static tipping load full 35° turn** (§)		**kg**	51 328	50 653	50 338	49 847	50 913	47 796	49 426
		lb	**113,158**	**111,671**	**110,976**	**109,893**	**112,244**	**105,372**	**108,965**
Static tipping load full 40° turn** (§)		**kg**	49 634	48 965	48 648	48 153	49 225	46 102	47 732
		lb	**109,424**	**107,950**	**107,250**	**106,159**	**108,523**	**101,638**	**105,231**
Static tipping load full 43° turn** (§)		**kg**	48 527	47 863	47 544	47 047	48 123	44 996	46 625
		lb	**106,984**	**105,519**	**104,817**	**103,720**	**106,092**	**99,198**	**102,791**
Breakout force*** (§)		**kg**	58 466	55 998	54 249	57 842	56 147	59 381	60 218
		lbf	**128,894**	**123,454**	**119,599**	**127,519**	**123,782**	**130,913**	**132,758**
Operating weight*** (§)		**kg**	98 610	99 012	99 391	100 786	97 469	102 956	101 232
		lb	**217,398**	**218,284**	**219,119**	**222,195**	**214,882**	**226,979**	**223,178**

*Tipping loads were calculated within guidelines of ISO 14397-1:2007 to include tire squash (Tire pressure at 683 kPa **[99 psi]**).
**Tipping load is calculated without tire squash.
***Static tipping load and operating weight shown are based on standard machine configurations with a fuel tank, coolant, lubricants, and operator.

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society for Automotive Engineers. SAE Standards J732C govern loader ratings and are denoted in the text by (§).

Bucket Type		High Lift						
		Rock			Heavy Duty Rock		High Abrasion Rock	
Ground Engaging Tools		Teeth & Segments	Teeth & Segments	Teeth & Segments	Teeth & Segments	Teeth & Segments	Teeth & Segments	Teeth & Segments
Cutting Edge Type		Spade	Spade	Spade	Spade	Spade	Spade	Spade
Rated bucket capacity (§)	m³	10.7	11.5	12.3	10.7	11.5	10.7	10.7
	yd³	**14.0**	**15.0**	**16.0**	**14.0**	**15.0**	**14.0**	**14.0**
Operating load at rated capacity	kg	19 051	19 051	19 051	19 051	19 051	19 051	19 051
	lb	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**
Struck capacity (§)	m³	8.9	9.5	10.2	8.9	9.5	8.9	8.9
	yd³	**11.6**	**12.4**	**13.3**	**11.6**	**12.4**	**11.6**	**11.6**
Bucket width (§)	mm	4824	4884	4824	4884	4824	4900	4900
	ft/in	**15'10"**	**16'0"**	**15'10"**	**16'7"**	**15'10"**	**16'11"**	**16'7"**
Dump clearance at full lift SAE 45° discharge (§) **Tooth tip**	mm	5224	5166	5112	5229	5162	5316	5316
	ft/in	**17'2"**	**16'11"**	**16'9"**	**17'2"**	**16'11"**	**17'5"**	**17'5"**
Reach at full lift SAE 45° discharge (§) **Tooth tip**	mm	2193	2246	2294	2189	2252	2159	2159
	ft/in	**7'2"**	**7'4"**	**7'6"**	**7'2"**	**7'5"**	**7'1"**	**7'1"**
Reach with boom horizontal and bucket level	mm	5504	5583	5655	5498	5590	5415	5415
	ft/in	**18'1"**	**18'4"**	**18'7"**	**18'0"**	**18'4"**	**17'9"**	**17'9"**
Digging depth (segment) (§)	mm	176	181	181	176	178	155	155
	in	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**	**6.0**	**6.0**
Overall length — bucket level ground (§)	mm	16 197	16 279	16 351	16 191	16 284	16 095	16 095
	ft/in	**53'2"**	**53'5"**	**53'8"**	**53'1"**	**53'5"**	**52'10"**	**52'10"**
Overall height with bucket at full raise (§)	mm	9930	9930	9930	9930	9930	9930	9930
	ft/in	**32'7"**	**32'7"**	**32'7"**	**32'7"**	**32'7"**	**32'7"**	**32'7"**
Loader clearance radius with bucket in carry position (§)	mm	11 326	11 352	11 349	11 324	11 352	11 313	11 313
	ft/in	**37'2"**	**37'3"**	**37'3"**	**37'2"**	**37'3"**	**37'1"**	**37'1"**
Tipping load straight* (§)	kg	51 408	50 761	50 436	49 938	51 017	47 875	49 522
	lb	**113,335**	**111,909**	**111,192**	**110,094**	**112,473**	**105,546**	**109,177**
Static tipping load full 35° turn* (§)	kg	44 798	44 172	43 833	43 332	44 427	41 268	42 916
	lb	**98,763**	**97,382**	**96,635**	**95,531**	**97,945**	**90,980**	**94,613**
Static tipping load full 40° turn* (§)	kg	42 946	42 325	41 981	41 481	42 580	39 417	41 065
	lb	**94,680**	**93,311**	**92,552**	**91,450**	**93,873**	**86,900**	**90,533**
Static tipping load full 43° turn* (§)	kg	41 753	41 135	40 789	40 288	41 390	38 224	39 873
	lb	**92,049**	**90,687**	**89,924**	**88,820**	**91,249**	**84,269**	**87,905**
Tipping load straight** (§)	kg	53 044	52 396	52 099	51 567	52 653	49 505	51 149
	lb	**116,942**	**115,513**	**114,858**	**113,686**	**116,080**	**109,140**	**112,764**
Static tipping load full 35° turn** (§)	kg	47 472	46 840	46 535	45 994	47 097	43 932	45 577
	lb	**104,658**	**103,264**	**102,592**	**101,399**	**103,831**	**96,853**	**100,480**
Static tipping load full 40° turn** (§)	kg	45 835	45 209	44 901	44 358	45 466	42 296	43 940
	lb	**101,049**	**99,669**	**98,990**	**97,793**	**100,235**	**93,247**	**96,871**
Static tipping load full 43° turn** (§)	kg	44 766	44 143	43 834	43 289	44 400	41 227	42 871
	lb	**98,692**	**97,319**	**96,637**	**95,436**	**97,885**	**90,890**	**94,514**
Breakout force*** (§)	kg	57 948	55 495	53 760	57 324	55 656	58 856	59 693
	lbf	**127,753**	**122,345**	**118,520**	**126,378**	**122,700**	**129,755**	**131,600**
Operating weight*** (§)	kg	99 788	100 182	100 561	101 956	99 963	104 126	102 404
	lb	**219,995**	**220,863**	**221,699**	**224,774**	**220,380**	**229,558**	**225,762**

*Tipping loads were calculated within guidelines of ISO 14397-1:2007 to include tire squash (Tire pressure at 683 kPa **[99 psi]**).
**Tipping load is calculated without tire squash.
***Static tipping load and operating weight shown are based on standard machine configurations with a fuel tank, coolant, lubricants, and operator.

NOTE: Specifications and ratings conform to all applicable standards recommended by the Society for Automotive Engineers. SAE Standards J732C govern loader ratings and are denoted in the text by (§).

SPECIFICATION DEFINITIONS FOR FRONT END LOADERS

Cat wheel and track loader specifications conform to Society of Automotive Engineers (SAE) definitions as expressed in standards J732 (JUN92), as follows:

Description of Specification Machine

On wheel loaders the tire inflation pressure at which specifications are taken must be described in addition to the current written basic machine description. On track loaders the type of grouser must be specified.

Hydraulic Cycle Times

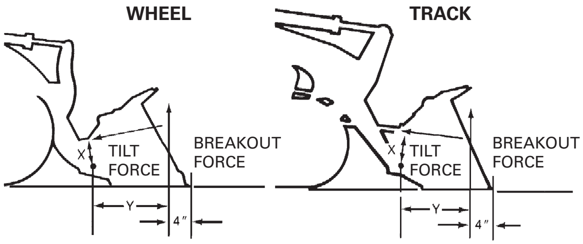
a. "Raise Time" — Time in seconds required to raise the bucket from level position on the ground.
b. "Lower Time" — Time in seconds required to lower the empty bucket from the full height to a level position on the ground.
c. "Dump Time" — Time in seconds required to move the bucket at maximum height from the maximum rollback position to full dump position while dumping the SAE loose material operating load.

Breakout Force

"Breakout force," pounds (and kilonewtons or kilograms) — the maximum sustained vertical upward force exerted 100 mm (4") behind the tip of the bucket cutting edge and achieved through the ability to lift and/or rollback about the specified pivot point under the following conditions:

a. Loader on a hard level surface with transmission in neutral.
b. All brakes released.
c. Unit at standard operating weight — rear of loader not tied down.
d. Bottom of cutting edge parallel to and not more than 20 mm (0.75") above or below the ground line.
e. When bucket circuit is used the pivot point must be specified as the bucket hinge pin, and the unit blocked under the bucket hinge pin pivot point in order to minimize linkage movement.
f. When the lift circuit is used, the pivot point must be specified as the lift arm hinge pin. Wheel loaders shall have front axle blocked to eliminate change in position of pivot pins due to tire deflection.
g. If both circuits are used simultaneously, the dominating pivot point listed in (e) or (f) must be specified.
h. If the circuit used causes the rear of the vehicle to leave the ground, then the vertical force value required to raise the rear of the vehicle is the breakout force.
i. For irregular shaped buckets, the tip of the bucket cutting edge referred to above shall mean the farther forward point of the cutting edge.

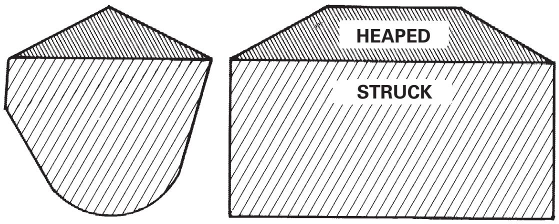
The following are illustrations used (according to provisions of SAE J732 JUN92) to measure Cat Loader breakout forces.



a. Breakout force resulting from rack back:
(Tilt Force) × (Dist. "X") = ("Y" Dist.) × (Breakout Force)

$$\frac{(\text{Tilt Force}) \times (\text{Dist. "X"})}{\text{"Y" Dist.}} = \text{Breakout Force}$$

SAE BUCKET RATING



SAE Bucket Capacities

Struck capacity is that volume contained in a bucket after a load is leveled by drawing a straight edge resting on the cutting edge and the back of the bucket.

Heaped capacity is a struck capacity plus that additional material that would heap on the struck load at a 2:1 angle of repose with the struck line parallel to the ground.

SAE J742 (FEB85) specifies that the addition of any auxiliary spill guard to protect against spillage which might injure the operator will not be included in bucket capacity ratings. Buckets with irregular shaped cutting edges (vee edge) the strike plane should be drawn at one-third the distance of the protruding portion of the cutting edge. Cat rock buckets are built with integral see-through rock guards. Cat light material buckets come standard with bolt-on edges. These features which add to actual bucket capacity are included in published ratings.

Dump Height

SAE J732 JUN92 specifies that dump height is the vertical distance from the ground to the lowest point of the cutting edge with the bucket hinge pin at maximum height and the bucket at a 45° dump angle. Dump angle is the angle in degrees that the longest flat section of the inside bottom of the bucket will rotate below horizontal.

SELECTING A MACHINE

Steps in selecting the proper size loader:

1. Determine production required or desired.
2. Determine loader cycle time and cycles per hour. A machine size must be assumed to select a basic cycle time.
3. Determine required payload per cycle in loose cubic yards and pounds (meters and kilograms).
4. Determine bucket size needed.
5. Make machine selection using bucket size and payload as criteria to meet production requirements.
6. Compare the loader cycle time used in calculations to the cycle time of the machine selected. If there is a difference, rework the process beginning at step 2.

1. Production Required

The production required of a wheel or track loader should be slightly greater than the production capability of the other critical units in the earth or material moving system. For example, if a hopper can handle 300 tons per hour, a loader capable of slightly more than 300 tons should be used. Required production should be carefully calculated so the proper machine and bucket selections are made.

2. Loader Cycle Times

When hauling loose granular material on a hard smooth operating surface, a .45-.55 minute basic cycle time is considered reasonable for Cat articulated loaders with a competent operator. This includes load, dump, four reversals of direction, full cycle of hydraulics and minimum travel.

Material type, pile height, and other factors may improve or reduce production, and should be added to or subtracted from the basic cycle time when applicable.

When hauls are involved, obtain the haul and return portion of the cycle from the estimated travel chart (this section). Add the haul and return times to the estimated basic cycle time to obtain total cycle time.

CYCLE TIME FACTORS

A basic cycle time (Load, Dump, Maneuver) of .45-.55 minutes is average for an articulated loader [the basic cycle for large loaders, 3 m^3 (4 yd^3) and up, can be slightly longer], but variations can be anticipated in the field. The following values for many variable elements are based on normal operations. Adding or subtracting any of the variable times will give the total basic cycle time.

	Minutes added (+) or Subtracted (–) From Basic Cycle
Machine	
— Material handler	–.05
Materials	
— Mixed	+.02
— Up to 3 mm (1/8 in)	+.02
— 3 mm (1/8 in) to 20 mm (3/4 in)	–.02
— 20 mm (3/4 in) to 150 mm (6 in)	.00
— 150 mm (6 in) and over	+.03 and Up
— Bank or broken	+.04 and Up
Pile	
— Conveyor or Dozer piled 3 m (10 ft) and up	.00
— Conveyor or Dozer piled 3 m (10 ft) or less	+.01
— Dumped by truck	+.02
Miscellaneous	
— Common ownership of trucks and loaders	Up to –.04
— Independently owned trucks	Up to +.04
— Constant operation	Up to –.04
— Inconsistent operation	Up to +.04
— Small target	Up to +.04
— Fragile target	Up to +.05

Using actual job conditions and the above factors, total cycle time can be estimated. Convert total cycle time to cycles per hour.

$$\textit{Cycles per hour at 100\% Efficiency} = \frac{\textit{60 min}}{\textit{Total Cycle Time in Minutes}}$$

Job efficiency is an important factor in machine selection. Efficiency is the actual number of minutes worked during an hour. Job efficiency accounts for bathroom breaks and other work interruptions.

$$\text{Cycles per hour at 50 minutes per hour (83\% efficiency)} = \text{Cycles per hour at 100\% efficiency} \times \frac{\text{50 min actual work time}}{\text{60 min hour}}$$

TRUCK LOADING

Average loader cycle times

910K-962H	0.45-0.50 min
966H-980H	0.50-0.55 min
986H-990K	0.55-0.60 min
992K-994K	0.60-0.70 min

3. Required Payload Per Cycle

Required payload per cycle is determined by dividing required hourly production by the number of cycles per hour.

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4. Bucket Selection

After required payload per cycle has been calculated, the payload should be divided by the loose cubic yard (meter) material weight to determine number of loose cubic yards (meters) required per cycle.

The bulk of material handled does not weigh 1800 kg/m^3 (3000 lb/yd^3), so a reasonable knowledge of material weight is necessary for accurate production estimates. The Tables Section has average weight for certain materials when actual weights are not known.

The percentage of rated capacity a bucket carries in various materials is estimated below. The bucket size required to handle the required volume per cycle is found with the aid of the percentage of rated bucket capacity called "Bucket Fill Factor."

The bucket size needed is determined by dividing loose cubic meters (or yards) required per cycle by the bucket fill factor.

$$\textit{Bucket size} = \frac{\textit{Volume Required/Cycle}}{\textit{Bucket Fill Factor}}$$

BUCKET FILL FACTORS

The following indicates the approximate amounts of material as a percent of rated bucket capacity which will actually be delivered per bucket per cycle. This is known as "Bucket Fill Factor."

Loose Material	Fill factor
Mixed moist aggregates	95-100%
Uniform aggregates up to 3 mm (1/8 in)	95-100
3 mm (1/8 in) to 9 mm (3/8 in)	90-95
12 mm (1/2 in) to 20 mm (3/4 in)	85-90
24 mm (1.0 in) and over	85-90

Blasted Rock

Well blasted	80-95%
Average	75-90
Poor	60-75

Other

Rock dirt mixtures	100-120%
Moist loam	100-110
Soil, boulders, roots	80-100
Cemented materials	85-95

NOTE: Fill factors on wheel loaders are affected by bucket penetration, breakout force, rack back angle, bucket profile and ground engaging tools such as bucket teeth or bolt-on replaceable cutting edges.

Example:

12 mm (1/2 in) material and 3 m^3 (4 yd^3) bucket.
$0.90 \times 3\ m^3 = 2.75$ Loose m^3 delivered per cycle.
$0.90 \times 4\ yd^3 = 3.6$ Loose yd^3 delivered per cycle.

NOTE: Check the static tipping load on the specific machine to determine if bucket load is in fact a safe operating load.

Bucket Selection

$$\textit{Tons Required/Cycle} = \frac{\textit{Tons Required/Hour}}{\textit{Cycles/Hour}}$$

$$\textit{Kg (Pounds) Required/Cycle} = \textit{Tons Required/Cycle} \times \textit{907 kg (2000 lb)}$$

$$\textit{Volume Required/Cycle} = \frac{\textit{kg (Pounds) Cycle}}{\textit{Material Weight kg/m}^3\ \textit{(lb/yd}^3\textit{)}}$$

Always select a machine with a greater capacity than the calculated required operating capacity. For most applications, payload above recommended and excessive counterweight can hinder machine performance and reduce dynamic stability and machine life.

For optimum performance in fast cycling situations such as truck loading, operating loads should not exceed the recommended capacity. To provide extra stability, calcium chloride ($CaCl_2$) ballast may be desired when operating at recommended operating load, see SAE Loader rating pages in this section. For specific stability data and optional tire sizes, see the "Performance Data" pages in this section.

When selecting special application buckets, such as multi-purpose and side dump the additional bucket weight must be deducted from recommended capacity.

Specific circumstances may involve other conditions which would also affect loader capacity. Because of the greatly varied applications and conditions, your Cat dealer should be contacted for guidance.

Example problem:

JOB CONDITIONS

Application	Truck loading
Production Required	450 metric ton (496 Tons) per hour
Material	9 mm (3/8") gravel in 6 m (20 ft) high stockpile
Density	1660 kg/m^3 (2800 lb/yd^3)

Trucks are 6-9 m^3 (8-12 yd^3) capacity and are owned by three contractors. Loading is constant. Hard level surface for loader maneuvering.

1. *PRODUCTION REQUIRED:* Given

2. *CYCLE TIME:* Assume loader size between 910K and 962H for initial choice of basic cycle.

(Refer to Cycle Time Factors in this section)

Independent trucks	.04 min
Basic Cycle	.50 min
Material	–.02 min
Independent trucks	+.04 min
Constant operation	–.02 min
Total Cycle	.50 min

NOTE: Load and carry times not required in total cycle.

$$\text{Cycles/hr at 83\% efficiency} = 120 \text{ cycles/hr} \times \frac{\text{50 min actual work time}}{\text{60 min per hr}} = 100 \text{ cycles/hr}$$

3. *VOLUME REQUIRED PER CYCLE*
(Density in tons)
Density in this example was given. When not given, refer to Tables Section to obtain an estimated density for the material being handled.

Metric: $\frac{1660 \text{ kg/m}^3}{1000 \text{ kg/ton}} = 1.66 \text{ ton/m}^3$

English: $\frac{2800 \text{ lb/yd}^3}{2000 \text{ lb/ton}} = 1.4 \text{ tons/yd}^3$

Production Rate Required

Metric: $\dfrac{450 \text{ tons/hr}}{1.66 \text{ tons/m}^3} = 271 \text{ m}^3\text{/hr}$

English: $\dfrac{496 \text{ tons/hr}}{1.4 \text{ tons/yd}^3} = 354 \text{ yd}^3\text{/hr}$

Volume Required per Cycle

Metric: $\dfrac{271 \text{ m}^3\text{/hr}}{100 \text{ cycles/hr}} = 2.71 \text{ m}^3\text{/cycle}$

English: $\dfrac{354 \text{ yd}^3\text{/hr}}{100 \text{ cycles/hr}} = 3.54 \text{ yd}^3\text{/cycle}$

4. *DETERMINE BUCKET SIZE*

BUCKET FILL FACTOR

The volume of material required per cycle has been determined. Because of varying material fill factors, buckets do not always carry their rated load, a larger capacity bucket may be needed to carry the volume required. For fill factors, refer to Bucket Fill Factor Chart in this section.

Rated Bucket Capacity Required (Heaped)

$\dfrac{2.71 \text{ m}^3\text{/cycle}}{0.95 \text{ fill factor}} = 2.85 \text{ m}^3$

$\dfrac{3.54 \text{ yd}^3\text{/cycle}}{0.95 \text{ fill factor}} = 3.73 \text{ yd}^3$

A 2.9 m^3 (3.75 yd^3) bucket would provide the required capacity.

5. *MACHINE SELECTION*

The bucket size required and material density lead to the choice of a 950H with a 2.9 m^3 (3.75 yd^3) General Purpose Bucket (see bucket selection guide pages which follow.)

Finally, SAE payload criteria must be satisfied as follows:

The required operating capacity must not exceed one-half of the full turn static tipping load of the loader as equipped with a specific bucket.

The required operating capacity of the machine is determined by the volume the machine will carry per load times the density.

$2.9 \text{ m}^3 \times 1660 \text{ kg/m}^3 = 4814 \text{ kg}$
$(3.75 \text{ yd}^3 \times 2800 \text{ lb/yd}^3 = 10{,}500 \text{ lb})$

One half of full turn static tipping load for the 950H with a 2.9 m^3 (3.75 yd^3) General Purpose Bucket is 5410 kg (11,925 lb). SAE criteria is satisfied.

● ● ●

An Alternative Method of Machine Selection

Another method of selecting the right Wheel Loader and bucket to meet production requirements is by use of the nomographs on the following pages. The method is quicker and easier than the preceding example because it does not require as many calculations, yet the accuracy is about the same within the normal limits of input data.

Be careful when entering and reading data from the nomographs because some scales increase from bottom to top, while others are the reverse. Do not be overly concerned with the precision as affected by pencil line width or reading to the hundredth of a m^3 (yd^3). Remember that bucket fill factor, material density and cycle time are at best close estimates.

Example problem:

A Wheel Loader must produce 230 m^3 (300 yd^3) per hour in a truck loading application. Estimated cycle time is .6 minutes, working 45 minutes per hour. Bucket fill factor is 95% and material density is 1780 kg/m^3 (3000 lb/yd^3).

Determine bucket size and machine model.

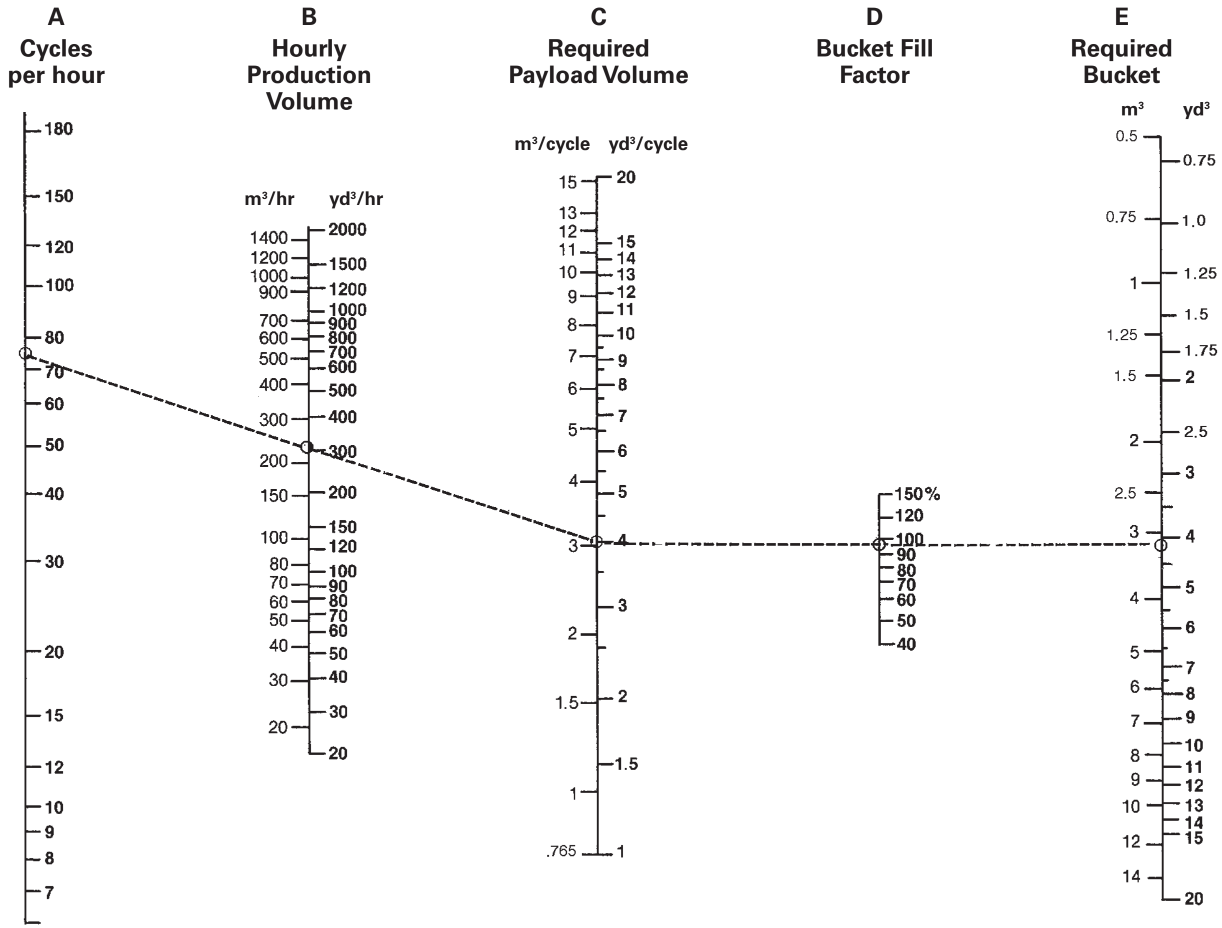
Solution:

At full efficiency, the Wheel Loader will cycle 100 times per hour. Since only an average of 45 minutes are available, only 75 cycles will be completed.

Starting on Scale A at 75 cycles per hour draw a straight line intersecting 230 m^3/hr (300 yd^3/hr) on Scale B and extending it on to Scale C giving 3 m^3/cycle (4 yd^3/cycle) required payload. Follow solution steps 1-10.

Production and Machine Selection Nomograph
● To find required bucket payload and bucket size

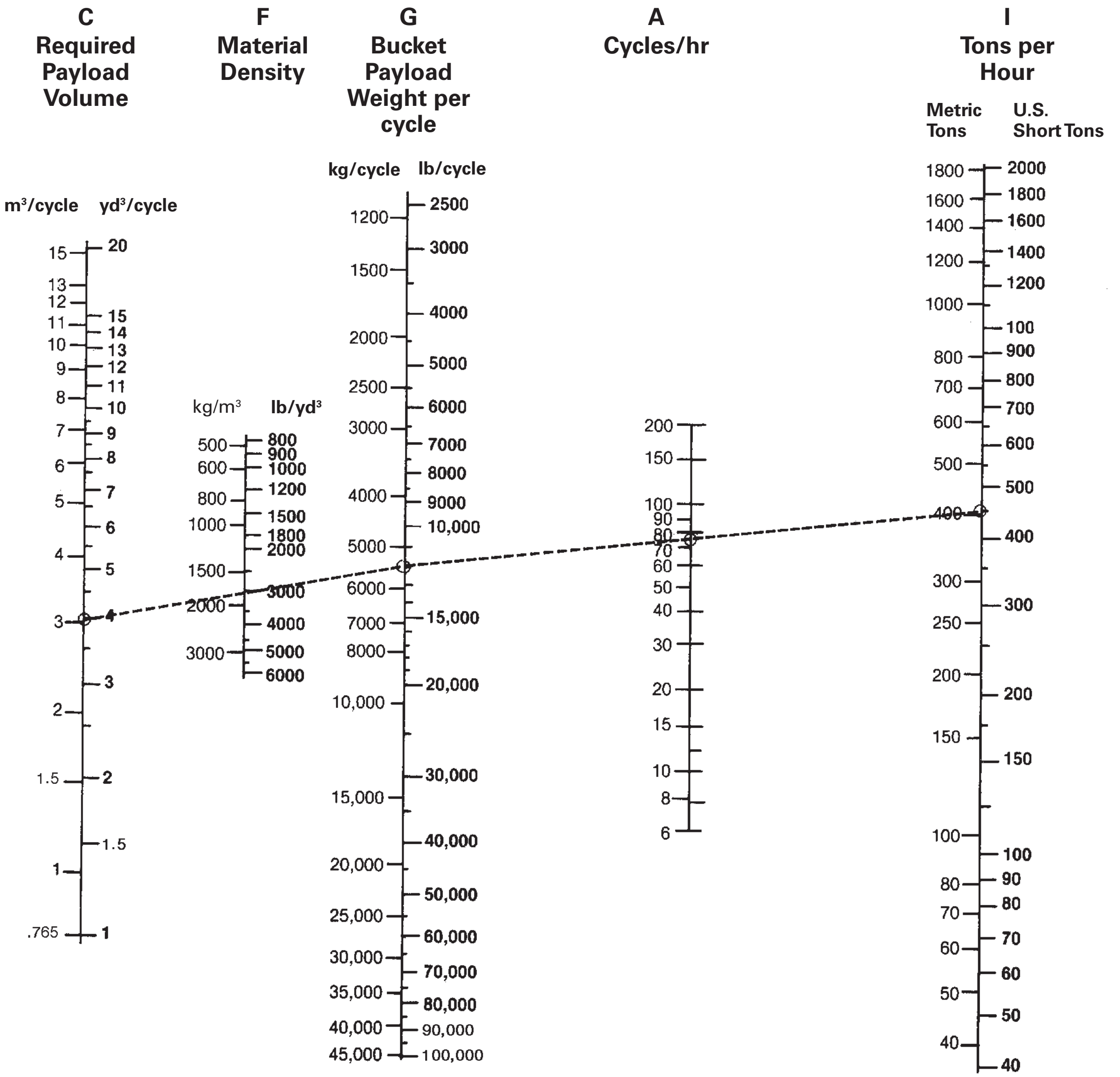
1. Enter required hourly production on Scale B 230 m^3/hr (300 yd^3/hr).
2. Enter cycles per hour on Scale A (60 ÷ .6 = 100 × .75 = 75 cycles/hr).
3. Connect A through B to C. This shows a required payload of 3 m^3 (4 yd^3) per cycle.
4. Enter estimated bucket fill factor on Scale D (0.95).
5. Connect C through Scale D to E for required bucket size 3 m^3 (4 yd^3).
6. Transfer cycles per hour Scale A and required payload Scale C to the following page.



7. Enter material density on Scale F 1780 kg/m³ (3000 lb/yd³).
8. Connect C through Scale F to Scale G to give payload weight per cycle 5300 kg (11,500 lb).
9. Compare Scale G quantity 5300 kg (11,500 lb) with recommended machine working range listed on the following bucket selection pages.

Operating capacity for the 950H with 3.1 m³ (4 yd³) bucket is dependent on material density and bucket capacity (see bucket selection pages that follow).

10. For hourly tonnage, draw a straight line from Scale G through Scale A to Scale I 400 metric tons (450 U.S. tons).



Model	Interface	Bucket Type	Width Range		Capacity Range		Weight Range		GET
			mm	in	m^3	yd^3	kg	lb	
986H	Pin On	General Purpose Performance Series	3695	**145**	6.1-7.7	**8.0-10.0**	3648-4065	**8042-8962**	K110
		Rock Performance Series	3772	**149**	5.4-6.1	**7.0-8.0**	3726-3941	**8214-8688**	K110
		Heavy Duty Rock Performance Series	4014	**158**	5.4	**7.0**	5061	**11,158**	K130
		Extreme Duty Rock	4146	**163**	5.0	**6.5**	5195	**12,050**	K130
		Serrated Edge Rock	3812	**150**	6.1	**8.0**	4232	**9330**	N/A
		Coal	3692	**145**	10.0	**13.5**	5195	**11,453**	BOCE Included
988K	Pin On	General Purpose Performance Series	3855	**152**	6.9-8.4	**9.0-11.0**	4539-4994	**10,007-11,010**	K110
		Rock Performance Series	4020	**158**	6.4-7.7	**8.3-10.0**	4880-5263	**10,759-11,603**	K130
		Heavy Duty Rock Performance Series	4080	**161**	6.4	**8.3**	6360	**14,021**	K130
		Heavy Duty Granite Performance Series	3986	**157**	6.4	**8.3**	7433	**16,385**	K130
		Serrated Edge Rock	3968	**156**	6.4-6.9	**8.3-9.0**	5455-5634	**12,026-12,421**	N/A
		Iron Ore	3922	**154**	4.7	**6.2**	5771	**12,723**	K130
		Coal	4120	**162**	11.5-13.0	**15.0-17.0**	6023-6435	**13,278-14,186**	BOCE Included
		Slag	3900-4032	**154-159**	5.4-6.4	**7.0-8.3**	7633-8454	**16,828-18,638**	J600/Serrated Edge

N/A = Not Applicable

Model	Interface	Bucket Type	Width Range		Capacity Range		Weight Range		GET
			mm	in	m³	yd³	kg	lb	
990K	Pin On	Rock Performance Series	4610	**182**	8.6-10.0	**11.25-13.0**	7247-7497	**15,977-16,528**	K130
		Heavy Duty Rock Performance Series	4670	**184**	8.6	**11.25**	8980	**19,798**	K130
		Heavy Duty Granite Performance Series	4634	**182**	8.6	**11.25**	12 055	**26,520**	K150
		Slag	4450-4500	**175-177**	8.5-9.2	**11.2-12.0**	9149-9613	**20,127-21,149**	Weld-on edge included
		Coal	4370	**172**	13.4	**17.5**	7460	**16,410**	BOCE Included
		Iron Ore	4450	**175**	7.0	**9.2**	8525	**18,750**	K150
		Serrated Edge Rock	4610	**182**	9.5	**12.4**	8140	**17,910**	N/A
992K	Pin On	Rock	4824-4884	**190-192**	10.7-12.2	**14.0-16.0**	9382-10 574	**20,684-23,262**	K150/K170
		Heavy Duty Rock	5068	**200**	10.7	**14.0**	11 560	**25,485**	K170
		High Abrasion Rock	5068	**200**	10.7	**14.0**	11 927	**26,295**	K150
		Heavy Duty Granite	5165	**203**	10.7	**14.0**	13 720	**30,247**	K150
		Coal	6170	**243**	19.0	**25.0**	12 504	**27,506**	BOCE Included
		Iron Ore	4900	**193**	9.0	**11.8**	11 172	**24,577**	K150
		Serrated Edge Rock	4824	**190**	12.3	**16.0**	10 282	**22,620**	N/A
993K	Pin On	Rock	5068	**200**	12.2-14.5	**16.0-19.0**	12 864-14 209	**28,301-31,260**	K170
		High Abrasion Rock	5160	**203**	12.2-13.0	**16.0-17.0**	15 205-15 456	**33,451-34,004**	K170
		Heavy Duty Granite	5160	**203**	13.0	**17.0**	17 418	**38,320**	K170
		Coal	6300	**248**	23.0	**31.0**	17 673	**38,880**	K170
		Iron Ore	5160	**203**	10.0	**13.0**	14 063	**30,940**	K170
		Serrated Edge Rock	5080	**200**	15.0	**19.5**	13 915	**30,615**	N/A
994K	Pin On	Rock	6223	**245**	19.1-24.5	**25-32**	19 205-21 293	**42,340-46,942**	Spade edge*
		Heavy Duty Rock	6240	**246**	19.1-21.4	**25-28**	20 699-21 303	**45,633-46,966**	Spade edge*
		Coal	6964	**274**	32.1-39.8	**42-52**	20 862-22 773	**45,992-50,206**	Straight edge*
		Iron Ore	6240	**246**	17.2	**22.5**	19 518	**43,029**	Spade edge*

*With teeth and segments.
N/A = Not Applicable

986H — Standard Lift

Material Density				Bucket Volume	
kg/m³	**tonnes/m³**	**lb/yd³**	**tons/yd³**	**m³**	**yd³**
1632-1795	1.63-1.80	**2750-3025**	**1.38-1.51**	6.1	**8**
1740-1914	1.74-1.91	**2933-3227**	**1.46-1.61**	5.7	**7.5**
1865-2051	1.86-2.05	**3143-3457**	**1.57-1.73**	5.4	**7**

*Density range covers 100% rated payload to 110% rated payload in accordance with Large Wheel Loader payload policy.

988K

Material Density				Bucket Volume	
kg/m³	**tonnes/m³**	**lb/yd³**	**tons/yd³**	**m³**	**yd³**
1468-1614	1.47-1.61	**2500-2750**	**1.25-1.38**	7.7	**10**
1638-1801	1.64-1.80	**2778-3056**	**1.39-1.53**	6.9	**9**
1766-1942	1.77-1.94	**3001-3300**	**1.50-1.65**	6.4	**8.33**

990K

Material Density				Bucket Volume	
kg/m³	**tonnes/m³**	**lb/yd³**	**tons/yd³**	**m³**	**yd³**
1590-1749	1.59-1.75	**2692-2962**	**1.35-1.48**	10	**13**
1728-1901	1.73-1.90	**2917-3208**	**1.46-1.60**	9.2	**12**
1849-2034	1.85-2.03	**3111-3422**	**1.56-1.71**	8.6	**11.25**

992K — Standard

Up to specified density for 100% fill factor

Bucket Volume		Material Density	
m³	**yd³**	**kg/m³**	**lb/yd³**
12.2	**16**	1780	**3000**
11.5	**15**	1890	**3200**
10.7	**14**	2030	**3430**

992K — High Lift

Up to specified density for 100% fill factor

Bucket Volume		Material Density	
m³	**yd³**	**kg/m³**	**lb/yd³**
12.2	**16**	1560	**2630**
11.5	**15**	1560	**2630**
10.7	**14**	1560	**2630**

993K — Standard

Up to specified density for 100% fill factor

Bucket Volume		Material Density	
m³	**yd³**	**kg/m³**	**lb/yd³**
15.3	**20**	1780	**3000**
14.5	**19**	1870	**3160**
13.8	**18**	1970	**3330**

993K — High Lift

Up to specified density for 100% fill factor

Bucket Volume		Material Density	
m³	**yd³**	**kg/m³**	**lb/yd³**
14.5	**19**	1720	**2890**
13.8	**18**	1810	**3060**
13.0	**17**	1920	**3240**

WHEEL TRACTOR-SCRAPERS

CONTENTS

WHEEL TRACTOR-SCRAPERS

Specifications
● Twin Engine Open Bowl
● Optional Push-Pull

MODEL	627K		637K		657G	
Flywheel Power: Tractor	304 kW	**407 hp**	425 kW	**570 hp**	421/447 kW	**564/600 hp**
Scraper	216 kW	**290 hp**	216 kW	**290 hp**	306/337 kW	**410/451 hp**
Approx. Operating Weight (Empty)◀	40 811 kg	**89,973 lb**	52 140 kg	**114,950 lb**	68 384 kg	**150,760 lb**
Scraper Capacity: Struck	13 m^3	**17.1 yd^3**	18.3 m^3	**24 yd^3**	24.5 m^3	**32 yd^3**
Heaped	18.4 m^3	**24 yd^3**	26 m^3	**34 yd^3**	33.6 m^3	**44 yd^3**
Rated Load	26 127 kg	**57,610 lb**	37 285 kg	**82,200 lb**	47 174 kg	**104,000 lb**
Weight Distribution — Empty: Front	**59%**		**59%**		**58%**	
Rear	**41%**		**41%**		**42%**	
Weight Distribution — Loaded: Front	**50%**		**50%**		**50%**	
Rear	**50%**		**50%**		**50%**	
Engine Model: Tractor	**C13 ACERT**		**C18 ACERT**		**C18 ACERT**	
Scraper	**C9.3 ACERT**		**C9 ACERT**		**C15 ACERT**	
Emission Standards	**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**		**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**		**Tier 3/Stage IIIA/ Japan 2006 (Tier 3) equivalent**	
Rated Engine RPM: Tractor	**2000**		**1900**		**1800**	
Scraper	**2150**		**2150**		**1800**	
Displacement: Tractor	12.5 L	**763 in^3**	18.1 L	**1105 in^3**	18.1 L	**1105 in^3**
Scraper	9.3 L	**567 in^3**	9.3 L	**567 in^3**	15.2 L	**928 in^3**
Top Speed (Loaded)	53.9 km/h	**33.5 mph**	55.8 km/h	**34.7 mph**	53 km/h	**33 mph**
180° Curb-to-Curb Turning Width	18.25 m	**59'11"**	19.94 m	**65'5"**	22.33 m	**73'3"**
Tires — Tractor/Scraper	**33.25R29★★E3**		**37.25R35★★E3**		**40.5/75R39★★E3**	
Width of Cut	3.14 m	**10'4"**	3.51 m	**11'6"**	3.85 m	**12'8"**
Maximum Depth of Cut	315 mm	**12.4"**	475 mm	**18.7"**	440 mm	**17.3"**
Maximum Depth of Spread	540 mm	**21.3"**	451 mm	**17.8"**	660 mm	**26"**
Fuel Tank Refill Capacity	1272 L	**336 U.S. gal**	1400 L	**370 U.S. gal**	1597 L	**424 U.S. gal**
Tractor DEF Tank	31.5 L	**8.3 U.S. gal**	31.5 L	**8.3 U.S. gal**	—	
Scraper DEF Tank	23.1 L	**6.1 U.S. gal**	22.9 L	**6.0 U.S. gal**	—	
GENERAL DIMENSIONS: Non Push-Pull						
Height — Overall Shipping	4.03 m	**13'2"**	4.15 m	**13'7"**	4.62 m	**15'2"**
Wheelbase	7.99 m	**26'2"**	8.81 m	**28'11"**	9.96 m	**32'8"**
Overall Length	14.02 m	**45'10"**	15.04 m	**49'4"**	16.2 m	**53'1"**
Overall Width	3.57 m	**11'7"**	3.94 m	**12'11"**	4.35 m	**14'4"**
Shipping Width (Draft Arm on Inside of Bowl)	—		—		3.91 m *	**12'10"**
Center Line of Scraper Tread	2.29 m	**7'5"**	2.46 m	**8'1"**	2.81 m	**9'3"**
Center Line of Tractor Tread	2.28 m	**7'4"**	2.46 m	**8'1"**	2.63 m	**8'8"**
GENERAL DIMENSIONS: Push-Pull						
Operating Weight (Empty)◀	42 158 kg	**92,942 lb**	54 005 kg	**119,060 lb**	72 804 kg	**160,505 lb**
Overall Length	15.58 m	**51'1"**	16.64 m	**54'7"**	18.01 m	**59'1"**
Weight Distribution — Empty:						
Front	**59%**		**61%**		**58%**	
Rear	**41%**		**39%**		**42%**	
Weight Distribution — Loaded:						
Front	**50%**		**51%**		**51%**	
Rear	**50%**		**49%**		**49%**	

*Standard Shipping Configuration.

◀ Operating weight includes standard machine, coolant, lubricants, full fuel tank, and operator. Operating weights for the 627K and 637K are based on Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) platform machines. Deduct 569 kg **(1254 lb)** for the operating weight for the 627K Tier 2/Stage II/Japan 2001 (Tier 2) equivalent. Deduct 650 kg **(1433 lb)** for the operating weight for the 637K Tier 2/Stage II/Japan 2001 (Tier 2) equivalent. 657G is not available in Tier 2/Stage II/Japan 2001 (Tier 2) equivalent.

NOTE: Wheel Tractor-Scrapers are not emission certified in Japan market.

MODEL	637K		657G	
Flywheel Power: Tractor	425 kW	**570 hp**	421/447 kW	**564/600 hp**
Scraper	216 kW	**290 hp**	306/337 kW	**410/451 hp**
Approx. Operating Weight (Empty)	53 425 kg	**117,782 lb**	72 190 kg	**158,817 lb**
Scraper Capacity: Struck	31 m^3	**41 yd^3**	45 m^3	**59 yd^3**
Heaped	38 m^3	**50 yd^3**	56 m^3	**73 yd^3**
Emission Standards	**Tier 4 Final/Stage IV/ Japan 2014 (Tier 4 Final)**		**Tier 3/Stage IIIA/ Japan 2006 (Tier 3) equivalent**	
Rated Load	37 285 kg	**82,200 lb**	49 895 kg	**110,000 lb**
Approx. Operating Weight (Loaded)	90 710 kg	**199,982 lb**	121 933 kg	**268,817 lb**
Top Speed (Loaded)	55.8 km/h	**34.7 mph**	53 km/h	**33 mph**
180° Curb-to-Curb Turning Width	21.46 m	**70'5"**	24.43 m	**80'2"**
GENERAL DIMENSIONS:				
Height — Overall Shipping	4.15 m	**13'7"**	4.62 m	**15'2"**
Wheelbase	9.57 m	**31'5"**	11.01 m	**36'1"**
Overall Length	15.48 m	**50'10"**	17.21 m	**56'5"**
Overall Width	3.94 m	**12'11"**	4.35 m	**14'4"**
Shipping Width (Draft Arm on Inside of Bowl)	—		3.91 m *	**12'10"**
Center Line of Scraper Tread	2.46 m	**8'1"**	2.81 m	**9'3"**
Center Line of Tractor Tread	2.46 m	**8'1"**	2.63 m	**8'8"**

*Standard Shipping Configuration.

◀Operating weight includes standard machine, coolant, lubricants, full fuel tank, and operator. Operating weights for the 637K are based on Tier 4 Final/ Stage IV/Japan 2014 (Tier 4 Final) and operating weights for the 657G are based on Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent platform machines. Deduct 650 kg **(1433 lb)** for the operating weight for the 637K Tier 2/Stage II/Japan 2001 (Tier 2) equivalent.

NOTE: Wheel Tractor-Scrapers are not emission certified in Japan market.

Coal Bowl

Coal Bowl Wheel Tractor-Scrapers are typically used for building and maintaining coal stockpiles and hauling coal to the supply system at coal power plants. The self-loading capability, large capacity, coal pile compaction, and high speed of Coal Bowl Wheel Tractor-Scrapers make them the tool of choice for moving coal both short and long distances. Coal Bowl Wheel Tractor-Scrapers are available in the 637K and 657G tandem engine models.

Coal Bowl Advantages:

- Load hoppers
- Manage coal stockpiles
- Compaction reduces risk of spontaneous combustion in coal stockpile
- Exclusively designed large capacity coal bowls

Notes:

- The 637K Coal Scraper is 736 mm **(29.0")** longer, the bowl sides are 476 mm **(18.7")** taller, and the apron is 499 mm **(19.6")** taller than its earthmoving counterpart.
- The 657G Coal Scraper is 1072 mm **(42.2")** longer, the bowl sides are 1010 mm **(39.8")** taller, the apron is 677 mm **(26.7")** taller, and the ejector is 944 mm **(37.2")** taller than its earthmoving counterpart.

USE OF RIMPULL-SPEED-GRADEABILITY CURVES

The following explanation applies to Rimpull-Speed-Gradeability curves for Wheel Tractor-Scrapers, Construction & Mining Trucks/Tractors and Articulated Trucks.

Maximum speed attainable, gear range and available rimpull can be determined from curves on the following pages when machine weight and total effective grade (or total resistance) are known.

Rimpull is the force (in kg, lb or kN) available between the tire and the ground to propel the machine (limited by traction).

Weight is defined as Gross Machine Weight (kg or lb) = Machine + Payload.

Total Effective Grade (or Total Resistance) is grade resistance plus rolling resistance expressed as percent grade.

Grade is measured or estimated.

Rolling resistance is estimated (see Tables section for typical values.)

10 kg/metric ton (20 lb/U.S. ton) = 1% adverse grade.

Example

With a 6% grade and a rolling resistance of 40 kg/metric ton (80 lb/U.S. ton), find total resistance.

Rolling resistance = 40 kg/t ÷ 10 = 4% Effective Grade

(English: 80 lb ÷ 20 = 4%)

Total resistance = 4% rolling + 6% grade = 10%

Altitude Derating

Rimpull force and speed must be derated for altitude similar to flywheel horsepower. The percentage loss in rimpull force approximately corresponds to the percentage loss in flywheel horsepower. See Tables Section for altitude derations.

Rimpull-Speed-Gradeability

To determine gradeability performance: Read from gross weight down to the % of total resistance. (Total resistance equals actual % grade *plus* 1% for each 10 kg/metric ton (20 lb./U.S. ton) of rolling resistance.) From this weight-resistance point, read horizontally to the curve with the highest obtainable speed range, then down to the maximum speed. Usable rimpull depends upon traction and weight on drive wheels.

Example problem:

A 631K with an estimated payload of 37 013 kg (81,600 lb) is operating on a total effective grade of 10%. Find the available rimpull and maximum attainable speed.

Empty weight payload = Gross Weight
47 628 kg + 37 013 kg = 84 641 kg
(105,002 lb + 81,600 lb = 186,602 lb)

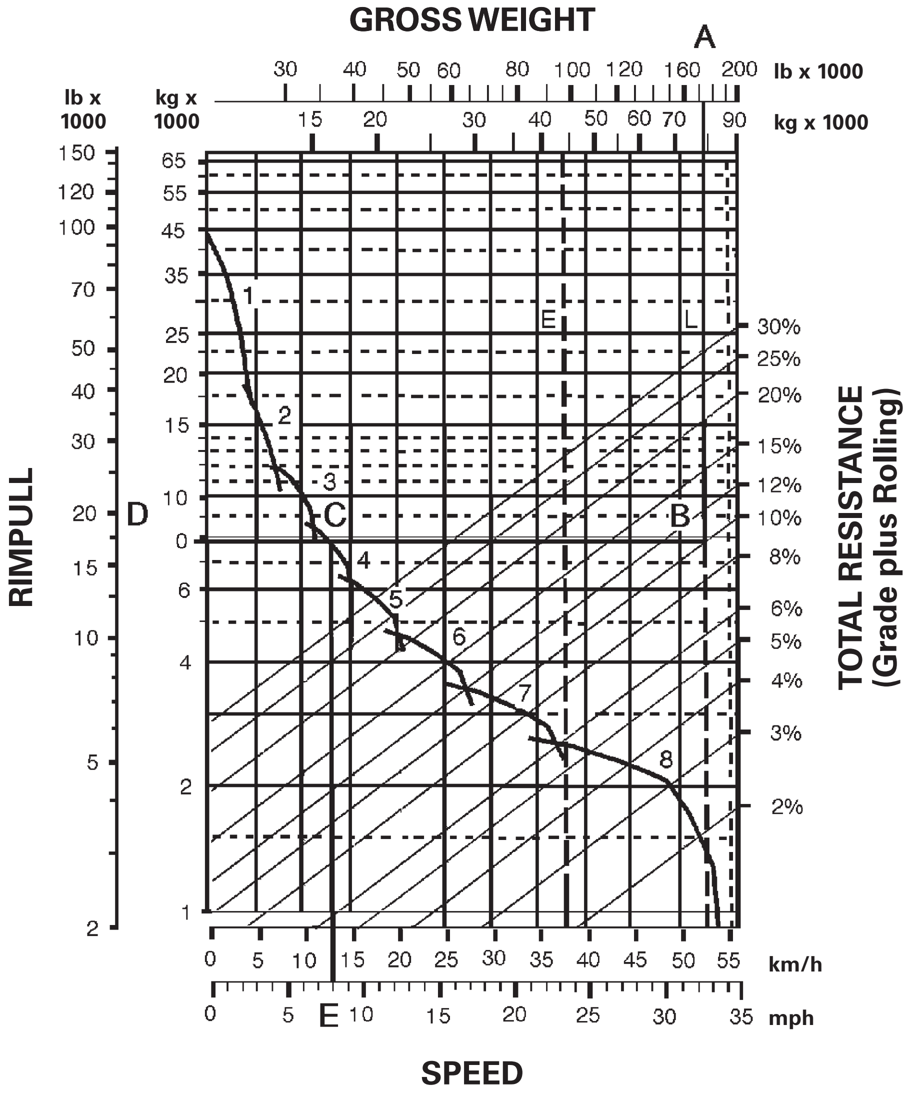
Solution: Using graph on the next page, read from 84 641 kg (186,602 lb) (point A) on top of gross weight scale down the line to the intersection of the 10% total resistance line (point B).

Go across horizontally from B to the Rimpull Scale on the left (point D). This gives the required rimpull: 7756 kg (17,100 lb).

Where the line cuts the speed curve (point C), read down vertically (point E) to obtain the maximum speed attainable for the 10% effective grade: 12.9 km/h (8 mph).

ANSWER: The machine will climb the 10% effective grade at a maximum speed of 12.9 km/h (8 mph) in 4th gear. Available rimpull is 7756 kg (17,100 lb).

● ● ●



KEY

1 — 1st Gear Torque Converter Drive
2 — 2nd Gear Torque Converter Drive
3 — 3rd Gear Direct Drive
4 — 4th Gear Direct Drive
5 — 5th Gear Direct Drive
6 — 6th Gear Direct Drive
7 — 7th Gear Direct Drive
8 — 8th Gear Direct Drive

KEY

A — Loaded 84 641 kg (186,602 lb)
B — Intersection with 10% total resistance line
C — Intersection with rimpull curve (4th gear)
D — Required rimpull 7756 kg (17,100 lb)
E — Speed 12.9 km/h (8 mph)

TYPICAL FIXED TIMES FOR SCRAPERS

(Times may vary depending on job conditions)

Model	Loaded By	Load Time (Min.)	Maneuver and Spread or Maneuver and Dump (Min.)
613G	Self	0.9	0.7
623K	Self	0.9	0.7
621K	One D8	0.5	0.7
627K	One D8	0.5	0.6
621K	One D9	0.4	0.7
627K	One D9	0.4	0.6
627K/PP	Self	0.9*	0.6
631K	One D9	0.6	0.7
637K	One D9	0.6	0.6
631K	One D10	0.5	0.7
637K	One D10	0.5	0.6
637K/PP	Self	1.0*	0.6
657G	One D11	0.6	0.6
657G	Push Pull Self	1.1*	0.6
637K	Coal	0.8	0.7
657G	Coal	0.8	0.6

*Load time per pair, including transfer time.

NOTE: Empty Weights shown on the Wheel Tractor-Scraper charts includes ROPS Canopy. When calculating TMPH loadings *any* additional weight must be considered in establishing mean tire loads.

USE OF RETARDER CURVES

The following explanation applies to retarder curves for Wheel Tractor-Scrapers and Articulated Trucks.

The speed that can be maintained (without use of service brake) when the machine is descending a grade with retarder fully on can be determined from the retarder curves in this section if gross machine weight and total effective grade are known.

Total Effective Grade (or Total Resistance) is grade assistance *minus* rolling resistance.

10 kg/metric ton (20 lb/U.S. ton) = 1% adverse grade.

Example

15% favorable grade with 5% rolling resistance. Find Total Effective Grade.

Total Effective Grade = 15% Grade Assistance — 5%

Rolling Resistance = 10% Total Effective Grade Assistance.

Example problem:

A 651E with an estimated payload of 47 175 kg (104,000 lb) descends a 10% total effective grade. Find constant speed and gear range with maximum retarder effort. Find travel time if the slope is 610 m (2000 ft) long.

Empty Weight + Payload = Gross Weight
= 60 950 kg + 47 175 kg = 108 125 kg
(134,370 lb + 104,000 lb = 238,370 lb)

Solution: Using the retarder curve below, read from 108 125 kg (238,370 lb) (point A) on top of gross weight scale down the line to the intersection of the 10% effective grade line (point B).

Go across horizontally from point B to the intersection of the retarder curve (point C). Point C intersects at the 5 (5th gear) range.

Where point C intersects the retarder curve, read down vertically to point D on the bottom scale to obtain the constant speed: 21.7 km/h (13.5 mph).

ANSWER: The 651E will descend the slope at 21.7 km/h (13.5 mph) in 5th gear. Travel time is 1.68 minutes.

$$\frac{610 \text{ m}}{363 \text{ m/min}} = 1.68 \text{ min}$$

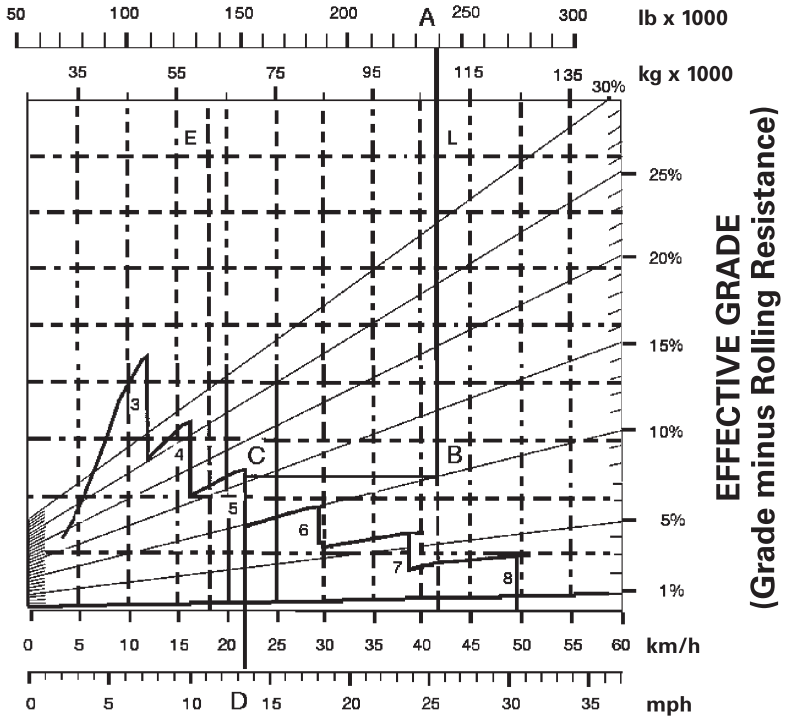
*(mph × 88 = F.P.M.)

$$\frac{2000 \text{ ft}}{13.5 \text{ mph} \times 88^*} = 1.68 \text{ min}$$

NOTE: The basic Distance-Speed-Time formula is 60 D ÷ S = T (or "60 D Street"), where 60 is minutes, D is distance, S is speed and T is time. In the above problem, 60 × 610 m ÷ 21.7 km/h × 1000 = T.

$$\frac{60 \times 610}{21.7 \times 1000} = T = (1.68)$$

GROSS WEIGHT



SPEED

KEY
3 — 3rd Gear Direct Drive
4 — 4th Gear Direct Drive
5 — 5th Gear Direct Drive
6 — 6th Gear Direct Drive
7 — 7th Gear Direct Drive
8 — 8th Gear Direct Drive

KEY
A — Loaded 108 125 kg (238,370 lb)
B — Intersection with 10% effective grade line
C — Intersection with retarder curve (5th gear)
D — Constant speed 21.7 km/h (13.5 mph)

MINING AND EARTHMOVING

CONTENTS

INTRODUCTION

This section explains the earthmoving principles used to determine machine productivity. It shows how to calculate production on-the-job or estimate production off-the-job.

ELEMENTS OF PRODUCTION

Production is the hourly rate at which material is moved. Production can be expressed in various units:

Metric

Bank Cubic Meters	— BCM —	bank m^3
Loose Cubic Meters	— LCM —	loose m^3
Compacted Cubic Meters	— CCM —	compacted m^3
Tonnes		

English

Bank Cubic Yards	— BCY —	bank yd^3
Loose Cubic Yards	— LCY —	loose yd^3
Compacted Cubic Yards	— CCY —	compacted yd^3
Tons		

For most earthmoving and material handling applications, production is calculated by multiplying the quantity of material (load) moved per cycle by the number of cycles per hour.

Production = Load/cycle × cycles/hour

The load can be determined by
1) load weighing with scales
2) load estimating based on machine rating
3) surveyed volume divided by load count
4) machine payload measurement system

Generally, earthmoving and overburden removal for coal mines are calculated by volume (bank cubic meters or bank cubic yards). Metal mines and aggregate producers usually work in weight (tons or tonnes).

Volume Measure — Material volume is defined according to its state in the earthmoving process. The three measures of volume are:

BCM (BCY) — one cubic meter (yard) of material as it lies in the natural bank state.

LCM (LCY) — one cubic meter (yard) of material which has been disturbed and has swelled as a result of movement.

CCM (CCY) — one cubic meter (yard) of material which has been compacted and has become more dense as a result of compaction.

In order to estimate production, the relationships between bank measure, loose measure, and compacted measure must be known.

Swell — Swell is the percentage of original volume (cubic meters or cubic yards) that a material increases when it is removed from the natural state. When excavated, the material breaks up into different size particles that do not fit together, causing air pockets or voids to reduce the weight per volume. For example to hold the same weight of one cubic unit of bank material it takes 30% more volume (1.3 times) after excavation. (Swell is 30%.)

$$1 + \text{Swell} = \frac{\text{Loose cubic volume for a given weight}}{\text{Bank cubic volume for the same given weight}}$$

$$\text{Bank} = \frac{\text{Loose}}{(1 + \text{Swell})}$$

$$\text{Loose} = \text{Bank} \times (1 + \text{Swell})$$

Example Problem:

If a material swells 20%, how many loose cubic meters (loose cubic yards) will it take to move 1000 bank cubic meters (1308 bank cubic yards)?

$$\text{Loose} = \text{Bank} \times (1 + \text{Swell}) =$$
$$1000 \text{ BCM} \times (1 + 0.2) = 1200 \text{ LCM}$$
$$1308 \text{ BCY} \times (1 + 0.2) = 1570 \text{ LCY}$$

How many bank cubic meters (yards) were moved if a total of 1000 loose cubic meters (1308 yards) have been moved? Swell is 25%.

$$\text{Bank} = \text{Loose} \div (1 + \text{Swell}) =$$
$$1000 \text{ LCM} \div (1 + 0.25) = 800 \text{ BCM}$$
$$1308 \text{ LCY} \div (1 + 0.25) = 1046 \text{ BCY}$$

Load Factor — Assume one bank cubic yard of material weighs 3000 lb. Because of material characteristics, this bank cubic yard swells 30% to 1.3 loose cubic yards when loaded, with no change in weight. If this 1.0 bank cubic yard or 1.3 loose cubic yards is compacted, its volume may be reduced to 0.8 compacted cubic yard, and the weight is still 3000 lb.

Instead of dividing by 1 + Swell to determine bank volume, the loose volume can be multiplied by the load factor.

If the percent of material swell is known, the load factor (L.F.) may be obtained by using the following relationship:

$$\text{L.F.} = \frac{100\%}{100\% + \%\text{ swell}}$$

Load factors for various materials are listed in the Tables Section of this handbook.

To estimate the machine payload in bank cubic yards, the volume in loose cubic yards is multiplied by the load factor:

$$\text{Load (BCY)} = \text{Load (LCY)} \times \text{L.F.}$$

The ratio between compacted measure and bank measure is called shrinkage factor (S.F.):

$$\text{S.F.} = \frac{\text{Compacted cubic yards (CCY)}}{\text{Bank cubic yards (BCY)}}$$

Shrinkage factor is either estimated or obtained from job plans or specifications which show the conversion from compacted measure to bank measure. Shrinkage factor should not be confused with percentage compaction (used for specifying embankment density, such as Modified Proctor or California Bearing Ratio [CBR]).

Material Density — Density is the weight per unit volume of a material. Materials have various densities depending on particle size, moisture content and variations in the material. The denser the material the more weight there is per unit of equal volume. Density estimates are provided in the Tables Section of this handbook.

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}} = \frac{\text{kg (lb)}}{\text{m}^3\,(\text{yd}^3)}$$

$$\text{Weight} = \text{Volume} \times \text{Density}$$

A given material's density changes between bank and loose. One cubic unit of loose material has less weight than one cubic unit of bank material due to air pockets and voids. To correct between bank and loose use the following equations.

$$1 + \text{Swell} = \frac{\text{kg/BCM}}{\text{kg/LCM}} \text{ or } \frac{\text{lb/BCY}}{\text{lb/LCY}}$$

$$\text{lb/LCY} = \frac{\text{lb/BCY}}{(1 + \text{Swell})}$$

$$\text{lb/BCY} = \text{lb/LCY} \times (1 + \text{Swell})$$

Fill Factor — The percentage of an available volume in a body, bucket, or bowl that is actually used is expressed as the fill factor. A fill factor of 87% for a hauler body means that 13% of the rated volume is not being used to carry material. Buckets often have fill factors over 100%.

Example Problem:

A 14 cubic yard (heaped 2:1) bucket has a 105% fill factor when operating in a shot sandstone (4125 lb/BCY and a 35% swell).

a) What is the loose density of the material?
b) What is the usable volume of the bucket?
c) What is the bucket payload per pass in BCY?
d) What is the bucket payload per pass in tons?

a) lb/LCY = lb/BCY ÷ (1 + Swell) = 4125 ÷ (1.35) = 3056 lb/LCY
b) LCY = rated LCY × fill factor = 14 × 1.05 = 14.7 LCY
c) lb/pass = volume × density lb/LCY = 14.7 × 3056 = 44,923 lb
BCY/pass = weight ÷ density lb/BCY = 44,923 ÷ 4125 = 10.9 BCY
or bucket LCY from part b ÷ (1 + Swell) = 14.7 ÷ 1.35 = 10.9 BCY
d) tons/pass = lb ÷ 2000 lb/ton = 44,923 ÷ 2000 = 22.5 tons

Example Problem:

Construct a 10,000 compacted cubic yard (CCY) bridge approach of dry clay with a shrinkage factor (S.F.) of 0.80. Haul unit is rated 14 loose cubic yards struck and 20 loose cubic yards heaped.

a) How many bank yards are needed?
b) How many loads are required?

a) $\text{BCY} = \frac{\text{CCY}}{\text{S.F.}} = \frac{10{,}000}{0.80} = 12{,}500 \text{ BCY}$

b) Load (BCY) = Capacity (LCY)
× Load factor (L.F.) = 20 × 0.81
= 16.2 BCY/Load

(L.F. of 0.81 from Tables)

$$\text{Number of loads required} = \frac{12{,}500 \text{ BCY}}{16.2 \text{ BCY/Load}} = 772 \text{ Loads}$$

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Soil Density Tests — There are a number of acceptable methods that can be used to determine soil density. Some that are currently in use are:

Nuclear density moisture gauge
Sand cone method
Oil method
Balloon method
Cylinder method

All these except the nuclear method use the following procedure:

1. Remove a soil sample from bank state.
2. Determine the volume of the hole.
3. Weigh the soil sample.
4. Calculate the bank density kg/BCM (lb/BCY).

The nuclear density moisture gauge is one of the most modern instruments for measuring soil density and moisture. A common radiation channel emits either neutrons or gamma rays into the soil. In determining soil density, the number of gamma rays absorbed and back scattered by soil particles is *indirectly* proportional to the soil density. When measuring moisture content, the number of moderated neutrons reflected back to the detector after colliding with hydrogen particles in the soil is *directly* proportional to the soil's moisture content.

All these methods are satisfactory and will provide accurate densities when performed correctly. Several repetitions are necessary to obtain an average.

NOTE: Several newer methods have been successfully applied, along with weigh scales to determine volume and loose density of material moved in hauler bodies. These measurements include photogrammatic and laser scanning technologies.

FIGURING PRODUCTION ON-THE-JOB

Load Weighing — The most accurate method of determining the actual load carried is by weighing. This is normally done by weighing the haul unit one wheel or axle at a time with portable scales. Any scales of adequate capacity and accuracy can be used. While weighing, the machine must be level to reduce error caused by weight transfer. Enough loads must be weighed to provide a good average. Machine weight is the sum of the individual wheel or axle weights.

The weight of the load can be determined using the empty and loaded weight of the unit.

Weight of
load = gross machine weight – empty weight

To determine the bank cubic measure carried by a machine, the load weight is divided by the bankstate density of the material being hauled.

$$\text{BCY} = \frac{\text{Weight of load}}{\text{Bank density}}$$

Times Studies — To estimate production, the number of complete trips a unit makes per hour must be determined. First obtain the unit's cycle time with the help of a stop watch. Time several complete cycles to arrive at an average cycle time. By allowing the watch to run continuously, different segments such as load time, wait time, etc. can be recorded for each cycle. Knowing the individual time segments affords a good opportunity to evaluate the balance of the spread and job efficiency. The following is an example of a scraper load time study form. Numbers in the white columns are stop watch readings; numbers in the shaded columns are calculated:

Total Cycle Times (less delays)	Arrive Cut	Wait Time	Begin Load	Load Time	End Load	Begin Delay	Delay Time	End Delay
	0.00	0.30	0.30	0.60	0.90			
3.50	3.50	0.30	3.80	0.65	4.45			
4.00	7.50	0.35	7.85	0.70	8.55	9.95	1.00	10.95
4.00	12.50	0.42	12.92	0.68	13.60			

NOTE: All numbers are in minutes

This may be easily extended to include other segments of the cycle such as haul time, dump time, etc. Haul roads may be further segmented to more accurately define performance, including measured speed traps. Similar forms can be made for pushers, loaders, dozers, etc. *Wait Time* is the time a unit must wait for another unit so that the two can function together (haul unit waiting for pusher). *Delay Time* is any time, other than wait time, when a machine is not performing in the work cycle (scraper waiting to cross railroad track).

To determine trips-per-hour at 100% efficiency, divide 60 minutes by the average cycle time less all wait and delay time. Cycle time may or may not include wait and/or delay time. Therefore, it is possible to figure different kinds of production: measured production, production without wait or delay, maximum production, etc. For example:

Actual Production: includes all wait and delay time.

Normal Production (without delays): includes wait time that is considered normal, but no delay time.

Maximum Production: to figure maximum (or optimum) production, both wait time and delay time are eliminated. The cycle time may be further altered by using an optimum load time.

Example (English)

A job study of a Wheel Tractor-Scraper might yield the following information:

Average wait time	= 0.28 minute
Average load time	= 0.65
Average delay time	= 0.25
Average haul time	= 4.26
Average dump time	= 0.50
Average return time	= 2.09
Average total cycle	= 8.03 minutes
Less wait & delay time	= 0.53
Average cycle 100% eff.	= 7.50 minutes

Weight of haul unit empty — 48,650 lb

Weights of haul unit loaded —

Weighing unit #1 — 93,420 lb
Weighing unit #2 — 89,770 lb
Weighing unit #3 — 88,760 lb

271,950 lb;
average = 90,650 lb

1. Average load weight = 90,650 lb – 48,650 lb = 42,000 lb
2. Bank density = 3125 lb/BCY
3. $$\text{Load} = \frac{\text{Weight of load}}{\text{Bank density}} = \frac{42{,}000\text{ lb}}{3125\text{ lb/BCY}} = 13.4\text{ BCY}$$
4. Cycles/hr = $$\frac{60\text{ min/hr}}{\text{Cycle time}} = \frac{60\text{ min/hr}}{7.50\text{ min/cycle}} = 80\text{ cycles/hr}$$
5. Production = Load/cycle × cycles/hr
(less delays) = 13.4 BCY/cycle × 8.0 cycles/hr
= 107.2 BCY/hr

Example (Metric)

A job study of a Wheel Tractor-Scraper might yield the following information:

Average wait time	= 0.28 minute
Average load time	= 0.65
Average delay time	= 0.25
Average haul time	= 4.26
Average dump time	= 0.50
Average return time	= 2.09
Average total cycle	= 8.03 minutes
Less wait & delay time	= 0.53
Average cycle 100% eff.	= 7.50 minutes

Weight of haul unit empty — 22 070 kg

Weights of haul unit loaded —

Weighing unit #1 — 42 375 kg
Weighing unit #2 — 40 720 kg
Weighing unit #3 — 40 260 kg

123 355 kg;
average = 41 120 kg

1. Average load weight = 41 120 kg – 22 070 kg = 19 050 kg
2. Bank density = 1854 kg/BCM
3. Load = $\dfrac{\text{Weight of load}}{\text{Bank density}}$

$$= \frac{19\ 050\text{ kg}}{1854\text{ kg/BCM}} = 10.3\text{ BCM}$$

4. Cycles/hr =

$$\frac{60\text{ min/hr}}{\text{Cycle time}} = \frac{60\text{ min/hr}}{7.50\text{ min/cycle}} = 80\text{ cycles/hr}$$

5. Production = Load/cycle × cycles/hr
(less delays) = 10.3 BCM/cycle × 8.0 cycles/hr
= 82 BCM/hrr

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ESTIMATING PRODUCTION OFF-THE-JOB

It is often necessary to estimate production of earthmoving machines which will be selected for a job. As a guide, the remainder of the section is devoted to discussions of various factors that may affect production. Some of the figures have been rounded for easier calculation.

Rolling Resistance (RR) is a measure of the force that must be overcome to roll or pull a wheel over the ground. It is affected by ground conditions and load — the deeper a wheel sinks into the ground, the higher the rolling resistance. Internal friction and tire flexing also contribute to rolling resistance. Experience has shown that minimum resistance is 1%-1.5% (see Typical Rolling Resistance Factors in Tables section) of the gross machine weight (on tires). A 2% base resistance is quite often used for estimating. Resistance due to tire penetration is approximately 1.5% of the gross machine weight for each inch of tire penetration (0.6% for each cm of tire penetration). Thus rolling resistance can be calculated using these relationships in the following manner:

RR = 2% of GMW + 0.6% of GMW per cm tire penetration

RR = 2% of GMW + 1.5% of GMW per inch tire penetration

It's *not* necessary for the tires to actually penetrate the road surface for rolling resistance to increase above the minimum. If the road surface flexes under load, the effect is nearly the same — the tire is always running "uphill." Only on very hard, smooth surfaces with a well compacted base will the rolling resistance approach the minimum.

When actual penetration takes place, some variation in rolling resistance can be noted with various inflation pressures and tread patterns.

NOTE: When figuring "pull" requirements for track-type tractors, rolling resistance applies only to the trailed unit's *weight on wheels*. Since track-type tractors utilize steel wheels moving on steel "roads," a tractor's rolling resistance is relatively constant and is accounted for in the Drawbar Pull rating.

Estimating Production Off-the-Job
● Grade Resistance
● Total Resistance
● Traction

Grade Resistance is a measure of the force that must be overcome to move a machine over unfavorable grades (uphill). Grade assistance is a measure of the force that assists machine movement on favorable grades (downhill).

Grades are generally measured in percent slope, which is the ratio between vertical rise or fall and the horizontal distance in which the rise or fall occurs. For example, a 1% grade is equivalent to a 1 m (ft) rise or fall for every 100 m (ft) of horizontal distance; a rise of 4.6 m (15 ft) in 53.3 m (175 ft) equals an 8.6% grade.

$$\frac{4.6 \text{ m (rise)}}{53.3 \text{ m (horizontal distance)}} = 8.6\% \text{ grade}$$

$$\frac{15 \text{ ft (rise)}}{175 \text{ ft (horizontal distance)}} = 8.6\% \text{ grade}$$

Uphill grades are normally referred to as adverse grades and downhill grades as favorable grades. Grade resistance is usually expressed as a positive (+) percentage and grade assistance is expressed as a negative (–) percentage.

It has been found that for each 1% increment of adverse grade an additional 10 kg (20 lb) of resistance must be overcome for each metric (U.S.) ton of machine weight. This relationship is the basis for determining the Grade Resistance Factor which is expressed in kg/metric ton (lb/U.S. ton):

Grade Resistance Factor = 10 kg/m ton × % grade
= 20 lb/U.S. ton × % grade

Grade resistance (assistance) is then obtained by multiplying the Grade Resistance Factor by the machine weight (GMW) in metric (U.S.) tons.

Grade Resistance = GR Factor × GMW in metric (U.S.) tons

Grade resistance may also be calculated using percentage of gross weight. This method is based on the relationship that grade resistance is approximately equal to 1% of the gross machine weight for 1% of grade.

Grade Resistance = 1% of GMW × % grade

Grade resistance (assistance) affects both wheel and track-type machines.

Total Resistance is the combined effect of rolling resistance (wheel vehicles) and grade resistance. It can be computed by summing the values of rolling resistance and grade resistance to give a resistance in kilogram (pounds) force.

Total Resistance = Rolling Resistance + Grade Resistance

Total resistance can also be represented as consisting completely of grade resistance expressed in percent grade. In other words, the rolling resistance component is viewed as a corresponding quantity of additional adverse grade resistance. Using this approach, total resistance can then be considered in terms of percent grade.

This can be done by converting the contribution of rolling resistance into a corresponding percentage of grade resistance. Since 1% of adverse grade offers a resistance of 10 kg (20 lb) for each metric or (U.S.) ton of machine weight, then each 10 kg (20 lb) of resistance per ton of machine weight can be represented as an additional 1% of adverse grade. Rolling resistance in percent grade and grade resistance in percent grade can then be summed to give Total Resistance in percent or Effective Grade. The following formulas are useful in arriving at Effective Grade.

Rolling Resistance (%) = 2% + 0.6% per cm tire penetration
= 2% + 1.5% per inch tire penetration
Grade Resistance (%) = % grade
Effective Grade (%) = RR (%) + GR (%)

Effective grade is a useful concept when working with Rimpull-Speed-Gradeability curves, Retarder curves, Brake Performance curves, and Travel Time curves.

Traction — is the driving force developed by a wheel or track as it acts upon a surface. It is expressed as usable Drawbar Pull or Rimpull. The following factors affect traction: weight on the driving wheel or tracks, gripping action of the wheel or track, and ground conditions. The coefficient of traction (for any roadway) is the ratio of the maximum pull developed by the machine to the total weight on the drivers.

$$\text{Coeff. of traction} = \frac{\text{Pull}}{\text{weight on drivers}}$$

Therefore, to find the usable pull for a given machine:
Usable pull = Coeff. of traction × weight on drivers

Example: Track-Type Tractor

What usable drawbar pull (DBP) can a 26 800 kg (59,100 lb) Track-type Tractor exert while working on firm earth? on loose earth? (See table section for coefficient of traction.)

Answer:
Firm earth — Usable DBP =
0.90 × 26 800 kg = 24 120 kg
(0.90 × 59,100 lb = 53,190 lb)
Loose earth — Usable DBP =
0.60 × 26 800 kg = 16 080 kg
(0.60 × 59,100 lb = 35,460 lb)

If a load required 21 800 kg (48,000 lb) pull to move it, this tractor could move the load on firm earth. However, if the earth were loose, the tracks would spin.

NOTE: D8R through D11R Tractors may attain higher coefficients of traction due to their suspended undercarriage.

Example: Wheel Tractor-Scraper

What usable rimpull can a 621F size machine exert while working on firm earth? on loose earth? The total loaded weight distribution of this unit is:

Drive unit	Scraper unit
wheels: 23 600 kg (52,000 lb)	wheels: 21 800 kg (48,000 lb)

Remember, use weight on drivers only.
Answer:
Firm earth — 0.55 × 23 600 kg = 12 980 kg
(0.55 × 52,000 lb = 28,600 lb)
Loose earth — 0.45 × 23 600 kg = 10 620 kg
(0.45 × 52,000 lb = 23,400 lb)

On firm earth this unit can exert up to 12 980 kg (28,600 lb) rimpull without excessive slipping. However, on loose earth the drivers would slip if more than 10 620 kg (23,400 lb) rimpull were developed.

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Altitude — Specification sheets show how much pull a machine can produce for a given gear and speed when the engine is operating at rated horsepower. When a standard machine is operated in high altitudes, the engine may require derating to maintain normal engine life. This engine deration will produce less drawbar pull or rimpull.

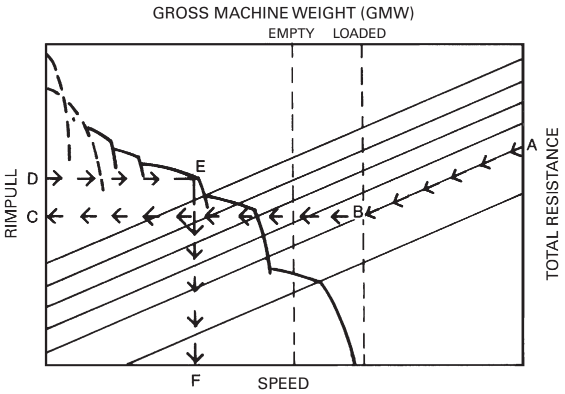
The Tables Section gives the altitude deration in percent of flywheel horsepower for current machines. It should be noted that some turbocharged engines can operate up to 4570 m (15,000 ft) before they require derating. Most machines are engineered to operate up to 1500-2290 m (5000-7500 ft) before they require deration.

The horsepower deration due to altitude must be considered in any job estimating. The amount of power deration will be reflected in the machine's gradeability and in the load, travel, and dump and load times (unless loading is independent of the machine itself). Altitude may also reduce retarding performance. Consult a Cat representative to determine if deration is applicable. Fuel grade (heat content) can have a similar effect of derating engine performance.

The example job problem that follows indicates one method of accounting for altitude deration: by increasing the appropriate components of the total cycle time by a percentage equal to the percent of horsepower deration due to altitude. (i.e., if the travel time of a hauling unit is determined to be 1.00 minute at full HP, the time for the same machine derated to 90% of full HP will be 1.10 min.) This is an approximate method that yields reasonably accurate estimates up to 3000 m (10,000 feet) elevation.

Travel time for hauling units derated more than 10% should be calculated as follows using Rimpull-Speed-Gradeability charts.

1) Determine total resistance (grade plus rolling) in percent.



2) Beginning at point A on the chart follow the total resistance line diagonally to its intersection, B, with the vertical line corresponding to the appropriate gross machine weight. (Rated loaded and empty GMW lines are shown dotted.)

3) Using a straight-edge, establish a horizontal line to the left from point B to point C on the rim-pull scale.

4) Divide the value of point C as read on the rimpull scale by the percent of total horsepower available after altitude deration from the Tables Section. This yields rimpull value D higher than point C.

5) Establish a horizontal line right from point D. The farthest right intersection of this line with a curved speed range line is point E.

6) A vertical line down from point E determines point F on the speed scale.

7) Multiply speed in kmh by 16.7 (mph by 88) to obtain speed in m/min (ft/min). Travel time in minutes for a given distance in feet is determined by the formula:

$$\text{Time (min)} = \frac{\text{Distance in m (ft)}}{\text{Speed in m/min (ft/min)}}$$

The Travel Time Graphs in sections on Wheel Tractor-Scrapers and Construction & Mining Trucks can be used as an alternative method of calculating haul and/or return times.

Job Efficiency is one of the most complex elements of estimating production since it is influenced by factors such as operator skill, minor repairs and adjustments, personnel delays, and delays caused by job layout. An approximation of efficiency, if no job data is available, is given below.

Operation	Working Hour	Efficiency Factor
Day	50 min/hr	0.83
Night	45 min/hr	0.75

These factors do not account for delays due to weather or machine downtime for maintenance and repairs. You must account for such factors based on experience and local conditions.

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The following example provides a method to manually estimate production and cost. Today, computer programs, such as Caterpillar's Fleet Production and Cost Analysis (FPC), provide a much faster and more accurate means to obtain those application results.

Example problem (English)

A contractor is planning to put the following spread on a dam job. What is the estimated production?

Equipment:
- 11 — 631G Wheel Tractor-Scrapers
- 2 — D9T Tractors with C-dozers
- 2 — 12H Motor Graders
- 1 — 825G Tamping Foot Compactor

Material:
- Description — Sandy clay; damp, natural bed
- Bank Density — 3000 lb/BCY
- Load Factor — 0.80
- Shrinkage Factor — 0.85
- Traction Factor — 0.50
- Altitude — 7500 ft

1. Estimate Payload:
Est. load (LCY) × L.F. × Bank Density = payload
31 LCY × 0.80 × 3000 lb/BCY = 74,400 lb payload

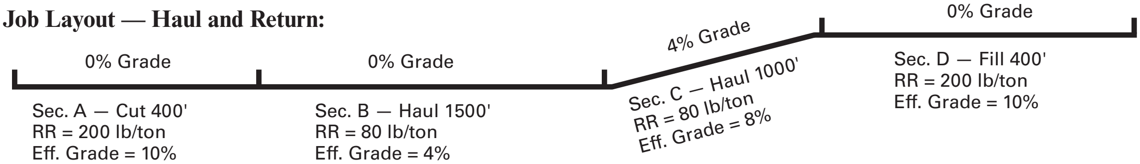
2. Establish Machine Weight:
Empty Wt. — 102,460 lb or 51.27 tons
Wt. of Load — 74,400 lb or 37.2 tons
Total (GMW) — 176,860 lb or 88.4 tons

3. Calculate Usable Pull (traction limitation):
Loaded: (weight on driving wheels = 54%) (GMW)
Traction Factor × Wt. on driving wheels =
0.50 × 176,860 lb × 54% = 47,628 lb
Empty: (weight on driving wheels = 69%) (GMW)
Traction Factor × Wt. on driving wheels =
0.50 × 102,460 lb × 69% = 35,394 lb

4. Derate for Altitude:
Check power available at 7500 ft from altitude deration table in the Tables Section.

631G — 100%	12H — 83%
D9T — 100%	825G —100%

Job Layout — Haul and Return:



Total Effective Grade = RR (%) ± GR (%)
Sec. A: Total Effective Grade = 10% + 0% = 10%
Sec. B: Total Effective Grade = 4% + 0% = 4%
Sec. C: Total Effective Grade = 4% + 4% = 8%
Sec. D: Total Effective Grade = 10% + 0% = 10%

Then adjust if necessary:
Load Time — controlled by D9T, at 100% power, no change.
Travel, Maneuver and Spread time — 631G, no change.

5. Compare Total Resistance to Tractive Effort on haul:

Grade Resistance —
GR = lb/ton × tons × adverse grade in percent
Sec. C: = 20 lb/ton × 88.4 tons × 4% grade = 7072 lb

Rolling Resistance —
RR = RR Factor (lb/ton) × GMW (tons)
Sec. A: = 200 lb/ton × 88.4 tons = 17,686 lb
Sec. B: = 80 lb/ton × 88.4 tons = 7072 lb
Sec. C: = 80 lb/ton × 88.4 tons = 7072 lb
Sec. D: = 200 lb/ton × 88.4 tons = 17,686 lb

Total Resistance —
TR = RR + GR
Sec. A: = 17,686 lb + 0 = 17,686 lb
Sec. B: = 7072 lb + 0 = 7072 lb
Sec. C: = 7072 lb + 6496 lb = 14,144 lb
Sec. D: = 17,686 lb + 0 = 17,686 lb

Check usable pounds pull against maximum pounds pull required to move the 631G.
Pull usable … 47,628 lb loaded
Pull required … 17,686 lb maximum total resistance
Estimate travel time for haul from 631G (loaded) travel time curve; read travel time from distance and effective grade.
Travel time (from curves):
Sec. A: 0.60 min
Sec. B: 1.00
Sec. C: 1.20
Sec. D: 0.60
3.40 min

NOTE: This is an estimate only; it *does not account for all the acceleration and deceleration tim*e, therefore it is not as accurate as the information obtained from a computer program.

6. Compare Total Resistance to Tractive Effort on return:

Grade Assistance —
GA = 20 lb/ton × tons × negative grade in percent
Sec. C: = 20 lb/ton × 51.2 tons × 4% grade = 4096 lb

Rolling Resistance —
RR = RR Factor × Empty Wt (tons)
Sec. D: = 200 lb/ton × 51.2 tons = 10,240 lb
Sec. C: = 80 lb/ton × 51.2 tons = 4091 lb
Sec. B: = 80 lb/ton × 51.2 tons = 4091 lb
Sec. A: = 200 lb/ton × 51.2 tons = 10,240 lb

Total Resistance —
TR = RR – GA
Sec. D: = 10,240 lb – 0 = 10,240 lb
Sec. C: = 4096 lb – 4096 lb = 0
Sec. B: = 4096 lb – 0 = 4096 lb
Sec. A: = 10,240 lb – 0 = 10,240 lb

Check usable pounds pull against maximum pounds pull required to move the 631G.
Pounds pull usable … 35,349 lb empty
Pounds pull required … 10,240 lb
Estimate travel time for return from 631G empty travel time curve.
Travel time (from curves):
Sec. A: 0.40 min
Sec. B: 0.55
Sec. C: 0.80
Sec. D: 0.40
2.15 min

7. Estimate Cycle Time:

Total Travel Time (Haul plus Return)	= 5.55 min
Adjusted for altitude: 100% × 5.55 min	= 5.55 min
Load Time	0.7 min
Maneuver and Spread Time	0.7 min
Total Cycle Time	6.95 min

8. Check pusher-scraper combinations:

Pusher cycle time consists of load, boost, return and maneuver time. Where actual job data is not available, the following may be used.

Boost time = 0.10 minute
Return time = 40% of load time
Maneuver time = 0.15 minute
Pusher cycle time = 140% of load time + 0.25 minute
Pusher cycle time = 140% of 0.7 min + 0.25 minute
= 0.98 + 0.25 = 1.23 minute

Scraper cycle time divided by pusher cycle time indicates the number of scrapers which can be handled by each pusher.

$$\frac{6.95 \text{ min}}{1.23 \text{ min}} = 5.65$$

Each push tractor is capable of handling five plus scrapers. Therefore the two pushers can adequately serve the eleven scrapers.

9. Estimate Production:

Cycles/hour = 60 min ÷ Total cycle time
= 60 min/hr ÷ 6.95 min/cycle
= 8.6 cycles/hr

Estimated load = Heaped capacity × L.F.
= 31 LCY × 0.80
= 24.8 BCY

Hourly unit production = Est. load × cycles/hr
= 24.8 BCY × 8.6 cycles/hr
= 213 BCY/hr

Adjusted production = Efficiency factor × hourly production
= 0.83 (50 min hour) × 213 BCY
= 177 BCY/hr

Hourly fleet production = Unit production × No. of units
= 177 BCY/hr × 11
= 1947 BCY/hr

10. Estimate Compaction:

Compaction requirement = S.F. × hourly fleet production
= 0.85 × 1947 BCY/hr
= 1655 CCY/hr

Compaction capability (given the following):

Compacting width, 7.4 ft	(W)
Average compacting speed, 6 mph	(S)
Compacted lift thickness, 7 in	(L)
No. of passes required, 3	(P)

825G production =

$$\text{CCY/hr} = \frac{W \times S \times L \times 16.3}{P} \text{ (conversion constant)}$$

$$= \frac{7.4 \times 6 \times 7 \times 16.3}{3}$$

= 1688 CCY/hr

Given the compaction requirement of 1655 CCY/hr, the 825G is an adequate compactor match-up for the rest of the fleet. However, any change to job layout that would increase fleet production would upset this balance.

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Example problem (Metric)

A contractor is planning to put the following spread on a dam job. What is the estimated production?

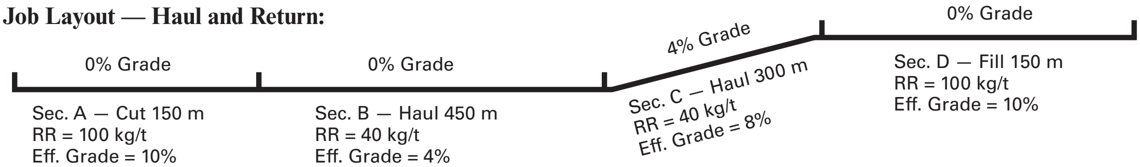
Equipment:

11 — 631G Wheel Tractor-Scrapers
2 — D9T Tractors with C-dozers
2 — 12H Motor Graders
1 — 825G Tamping Foot Compactor

Material:

Description — Sandy clay; damp, natural bed
Bank Density — 1770 kg/BCM
Load Factor — 0.80
Shrinkage Factor — 0.85
Traction Factor — 0.50
Altitude — 2300 meters

Job Layout — Haul and Return:



Total Effective Grade = RR (%) ± GR (%)
Sec. A: Total Effective Grade = 10% + 0% = 10%
Sec. B: Total Effective Grade = 4% + 0% = 4%
Sec. C: Total Effective Grade = 4% + 4% = 8%
Sec. D: Total Effective Grade = 10% + 0% = 10%

1. Estimate Payload:
Est. load (LCM) × L.F. × Bank Density = payload
24 LCM × 0.80 × 1770 kg/BCM = 34 000 kg payload

2. Machine Weight:
Empty Wt. — 46 475 kg or 46.48 metric tons
Wt. of Load — 34 000 kg or 34 metric tons
Total (GMW) — 80 475 kg or 80.48 metric tons

3. Calculate Usable Pull (traction limitation):
Loaded: (weight on driving wheels = 54%) (GMW)
Traction Factor × Wt. on driving wheels =
0.50 × 80 475 kg × 54% = 21 728 kg
Empty: (weight on driving wheels = 69%) (GMW)
Traction Factor × Wt. on driving wheels =
0.50 × 46 475 kg × 69% = 16 034 kg

4. Derate for Altitude:
Check power available at 2300 m from altitude deration table in the Tables Section.
631G — 100% 12H — 83%
D9T — 100% 825G — 100%

Then adjust if necessary:
Load Time — controlled by D9T, at 100% power, no change.
Travel, Maneuver and Spread time — 631G, no change.

5. Compare Total Resistance to Tractive Effort on haul:
Grade Resistance —
GR = 10 kg/metric ton × tons × adverse grade in percent
Sec. C: = 10 kg/metric ton × 80.48 metric tons × 4% grade = 3219 kg

Rolling Resistance —
RR = RR Factor (kg/mton) × GMW (metric tons)
Sec. A: = 100 kg/metric ton × 80.48 metric tons = 8048 kg
Sec. B: = 40 kg/metric ton × 80.48 metric tons = 3219 kg
Sec. C: = 40 kg/metric ton × 80.48 metric tons = 3219 kg
Sec. D: = 100 kg/metric ton × 80.48 metric tons = 8048 kg

Total Resistance —
TR = RR + GR

Sec. A:	= 8048 kg	+	0	= 8048 kg
Sec. B:	= 3219 kg	+	0	= 3219 kg
Sec. C:	= 3219 kg	+	3219 kg	= 6438 kg
Sec. D:	= 8048 kg	+	0	= 8048 kg

Check usable kilogram force against maximum kilogram force required to move the 631G.
Force usable … 21 728 kg loaded
Force required … 8048 kg maximum total resistance

Estimate travel time for haul from 631G (loaded) travel time curve; read travel time from distance and effective grade.

Travel time (from curves):
Sec. A: 0.60 min
Sec. B: 1.00
Sec. C: 1.20
Sec. D: 0.60
3.40 min

NOTE: This is an estimate only; it *does not account for all the acceleration and deceleration tim*e, therefore it is not as accurate as the information obtained from a computer program.

6. Compare Total Resistance to Tractive Effort on return:
Grade Assistance —
GA = 10 kg/mton × metric tons × negative grade in percent
Sec. C: = 10 kg/metric ton × 46.48 metric tons × 4% grade = 1859 kg

Rolling Resistance —

RR = RR Factor × Empty Wt.

Sec. D: = 100 kg/metric ton × 46.48 metric tons
= 4648 kg
Sec. C: = 40 kg/metric ton × 46.48 metric tons
= 1859 kg
Sec. B: = 40 kg/metric ton × 46.48 metric tons
= 1859 kg
Sec. A: = 100 kg/metric ton × 46.48 metric tons
= 4648 kg

Total Resistance —

TR = RR – GA

Sec. D: = 4648 kg – 0 = 4648 kg
Sec. C: = 1859 kg – 1859 kg = 0
Sec. B: = 1859 kg – 0 = 1859 kg
Sec. A: = 4648 kg – 0 = 4648 kg

Check usable kilogram force against maximum force required to move the 631G.

Kilogram force usable … 16 034 kg empty
Kilogram force required … 4645 kg

Estimate travel time for return from 631G empty travel time curve.

Travel time (from curves):

Sec. A: 0.40 min
Sec. B: 0.55
Sec. C: 0.80
Sec. D: 0.40
2.15 min

7. Estimate Cycle Time:

Total Travel Time (Haul plus Return)	=	5.55 min
Adjusted for altitude: 100% × 5.55 min	=	5.55 min
Load Time		0.7 min
Maneuver and Spread Time		0.7 min
Total Cycle Time		6.95 min

8. Check pusher-scraper combinations:

Pusher cycle time consists of load, boost, return and maneuver time. Where actual job data is not available, the following may be used.

Boost time = 0.10 minute
Return time = 40% of load time
Maneuver time = 0.15 minute
Pusher cycle time = 140% of load time + 0.25 minute
Pusher cycle time = 140% of 0.7 min + 0.25 minute
= 0.98 + 0.25 = 1.23 minute

Scraper cycle time divided by pusher cycle time indicates the number of scrapers which can be handled by each pusher.

$$\frac{6.95\text{ min}}{1.23\text{ min}} = 5.65$$

Each push tractor is capable of handling five plus scrapers. Therefore the two pushers can adequately serve the eleven scrapers.

9. Estimate Production:

Cycles/hour = 60 min ÷ Total cycle time
= 60 min/hr ÷ 6.95 min/cycle
= 8.6 cycles/hr

Estimated load = Heaped capacity × L.F.
= 24 LCM × 0.80
= 19.2 BCM

Hourly unit production = Est. load × cycles/hr
= 19.2 BCM × 8.6 cycles/hr
= 165 BCM

Adjusted production = Efficiency factor × hourly production
= 0.83 (50 min hour) × 165 BCM
= 137 BCM/hour

Hourly fleet production = Unit production × No. of units
= 137 BCM/hr × 11 units
= 1507 BCM/hr

10. Estimate Compaction:

Compaction requirement = S.F. × hourly fleet production
= 0.85 × 1507 BCM/hr
= 1280 CCM/hr

Compaction capability (given the following):

Compacting width, 2.26 m	(W)
Average compacting speed, 9.6 km/h	(S)
Compacted lift thickness, 18 cm	(L)
No. of passes required, 3	(P)

825G production =

$$\text{CCY/hr} = \frac{W \times S \times L \times 10}{P} \text{ (conversion factor)}$$

$$= \frac{2.26 \times 9.6 \times 18 \times 10}{3}$$

$$= 1302$$

Given the compaction requirement of 1280 CCM/h, the 825G is an adequate compactor match-up for the rest of the fleet. However, any change to job layout that would increase fleet production would upset this balance.

PRODUCTION ESTIMATING

Loading Match — Loading tools have a production range that varies with material, bucket configuration, target size, operator skill and load area conditions. The loader/truck matches given in the following table are with the typical number of passes and production range.

Your Cat® dealer can provide advice and estimates based on your specific conditions.

FUEL CONSUMPTION AND PRODUCTIVITY

Fuel efficiency is the term used to relate fuel consumption and machine productivity. It is expressed in units of material moved per volume of fuel consumed. Common units are cubic meters or tonnes per liter of fuel (cubic yards or tons/gal). Determining fuel efficiency requires measuring both fuel consumption and production.

Measuring fuel consumption involves tapping into the vehicle's fuel supply system — without contaminating the fuel. The amount of fuel consumed during operation is then measured on a weight or volumetric basis and correlated with the amount of work the machine has done. Cat machines equipped with VIMS™ system can record fuel consumed with relative accuracy, given the engine is performing close to specifications.

Cat Earthmoving and Mining Systems Production/50 Min. Hr.

Please refer to the individual machine section for production targets.

Cat Aggregate Systems Production/50 Min. Hr.

Please refer to the individual machine section for production targets.

FORMULAS AND RULES OF THUMB

Production, hourly = Load (BCM)/cycle × cycles/hr
= Load (BCY)/cycle × cycles/hr

Load Factor (L.F.) $= \dfrac{100\%}{100\% + \%\ \text{swell}}$

Load (bank measure) = Loose cubic meters (LCM) × L.F.
= Loose cubic yards (LCY) × L.F.

Shrinkage Factor (S.F.) $= \dfrac{\text{Compacted cubic meters (or yards)}}{\text{Bank cubic meters (or yards)}}$

Density = Weight/Unit Volume

Load (bank measure) $= \dfrac{\text{Weight of load}}{\text{Bank density}}$

Rolling Resistance Factor
= 20 kg/t + (6 kg/t/cm × cm)
= 40 lb/ton + (30 lb/ton/inch × inches)

Rolling Resistance
= RR Factor (kg/t) × GMW (tons)
= RR Factor (lb/ton) × GMW (tons)

Rolling Resistance (general estimation)
= 2% of GMW + 0.6% of GMW per cm tire penetration
= 2% of GMW + 1.5% of GMW per inch tire penetration

$$\%\ \text{Grade} = \frac{\text{vertical change in elevation (rise)}}{\text{corresponding horizontal distance (run)}}$$

Grade Resistance Factor = 10 kg/m ton × % grade
= 20 lb/ton × % grade

Grade Resistance = GR Factor (kg/t) × GMW (tons)
= GR Factor (lb/ton) × GMW (tons)

Grade Resistance = 1% of GMW × % grade

Total Resistance
= Rolling Resistance (kg or lb) + Grade Resistance (kg or lb)

Total Effective Grade (%) = RR (%) + GR (%)

Usable pull (traction limitation)
= Coeff. of traction × weight on drivers
= Coeff. of traction × (Total weight × % on drivers)

Pull required = Rolling Resistance + Grade Resistance
= Total Resistance

Total Cycle Time = Fixed time + Variable time

Fixed time: See respective machine production section.

Variable time = Total haul time + Total return time

$$\textit{Travel Time} = \frac{\text{Distance (m)}}{\text{Speed (m/min)}} = \frac{\text{Distance (ft)}}{\text{Speed (fpm)}}$$

$$\textit{Cycles per hour} = \frac{\text{60 min/hr}}{\text{Total cycle time (min/cycle)}}$$

Adjusted production = Hourly production × Efficiency factor

$$\textit{No. of units required} = \frac{\text{Hourly production required}}{\text{Unit hourly production}}$$

$$\textit{No. of scrapers a pusher will load} = \frac{\text{Scraper cycle time}}{\text{Pusher cycle time}}$$

Pusher cycle time (min) = 1.40 Load time (min) + 0.25 min

$$\textit{Grade Horsepower} = \frac{\text{GMW (kg)} \times \text{Total Effective Grade} \times \text{Speed (km/h)}}{273.75} = \frac{\text{GMW (lb)} \times \text{Total Effective Grade} \times \text{Speed (mph)}}{375}$$

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TABLES

CONTENTS

SWELL — VOIDS — LOAD FACTORS

SWELL (%)	VOIDS (%)	LOAD FACTOR
5	4.8	0.952
10	9.1	0.909
15	13.0	0.870
20	16.7	0.833
25	20.0	0.800
30	23.1	0.769
35	25.9	0.741
40	28.6	0.714
45	31.0	0.690
50	33.3	0.667
55	35.5	0.645
60	37.5	0.625
65	39.4	0.606
70	41.2	0.588
75	42.9	0.571
80	44.4	0.556
85	45.9	0.541
90	47.4	0.526
95	48.7	0.513
100	50.0	0.500

Throughout this document, references to Tier 4 Interim/Stage IIIB/Japan 2011 (Tier 4 Interim) include U.S. EPA Tier 4 Interim, EU Stage IIIB, and Japan 2011 (Tier 4 Interim) equivalent emission standards. References to Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) include U.S. EPA Tier 4 Final, EU Stage IV, and Japan 2014 (Tier 4 Final) emission standards.

Throughout this document, references to Tier 1/Stage I include U.S. EPA Tier 1 and EU Stage I equivalent emission standards. References to Tier 2/Stage II/Japan 2001 (Tier 2) equivalent include U.S. EPA Tier 2, EU Stage II, and Japan 2001 (Tier 2) equivalent emission standards. References to Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent include U.S. EPA Tier 3, EU Stage IIIA, and Japan 2006 (Tier 3) equivalent emission standards.

BUCKET FILL FACTORS

Loose Material	Fill Factor
Mixed Moist Aggregates	95-100%
Uniform Aggregates up to 3 mm (1/8")	95-100
3 mm-9 mm (1/8"-3/8")	90-95
12 mm-20 mm (1/2"-3/4")	85-90
24 mm (1") and over	85-90
Blasted Rock	
Well Blasted	80-95%
Average Blasted	75-90
Poorly Blasted	60-75
Other	
Rock Dirt Mixtures	100-120%
Moist Loam	100-110
Soil, Boulders, Roots	80-100
Cemented Materials	85-95

NOTE: Loader bucket fill factors are affected by bucket penetration, breakout force, rack back angle, bucket profile and ground engaging tools such as bucket teeth or bolt-on replaceable cutting edges.

NOTE: For bucket fill factors for hydraulic excavators, see bucket payloads in the hydraulic excavator section.

NOTE: Above values are not valid for Hydraulic Mining Shovels.

ANGLE OF REPOSE OF VARIOUS MATERIALS

MATERIAL	ANGLE BETWEEN HORIZONTAL AND SLOPE OF HEAPED PILE	
	Ratio	Degrees
Coal, industrial	1.4:1—1.3:1	35-38
Common earth, Dry	2.8:1—1.0:1	20-45
Moist	2.1:1—1.0:1	25-45
Wet	2.1:1—1.7:1	25-30
Gravel, Round to angular	1.7:1—0.9:1	30-50
Sand & clay	2.8:1—1.4:1	20-35
Sand, Dry	2.8:1—1.7:1	20-30
Moist	1.8:1—1.0:1	30-45
Wet	2.8:1—1.0:1	20-45

TYPICAL ROLLING RESISTANCE FACTORS

Various tire sizes and inflation pressures will greatly reduce or increase the rolling resistance. The values in this table are approximate, particularly for the track and track + tire machines. These values can be used for estimating purposes when specific performance information on particular equipment and given soil conditions is not available. See Mining and Earthmoving Section for more detail.

UNDERFOOTING	ROLLING RESISTANCE, PERCENT*			
	Tires		Track	Track
	Bias	Radial	**	+Tires
A very hard, smooth roadway, concrete, cold asphalt or dirt surface, no penetration or flexing	1.5%*	1.2%	0%	1.0%
A hard, smooth, stabilized surfaced roadway without penetration under load, watered, maintained	2.0%	1.7%	0%	1.2%
A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered	3.0%	2.5%	0%	1.8%
A dirt roadway, rutted or flexing under load, little maintenance, no water, 25 mm (1") tire penetration or flexing	4.0%	4.0%	0%	2.4%
A dirt roadway, rutted or flexing under load, little maintenance, no water, 50 mm (2") tire penetration or flexing	5.0%	5.0%	0%	3.0%
Rutted dirt roadway, soft under travel, no maintenance, no stabilization, 100 mm (4") tire penetration or flexing	8.0%	8.0%	0%	4.8%
Loose sand or gravel	10.0%	10.0%	2%	7.0%
Rutted dirt roadway, soft under travel, no maintenance, no stabilization, 200 mm (8") tire penetration and flexing	14.0%	14.0%	5%	10.0%
Very soft, muddy, rutted roadway, 300 mm (12") tire penetration, no flexing	20.0%	20.0%	8%	15.0%

*Percent of combined machine weight.

**Assumes drag load has been subtracted to give Drawbar Pull for good to moderate conditions. Some resistance added for very soft conditions.

WEIGHT* OF MATERIALS	LOOSE		BANK		LOAD FACTORS
	kg/m³	lb/yd³	kg/m³	lb/yd³	
Basalt	1960	**3300**	2970	**5000**	0.67
Bauxite, Kaolin	1420	**2400**	1900	**3200**	0.75
Caliche	1250	**2100**	2260	**3800**	0.55
Carnotite, uranium ore	1630	**2750**	2200	**3700**	0.74
Cinders	560	**950**	860	**1450**	0.66
Clay — Natural bed	1660	**2800**	2020	**3400**	0.82
Dry	1480	**2500**	1840	**3100**	0.81
Wet	1660	**2800**	2080	**3500**	0.80
Clay & gravel — Dry	1420	**2400**	1660	**2800**	0.85
Wet	1540	**2600**	1840	**3100**	0.85
Coal — Anthracite, Raw	1190	**2000**	1600	**2700**	0.74
Washed	1100	**1850**			0.74
Ash, Bituminous Coal	530-650	**900-1100**	590-890	**1000-1500**	0.93
Bituminous, Raw	950	**1600**	1280	**2150**	0.74
Washed	830	**1400**			0.74
Decomposed rock —					
75% Rock, 25% Earth	1960	**3300**	2790	**4700**	0.70
50% Rock, 50% Earth	1720	**2900**	2280	**3850**	0.75
25% Rock, 75% Earth	1570	**2650**	1960	**3300**	0.80
Earth — Dry packed	1510	**2550**	1900	**3200**	0.80
Wet excavated	1600	**2700**	2020	**3400**	0.79
Loam	1250	**2100**	1540	**2600**	0.81
Granite — Broken	1660	**2800**	2730	**4600**	0.61
Gravel — Pitrun	1930	**3250**	2170	**3650**	0.89
Dry	1510	**2550**	1690	**2850**	0.89
Dry 6-50 mm (1/4"-2")	1690	**2850**	1900	**3200**	0.89
Wet 6-50 mm (1/4"-2")	2020	**3400**	2260	**3800**	0.89
Gypsum — Broken	1810	**3050**	3170	**5350**	0.57
Crushed	1600	**2700**	2790	**4700**	0.57
Hematite, iron ore, high grade	1810-2450	**4000-5400**	2130-2900	**4700-6400**	0.85
Limestone — Broken	1540	**2600**	2610	**4400**	0.59
Crushed	1540	**2600**	—	**—**	—
Magnetite, iron ore	2790	**4700**	3260	**5500**	0.85
Pyrite, iron ore	2580	**4350**	3030	**5100**	0.85
Sand — Dry, loose	1420	**2400**	1600	**2700**	0.89
Damp	1690	**2850**	1900	**3200**	0.89
Wet	1840	**3100**	2080	**3500**	0.89
Sand & clay — Loose	1600	**2700**	2020	**3400**	0.79
Compacted	2400	**4050**			
Sand & gravel — Dry	1720	**2900**	1930	**3250**	0.89
Wet	2020	**3400**	2230	**3750**	0.91
Sandstone	1510	**2550**	2520	**4250**	0.60
Shale	1250	**2100**	1660	**2800**	0.75
Slag — Broken	1750	**2950**	2940	**4950**	0.60
Snow — Dry	130	**220**			
Wet	520	**860**			
Stone — Crushed	1600	**2700**	2670	**4500**	0.60
Taconite	1630-1900	**3600-4200**	2360-2700	**5200-6100**	0.58
Top Soil	950	**1600**	1370	**2300**	0.70
Taprock — Broken	1750	**2950**	2610	**4400**	0.67
Wood Chips**	—	**—**	—	**—**	—

*Varies with moisture content, grain size, degree of compaction, etc. Tests must be made to determine exact material characteristics.

**Weights of commercially important wood species can be found in the last pages of the Logging & Forest Products section. To obtain wood weights use the following equations: $lb/yd^3 = (lb/ft^3) \times .4 \times 27$

$kg/m^3 = (kg/m^3) \times .4$

ALTITUDE DERATION

PERCENT FLYWHEEL HORSEPOWER AVAILABLE AT SPECIFIED ALTITUDES

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
D3K XL	100	100	100	100	88	85
D3K LGP	100	100	100	100	88	85
D4K XL	100	100	100	100	88	85
D4K LGP	100	100	100	100	88	85
D5K XL	100	100	100	100	88	85
D5K LGP	100	100	100	100	88	85
D5R2 XL & LGP	100	100	100	100	N/A	N/A
D5T XL	100	100	100	100	N/A	N/A
D6K2 XL & LGP	100	100	100	100	N/A	N/A
D6N XL & LGP*	100	100	100	100	100	100
D6R Series 3 (All)	100	100	100	100	92	84
D6R2	100	100	100	100	92	84
D6T[1]	100	100	100	100	100	100
D7E	100	100	100	100	99	95
D7R	100	100	100	100	100	96
D8R	100	100	100	93	85	77
D8T	100	100	100	100	100	100
D9R	100	100	100	93	85	77
D9T[1]	100	100	100	100	100	100
D9T[2]	100	100	100	99	92	83
D9T[3]	100	100	100	100	100	100
D9T[4]	100	100	100	98	91	80
D9T[5]	100	100	100	100	99	88
D10T2[5]**	100	100	100	100	100	100
D10T2[6]**	100	100	100	100	100	100
D11T/D11T CD[5]***	100	100	100	100	100	86
D11T/D11T CD[6]***	100	100	100	100	83	67

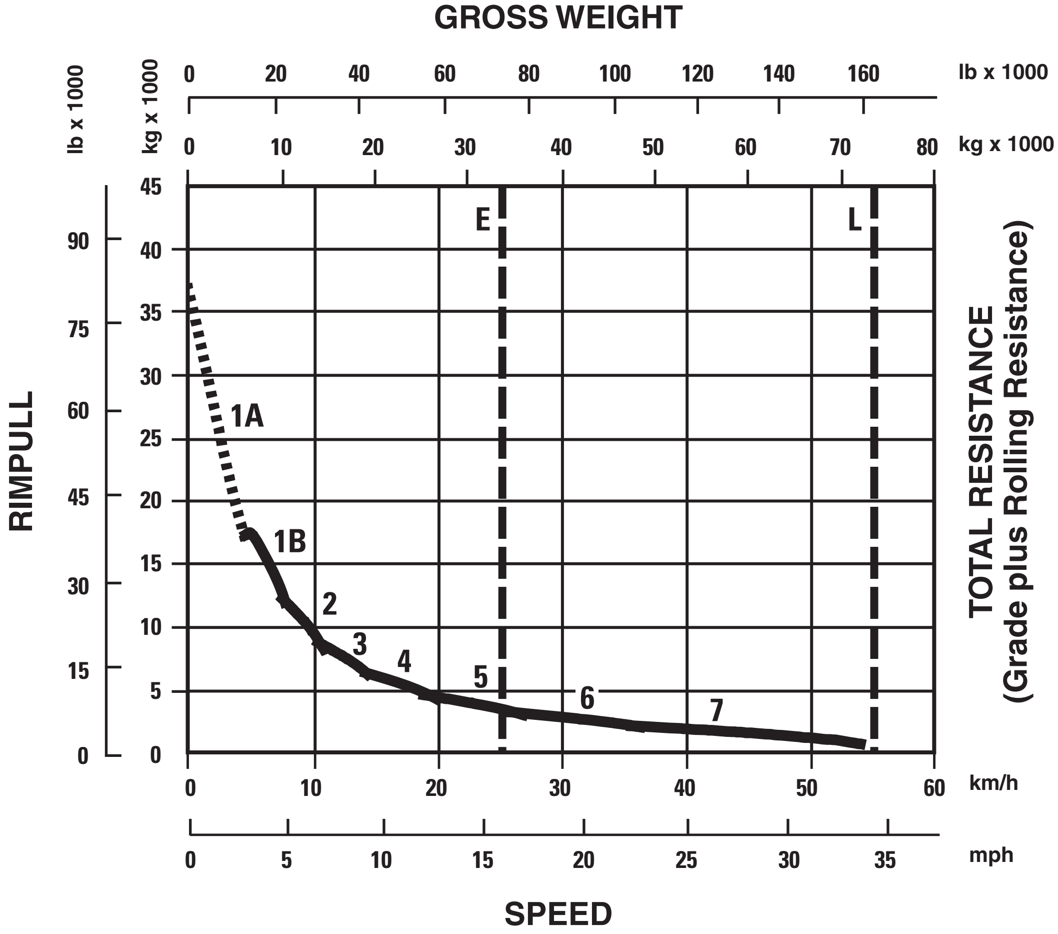
*Information not available at time of printing.
**In forward gears.
***D11T — High altitude arrangement available.
[1] Meets Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.
[2] Meets Tier 3 equivalent emission standards, North America — Standard Altitude.
[3] Meets Tier 3 equivalent emission standards, North America — High Altitude.
[4] Meets Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.
[5] Meets Tier 2/Stage II/Japan 2001 (Tier 2) equivalent emission standards.
[6] Meets Tier 4 Final.

ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
120K	100	100	100	97	92	85
120K2	100	100	100	97	92	85
120M	100	100	100	100	95	88
120M AWD	100	98	96	94	89	85
120M2	100	100	100	100	94	82
120M2 AWD	100	100	100	100	94	82
12K	100	99	98	94	89	85
12M	100	100	100	100	95	88
12M2	100	100	100	100	100	100
12M2 AWD	100	100	100	100	100	99
12M3	100	100	100	100	100	100
12M3 AWD	100	100	100	100	100	98
140K	100	100	100	100	92	90
140K2	100	100	100	100	92	90
140M	100	100	100	100	92	90
140M AWD	100	100	100	100	92	90
140M2	100	100	100	100	100	99
140M2 AWD	100	100	100	100	97	93
140M3	100	100	100	100	100	98
140M3 AWD	100	100	100	100	100	90
160K	100	100	100	100	92	90
160M	100	100	100	100	92	90
160M AWD	100	100	100	100	92	90
160M2	100	100	100	99	95	91
160M2 AWD	100	100	100	99	94	88
160M3	100	100	100	100	100	90
160M3 AWD	100	100	100	100	98	83
14M3*	100	100	100	100	100	97
14M3**	100	100	100	100	100	100
14M3***	100	100	100	100	100	100
16M3*	100	100	100	100	100	100
16M3**	100	100	100	100	100	95
16M3***	100	100	100	100	100	100
18M3*	100	100	100	100	100	100
18M3**	100	100	100	100	100	95
18M3***	100	100	100	100	100	100
24M B9K**	100	100	95	90	80	70
24M B9K Unregulated	100	100	100	100	90	85
24M B93**	100	100	100	98	89	75
24M B93*	100	100	100	100	91	86

*Meets Tier 2/Stage II/Japan 2001 (Tier 2) equivalent emission standards.
**Meets Tier 3/Stage IIIA/Japan 2006 (Tier 3) equivalent emission standards.
***Meets Tier 4 Final/Stage IV/Japan 2014 (Tier 4 Final) emission standards.

STANDARD*



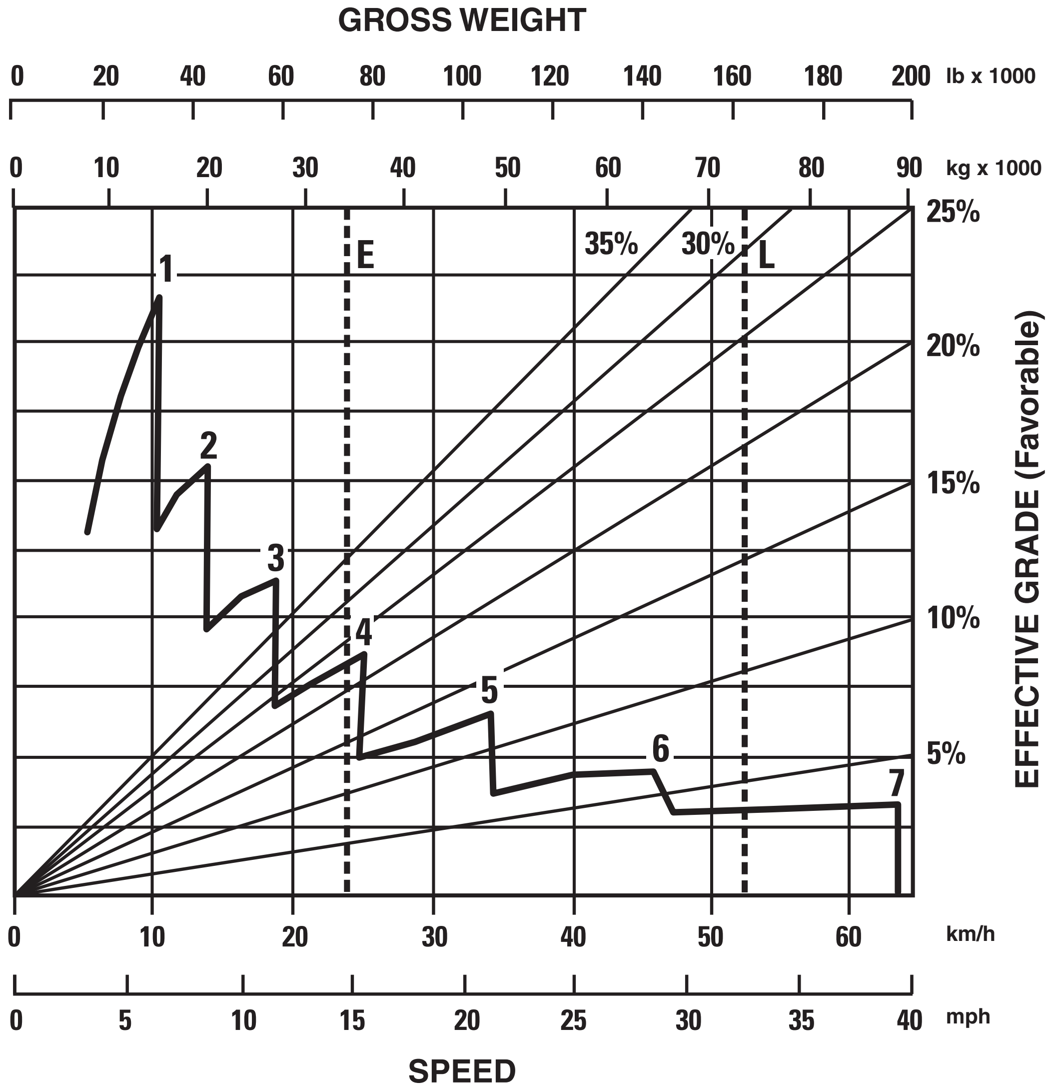
KEY

1A — 1st Gear (Converter Drive)
1B — 1st Gear (Direct Drive)
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

E — Empty 34 393 kg (75,824 lb)
L — Loaded 73 975 kg (163,087 lb)

*At sea level.



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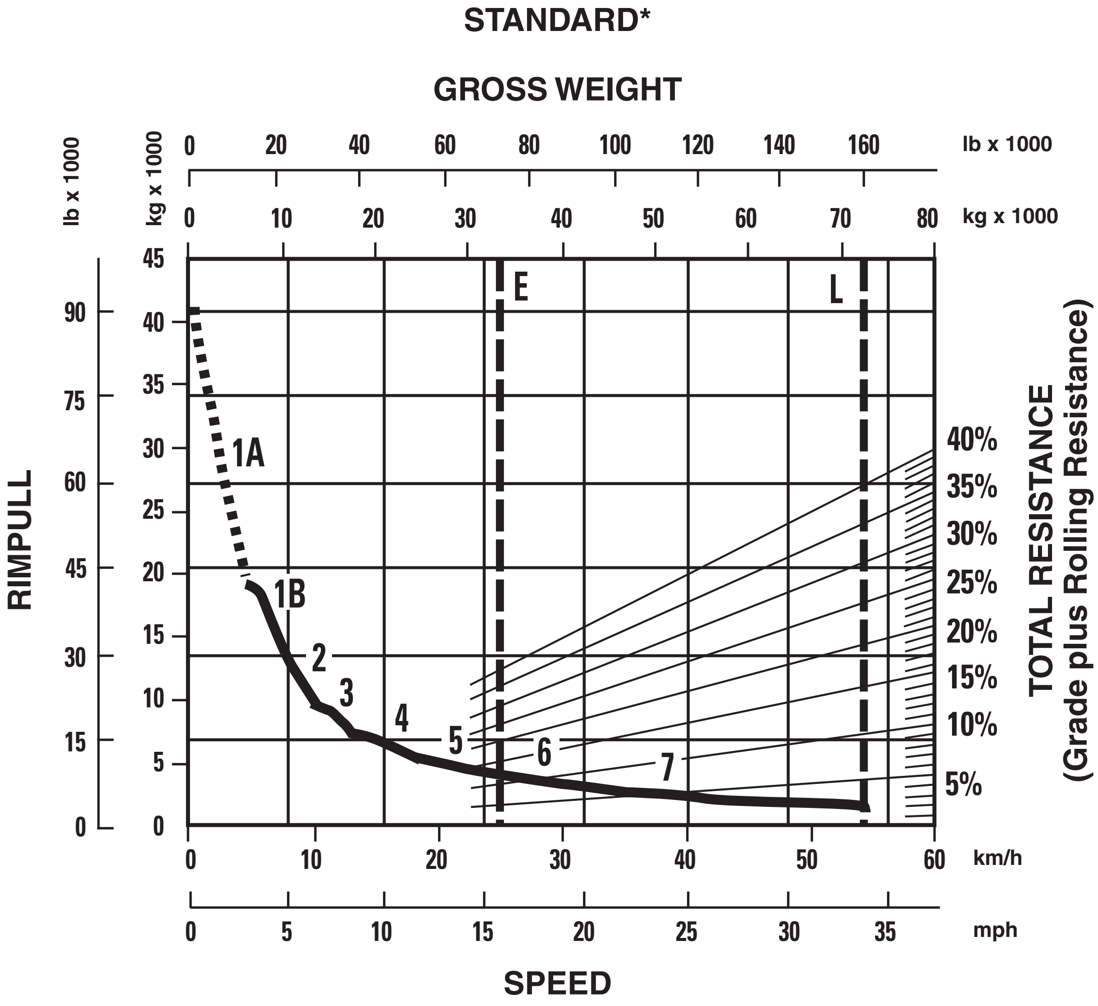

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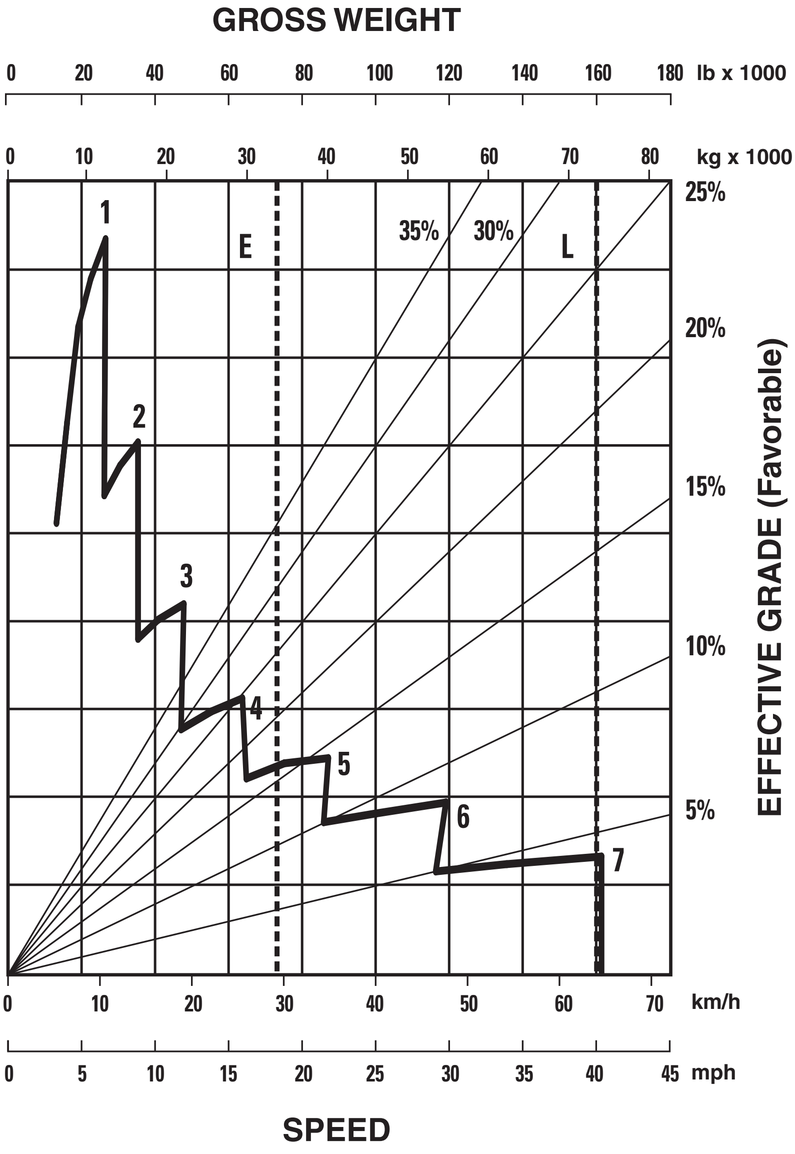
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

E — Empty 34 127 kg (75,237 lb)
L — Loaded 73 709 kg (162,500 lb)

*At sea level.

740B Series Brake/Retarder Performance Curve
- 29.5R25 Tires
- Tier 2



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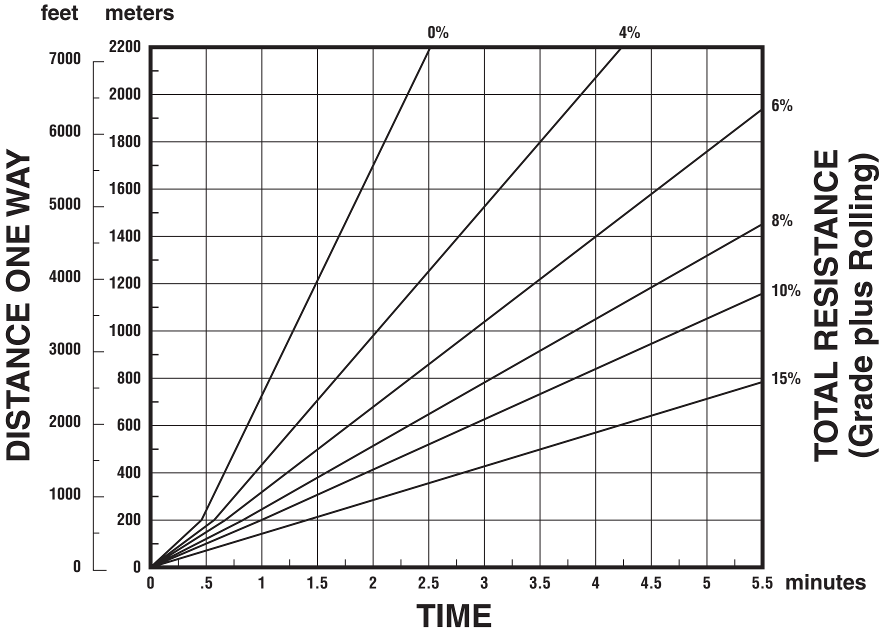
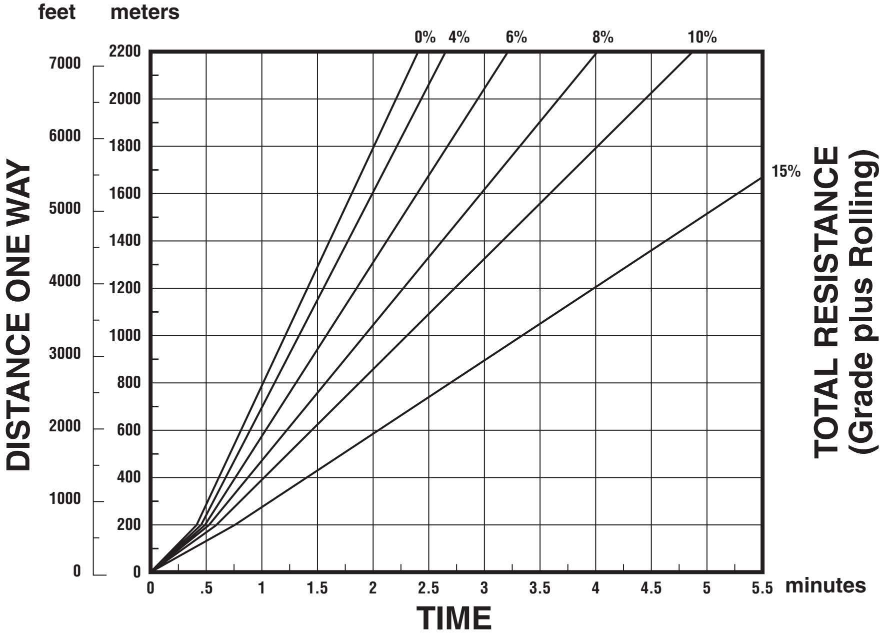
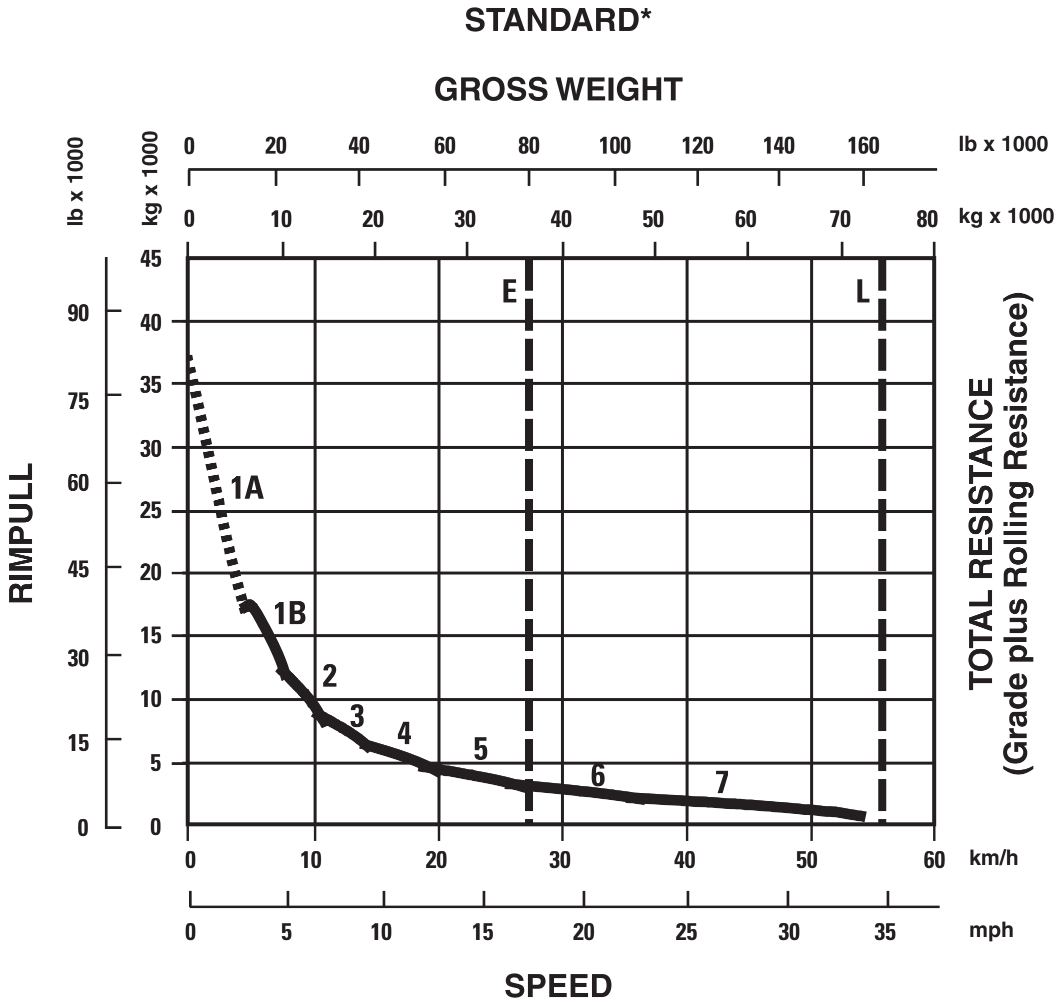
L — Loaded 73 709 kg (162,500 lb)

LOADED



EMPTY





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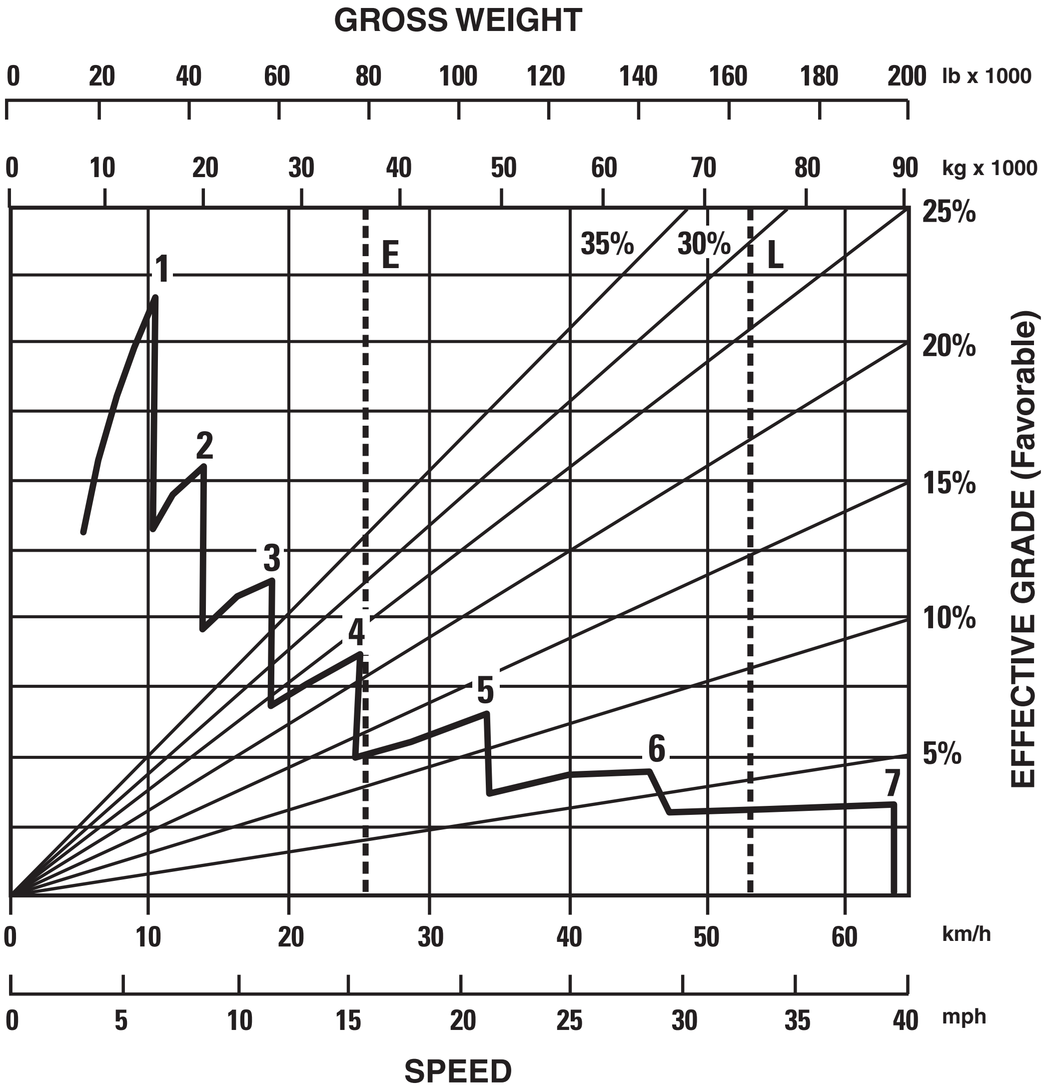
1B — 1st Gear (Direct Drive)
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

E — Empty 36 895 kg (81,340 lb)
L — Loaded 74 895 kg (165,115 lb)

*At sea level.



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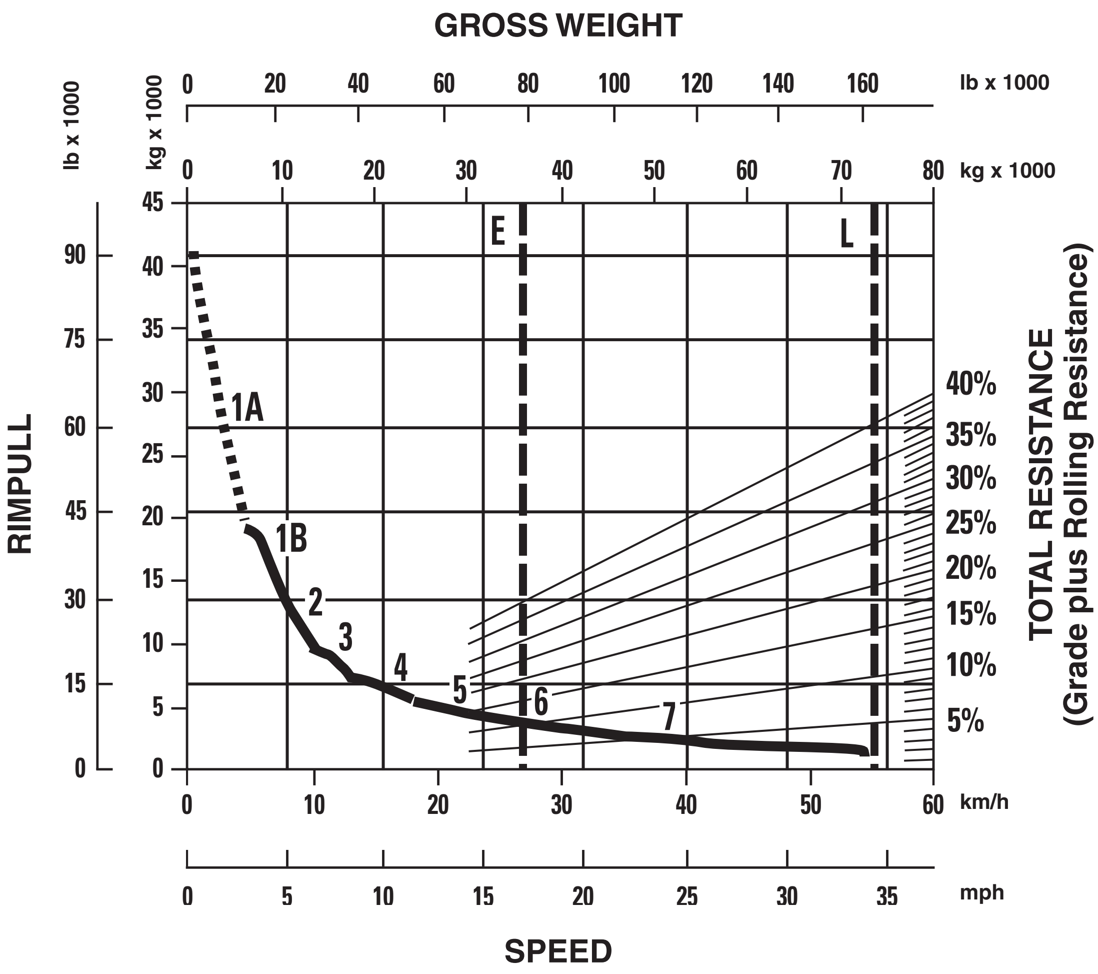
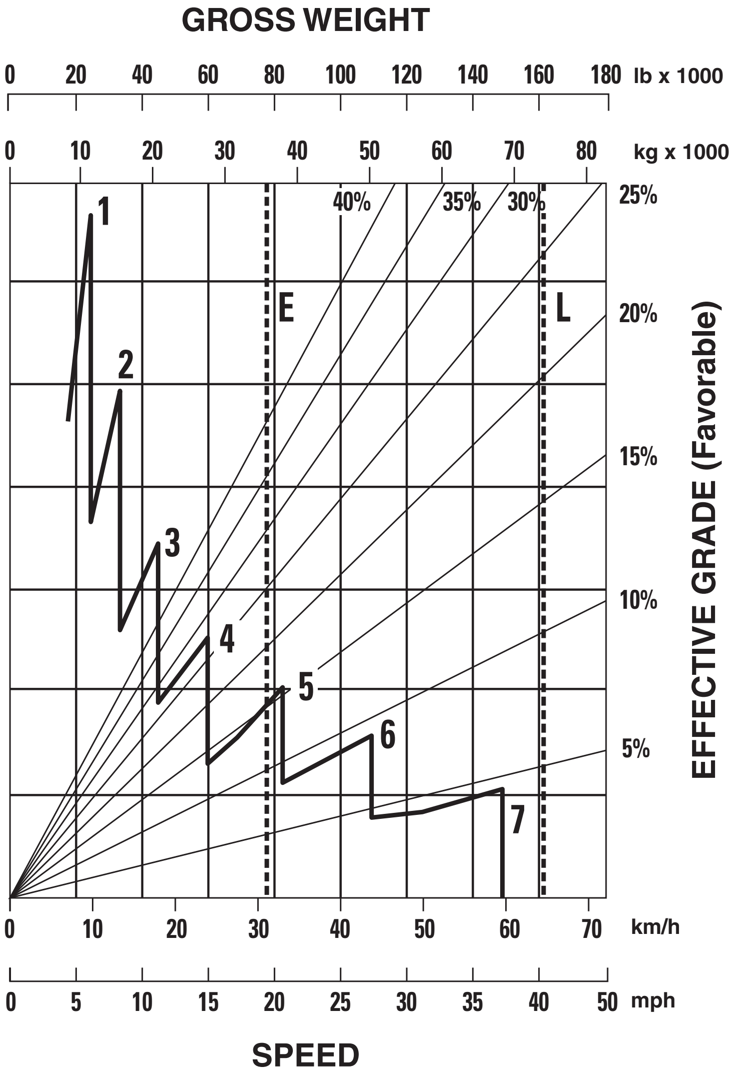
STANDARD*



KEY	
1A	1st Gear (Converter Drive)
1B	1st Gear (Direct Drive)
2	2nd Gear
3	3rd Gear
4	4th Gear
5	5th Gear
6	6th Gear
7	7th Gear

KEY	
E	Empty 36 629 kg (80,753 lb)
L	Loaded 74 629 kg (164,529 lb)

*At sea level.



KEY

1 — 1st Gear
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

E — Empty 36 629 kg (80,753 lb)
L — Loaded 74 629 kg (164,529 lb)

MODEL	735B Series		740B Series		740B EJ Series	
Gross Power — SAE J1995	337 kW	**452 hp**	365 kW	**489 hp**	365 kW	**489 hp**
Net Power — SAE J1349	326 kW	**437 hp**	354 kW	**474 hp**	354 kW	**474 hp**
Net Power — ISO 14396	333 kW	**447 hp**	361 kW	**484 hp**	361 kW	**484 hp**
Operating Weight (Empty)*	32 473 kg	**71,591 lb**	34 393 kg	**75,824 lb**	36 895 kg	**81,340 lb**
Top Speed (Loaded)	51.1 km/h	**31.7 mph**	54.7 km/h	**34 mph**	54.7 km/h	**34 mph**
GMW — Gross Machine Weight	65 173 kg	**143,682 lb**	73 975 kg	**163,087 lb**	74 895 kg	**165,115 lb**
Distribution Empty:						
Front	**61.9%**		**60.1%**		**58.0%**	
Center	**20.2%**		**21.0%**		**22.0%**	
Rear	**18.0%**		**18.9%**		**20.0%**	
Distribution Loaded:						
Front	**36.0%**		**35.0%**		**30.8%**	
Center	**33.0%**		**33.0%**		**35.1%**	
Rear	**32.0%**		**32.0%**		**34.1%**	
Max. Capacity**	32.7 t	**36 T**	39.5 t	**43.5 T**	38 t	**42 T**
Struck (SAE)	14.7 m^3	**19.2 yd^3**	18.5 m^3	**24.2 yd^3**	17.8 m^3	**23.3 yd^3**
Heaped (2:1) (SAE)	19.7 m^3	**25.8 yd^3**	24 m^3	**31.4 yd^3**	23.1 m^3	**30.2 yd^3**
Tailgate Heaped SAE 2:1	20.9 m^3	**27.3 yd^3**	25.5 m^3	**33.5 yd^3**	—	
Tailgate Struck	15.2 m^3	**19.9 yd^3**	19.5 m^3	**25.5 yd^3**	—	
Engine Model	**ACERT C15**		**ACERT C15**		**ACERT C15**	
No. Cylinders	**6**		**6**		**6**	
Bore	137 mm	**5.4"**	137 mm	**5.4"**	137 mm	**5.4"**
Stroke	171.5 mm	**6.75"**	171.5 mm	**6.75"**	171.5 mm	**6.75"**
Displacement	15.2 L	**926 in^3**	15.2 L	**926 in^3**	15.2 L	**926 in^3**
Tires, Front, Center, Rear	**26.5R25 Radials**		**29.5R25 Radials**		**29.5R25 Radials**	
Circular Clearance Diameter	17.2 m	**56'5"**	17.2 m	**56'5"**	18.2 m	**59'6"**
Fuel Tank Refill Capacity	565 L	**149.3 U.S. gal**	565 L	**149.3 U.S. gal**	565 L	**149.3 U.S. gal**
General Dimensions (Empty):						
Height to Cab Top	3.7 m	**12'1"**	3.75 m	**12'3"**	3.75 m	**12'3"**
Wheel Base (Front-Center of Bogie)	5.23 m	**17'2"**	5.23 m	**17'2"**	5.58 m	**18'3"**
Overall Length	10.99 m	**36'1"**	10.99 m	**36'1"**	11.69 m	**38'4"**
Loading Height (Empty)	2.98 m	**9'8"**	3.2 m	**10'6"**	3.07 m	**10'1"**
Height at Full Dump	6.81 m	**22'4"**	7.1 m	**23'4"**	—	
Body Length	6.09 m	**20'0"**	6.3 m	**20'6"**	6.73 m	**22'1"**
Width (Operating — Over Mirrors)	3.82 m	**12'6"**	3.82 m	**12'6"**	3.82 m	**12'6"**
Front Tire Tread	2.69 m	**8'8"**	2.69 m	**8'8"**	2.69 m	**8'8"**

*Includes coolant, lubricant and full fuel tank.
**Rating dependent on optional equipment. Maximum gross weight (empty weight plus payload) should not be exceeded.

MODEL	**735B Series**		**740B Series**		**740B EJ Series**	
Gross Power — SAE J1995	336 kW	**450 hp**	361 kW	**484 hp**	361 kW	**484 hp**
Net Power — SAE J1349	326 kW	**438 hp**	352 kW	**472 hp**	352 kW	**472 hp**
Net Power — ISO 9249	330 kW	**442 hp**	356 kW	**477 hp**	356 kW	**477 hp**
Net Power — EEC 80/1269	330 kW	**442 hp**	356 kW	**477 hp**	356 kW	**477 hp**
Operating Weight (Empty)*	32 206 kg	**71,002 lb**	34 127 kg	**75,237 lb**	36 629 kg	**80,753 lb**
Top Speed (Loaded)	51.1 km/h	**31.7 mph**	54.7 km/h	**34 mph**	54.7 km/h	**34 mph**
GMW — Gross Machine Weight	64 906 kg	**143,093 lb**	73 709 kg	**162,500 lb**	74 629 kg	**164,529 lb**
Distribution Empty:						
Front	**61.2%**		**59.5%**		**57.4%**	
Center	**20.5%**		**21.3%**		**22.3%**	
Rear	**18.3%**		**19.2%**		**20.3%**	
Distribution Loaded:						
Front	**35.6%**		**34.6%**		**30.4%**	
Center	**32.8%**		**33.2%**		**35.3%**	
Rear	**31.7%**		**32.2%**		**34.3%**	
Max. Capacity**	32.7 t	**36 T**	39.5 t	**43.5 T**	38 t	**42 T**
Struck (SAE)	14.7 m^3	**19.2 yd^3**	18.5 m^3	**24.2 yd^3**	17.8 m^3	**23.3 yd^3**
Heaped (2:1) (SAE)	19.7 m^3	**25.8 yd^3**	24 m^3	**31.4 yd^3**	23.1 m^3	**30.2 yd^3**
Tailgate Heaped SAE 2:1	20.9 m^3	**27.3 yd^3**	25.5 m^3	**33.5 yd^3**	**—**	
Tailgate Struck	15.2 m^3	**19.9 yd^3**	19.5 m^3	**25.5 yd^3**	**—**	
Engine Model	**ACERT C15**		**ACERT C15**		**ACERT C15**	
No. Cylinders	**6**		**6**		**6**	
Bore	137 mm	**5.4"**	137 mm	**5.4"**	137 mm	**5.4"**
Stroke	171.5 mm	**6.75"**	171.5 mm	**6.75"**	171.5 mm	**6.75"**
Displacement	15.2 L	**926 in^3**	15.2 L	**926 in^3**	15.2 L	**926 in^3**
Tires, Front, Center, Rear	**26.5R25 Radials**		**29.5R25 Radials**		**29.5R25 Radials**	
Circular Clearance Diameter	17.2 m	**56'5"**	17.2 m	**56'5"**	18.2 m	**59'6"**
Fuel Tank Refill Capacity	565 L	**149.3 U.S. gal**	565 L	**149.3 U.S. gal**	565 L	**149.3 U.S. gal**
General Dimensions (Empty):						
Height to Cab Top	3.7 m	**12'1"**	3.75 m	**12'3"**	3.75 m	**12'3"**
Wheel Base (Front-Center of Bogie)	5.23 m	**17'2"**	5.23 m	**17'2"**	5.58 m	**18'3"**
Overall Length	10.99 m	**36'1"**	10.99 m	**36'1"**	11.69 m	**38'4"**
Loading Height (Empty)	2.98 m	**9'8"**	3.2 m	**10'6"**	3.07 m	**10'1"**
Height at Full Dump	6.81 m	**22'4"**	7.1 m	**23'4"**	**—**	
Body Length	6.09 m	**20'0"**	6.3 m	**20'6"**	6.73 m	**22'1"**
Width (Operating — Over Mirrors)	3.82 m	**12'6"**	3.82 m	**12'6"**	3.82 m	**12'6"**
Front Tire Tread	2.69 m	**8'8"**	2.69 m	**8'8"**	2.69 m	**8'8"**

*Includes coolant, lubricant and full fuel tank.
**Rating dependent on optional equipment. Maximum gross weight (empty weight plus payload) should not be exceeded.

MODEL	777D†		777F	
Body Type	**Dual Slope Lined**		**Dual Slope Lined**	
Target Gross Machine Weight §	163 360 kg	**360,143 lb**	163 293 kg	**360,000 lb**
Basic Machine Weight*	33 951 kg	**74,849 lb**	33 438 kg	**73,718 lb**
Attachments**	17 377 kg	**38,310 lb**	17 114 kg	**37,730 lb**
Body Weight without Liners***	16 070 kg	**35,428 lb**	16 420 kg	**36,200 lb**
Full Liner	5432 kg	**11,975 lb**	5767 kg	**12,714 lb**
Operating Machine Weight	72 830 kg	**160,562 lb**	72 739 kg	**160,360 lb**
Debris (2% of Operating Machine Weight)	1457 kg	**3211 lb**	1455 kg	**3207 lb**
Empty Operating Weight	74 287 kg	**163,774 lb**	74 194 kg	**163,568 lb**
Target Payload §	90.9 m tons	**100 tons**	90.7 m tons	**100 tons**
Capacity:				
Heaped (2:1) (SAE) Base Body	60.1 m^3	**78.6 yd^3**	60.2 m^3	**78.8 yd^3**
Distribution Empty:				
Front	**47%**		**45%**	
Rear	**53%**		**55%**	
Distribution Loaded:				
Front	**33%**		**33%**	
Rear	**67%**		**67%**	
Engine Model	**3508B EUI**		**C32 ACERT**	
Number of Cylinders	**8**		**12**	
Bore	170 mm	**6.7"**	145 mm	**5.7"**
Stroke	190 mm	**7.5"**	162 mm	**6.4"**
Displacement	34.5 L	**2105 in^3**	32.1 L	**1959 in^3**
Net Power	699 kW	**938 hp**	700 kW	**938 hp**
Gross Power	746 kW	**1000 hp**	758 kW	**1016 hp**
Standard Tires	**27.00-R49 (E4)**		**27.00R49 (E4)**	
Machine Clearance Turning Circle	28.4 m	**93'2"**	28.4 m	**93'2"**
Fuel Tank Refill Capacity	1137 L	**300 U.S. gal**	1136 L	**300 U.S. gal**
Top Speed (Loaded)	60.4 km/h	**39.9 mph**	64.5 km/h	**40.1 mph**
GENERAL DIMENSIONS (Empty):				
Height to Canopy Rock Guard Rail	5.14 m	**16'10"**	5.17 m	**17'0"**
Wheelbase	4.57 m	**15'0"**	4.56 m	**15'0"**
Overall Length (Base Body)	9.78 m	**32'1"**	10.54 m	**34'7"**
Loading Height (Base Body)	4.38 m	**14'4"**	4.38 m	**14'4"**
Height at Full Dump	10.06 m	**33'0"**	10.33 m	**33'11"**
Body Length (Target Length)	7.23 m	**23'9"**	9.83 m	**32'3"**
Width (Operating)	6.11 m	**20'0"**	6.49 m	**21'4"**
Width (Shipping)***	3.51 m	**11'5"**	3.51 m	**11'5"**
Front Tire Tread	4.17 m	**13'8"**	4.17 m	**13'8"**

*See Weight Definitions and Relations on 9-11. Note: No mandatory or optional attachments or fuel.
**Typical selection of mandatory and optional attachments.
***Data provided is for a representative body and liner package. Several dual slope, flat floor, and mine specific design (MSD) bodies and liner packages are available. All weights, capacities, and dimensions are dependent on the machine configuration (body type, attachments, tires, and optional equipment selected).
§ Reference Caterpillar's latest 10/10/20 Payload Policy for information on gross machine operating weight and target payload.
† India sourced, only available in Asia Pacific.

Appendix D.5

Direct Quotes

Fred Charles

From: Fawcett, Clayton <CFawcett@conteches.com>
Sent: Tuesday, February 5, 2019 9:25 AM
To: Fred Charles
Subject: RE: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Fred,

Hello and good morning. I hope this message finds you doing well. I made it back in to the office this morning and saw your e-mails.

Material and installation costs we discussed in September are still good. Please feel free to use those to complete your estimate.

Regarding your questions:

1 Yes, installation costs are the same for both downchutes and dissipator basins.
2 Yes, installation cost does include crushed stone infill (purchase and install)

Regarding your follow up e-mail with questions pertaining to cut-off walls.

1 Cut-off walls are not always required, however they are a good idea. The use of cut-off walls has increased in the last five years and as such, they are now recommended for inclusion at dissipator basins.
2 Material and installation costs for the installation of a cut-off wall <u>are not</u> included in the costs previously discussed and should be added.

I hope this information helps. Feel free to contact me directly with any additional questions.

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Fred Charles [mailto:fcharles@telesto-inc.com]
Sent: Sunday, February 3, 2019 3:28 PM
To: Fawcett, Clayton <CFawcett@conteches.com>
Subject: confirm or update costs for ACBs (reply requested by end of day Monday Feb 4, if possible)

Hi Clayton. This email is a follow up to our email correspondence in September 2018 regarding material and installation costs for articulated concrete blocks (ACBs) used for downdrains at Chino. We've been using the cost info you passed along to me at that time. Now, I need you to confirm those costs or update them. We will use this information in a reclamation cost estimate (financial assurance for closure bonding) which we are currently finalizing for Chino and other mines in that area.

<u>Costs</u>
As we had discussed, the material costs for ACBs (includes non-woven geotextile and microgrid/geogrid) are as follows:

- $7.42/square foot (Block Class 40T, for the channel of each downdrain)

- $10.65/square foot (Block Class 70T, for the dissipation basin at bottom of each downdrain)

Also, you quoted $4.63/square foot for installation costs, which covers the following installation process: off-load the truck and place delivered ACBs in temporary storage area, fine grade base/subgrade soils, compact soils to 90% Standard Proctor (D698), place and secure filter fabric (non-woven geotextile), place 4-6" drainage layer overlaid by geogrid, place ACBs in final configuration, grout seams, and backfill ACBs with crushed stone.

2 questions
In addition to you confirming or updating the material and installation costs, I have two questions: (1) Is the installation cost ($4.63/square foot) the same for both channel downdrains and dissipation basins? (2) Does the installation or material cost include the crushed stone used to backfill the ACBs?

Please create a new email to me with updated unit costs or reply to this email to confirm what I show is still correct. I will present what you provide for documentation in the cost estimate we submit to the state agencies.

Thanks,

Fred Charles, Ph.D., P.E. Senior Engineer
Office: 970-484-7704, Ext 120 Cell: 720-318-5021
3801 Automation Way, Suite 201, Fort Collins, CO 80525
fcharles@telesto-inc.com

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Taryn Tigges

From: Clayton Fawcett <Clayton.Fawcett@ContechLLC.com>
Sent: Monday, January 11, 2021 10:45 AM
To: Taryn Tigges
Subject: RE: [EXTERNAL] RE: Tyrone Mine Armorflex Analysis 40T

That make sense.

We are including the geotextile, geogrid, ACB, and freight to the jobsite.

Clayton Fawcett PE (co)
Armortec Area Manager - West

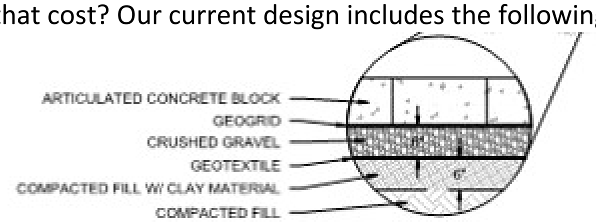
CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Taryn Tigges [mailto:ttigges@telesto-inc.com]
Sent: Monday, January 11, 2021 10:44 AM
To: Clayton Fawcett <Clayton.Fawcett@ContechLLC.com>
Subject: [EXTERNAL] RE: Tyrone Mine Armorflex Analysis 40T

Hi Clayton,

You too! Weekends go by too quickly.

Thanks for the information. They are just updating costing information. Can you also confirm again what's included in that cost? Our current design includes the following:



Can you let me know what I need to account for separately? I believe you had mentioned geotextile is part of the cost.

Thanks,

Taryn Tigges, PE | Civil Engineer
Office: 970-484-7704 | Cell: 515-520-9454
750 14th St SW | Loveland, CO 80537

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From: Clayton Fawcett <Clayton.Fawcett@ContechLLC.com>
Sent: Monday, January 11, 2021 10:39 AM
To: Taryn Tigges <ttigges@telesto-inc.com>; CFawcett@conteches.com
Cc: KMeyer@conteches.com
Subject: RE: Tyrone Mine Armorflex Analysis 40T

Hi Taryn,

I hope the weekend treated you well. Current pricing as of January 2021 is 10.27 / sf delivered for this material.

Are they getting ready to proceed or just updating the costing information?

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Taryn Tigges [mailto:ttigges@telesto-inc.com]
Sent: Thursday, January 7, 2021 2:15 PM
To: CFawcett@conteches.com
Cc: KMeyer@conteches.com
Subject: FW: Tyrone Mine Armorflex Analysis 40T

Hi Clayton,

It has been a few months since I talked to you but I was wondering if you could send an updated cost for current (January 2021) prices for the Armorflex 50T ACB system? Let me know if you need any additional information.

Thanks,

Taryn Tigges, PE | Civil Engineer
Office: 970-484-7704 | Cell: 515-520-9454
750 14th St SW | Loveland, CO 80537

www.telesto-inc.com

From: Fawcett, Clayton <CFawcett@conteches.com>
Sent: Thursday, May 28, 2020 3:28 PM
To: Taryn Tigges <ttigges@telesto-inc.com>
Cc: Meyer, Kenneth <KMeyer@conteches.com>
Subject: RE: Tyrone Mine Armorflex Analysis 40T

Taryn,

Good speaking with you this afternoon. See attached for revised calculations per your direction below. That is, with the exception of the Manning's *n* value which is 0.025.

Cost for the Armorflex 50T ACB system is $9.77 / sf delivered. This does include ACB mats with galvanized cable, geotextile fabric, and freight to the jobsite via Over the Road Flatbed Trucks.

Feel free to let me know if you have any additional questions.

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Taryn Tigges [mailto:ttigges@telesto-inc.com]
Sent: Thursday, May 28, 2020 2:16 PM
To: Fawcett, Clayton <CFawcett@conteches.com>
Subject: RE: Tyrone Mine Armorflex Analysis 40T

Hi Clayton,

You previously spoke with our intern, Jessica, for ACB selection on a Freeport project. I have a couple questions for you regarding that project:

1. I had run some calculations with the following factor of safety method, which is giving me different results than your spreadsheet: https://www.conteches.com/knowledge-center/pdh-article-series/articulated-concrete-block-design
   Are you using a newer method?

2. Can you revise your calculations for the following channel design and flow rate:
   a. Manning's n = 0.015
   b. Bed Slope = 0.05
   c. Side slope = 2:1
   d. Bottom width = 15 feet, Top width = 28 feet
   e. Hydraulic Depth = 3.3 feet
   f. Radius of curvature = 240 feet

g. Flow rate = 2717 cfs (velocity = 38.8 ft/s for area of 70.1 sf)

A side slope of 3:1 is not obtainable for this project so you don't need to run that calculation. Let me know if you need additional information and let me know what block type you recommend based on these conditions.

Thank you for your time!

Taryn Tigges, PE | Civil Engineer
Office: 970-484-7704 | Cell: 515-520-9454
750 14th St SW | Loveland, CO 80537

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From: Jessica Menconi <jmenconi@telesto-inc.com>
Sent: Wednesday, April 22, 2020 2:12 PM
To: Taryn Tigges <ttigges@telesto-inc.com>
Subject: FW: Tyrone Mine Armorflex Analysis 40T

From: Fawcett, Clayton <CFawcett@conteches.com>
Sent: Wednesday, April 22, 2020 12:29 PM
To: Jessica Menconi <jmenconi@telesto-inc.com>
Cc: Taryn Tigges <taryn.tigges@gmail.com>
Subject: RE: Tyrone Mine Armorflex Analysis 40T

Jessica,

I have to apologize. I thought I sent that already.

See attached. My guess is that Freeport won't accept it as it is below the minimum 1.8 Factor of Safety that they have previously established.

Regards,

Clayton Fawcett PE (co)
Armortec Area Manager - West

CONTECH Engineered Solutions
970-290-2971 (cell)
cfawcett@conteches.com

From: Jessica Menconi [mailto:jmenconi@telesto-inc.com]
Sent: Wednesday, April 22, 2020 12:15 PM

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FREEPORT MCMORAN – NEW MEXICO MINING OPERATIONS

PRICE ESTIMATES FOR REVEGETATION SERVICES FOR BUDGETING ESTIMATES

Table 1 –Freeport McMoRan, New Mexico Mining Operations – Price Estimates for Revegetation Services for Budgeting Estimates, prepared April, 2018.

	REVEGETATION OPERATION	ESTIMATED QUANTITY	UNITS	COST/UNIT ($)	TOTAL COST
I.	**OPERATIONS:**				
1	**SCARIFYING**	500	Acres	$30.00	$15,000.00
2	**DISCING**	500	Acres	$20.00	$10,000.00
3	**DRILL SEEDING (special Rangeland Drill)**	500	Acres	$80.00	$40,000.00
4	**MULCHING**	500	Acres	$148.00	$74,000.00
5	**CRIMPING**	500	Acres	$55.00	$27,500.00
6	**DAILY PER DIEM, ETC.**	50	Days	$385.00	$19,250.00
7	**MOBILIZATION**	1	Each	$13,500.00	$13,500.00
	Subtotal				**$199,250.00**
II.	**MATERIALS:**				
1	**SEED** at 8.9 PLS/acre	500	Acres	$210.00	$105,000.00
2	**HAY MULCH** - nox. weed free, native	1000	Tons	$245.00	$245,000.00
	Subtotal				**$350,000.00**
	TOTAL ESTIMATED REVEGETATION COST BEFORE TAX				**$549,250.00**
	Add New Mexico Gross Receipts Tax	5.9375	%		**$32,611.72**
	ESTIMATED REVEGETATION COST PER ACRE:			**$1,163.72**	
	TOTAL ESTIMATED REVEGETATION COST				**$581,861.72**

Estimate prepared by Ron Schreibeis, Rocky Mountain Reclamation, for use for Budgeting Estimates.

Appendix D.6

Fuel Cost

Fuel Price Data

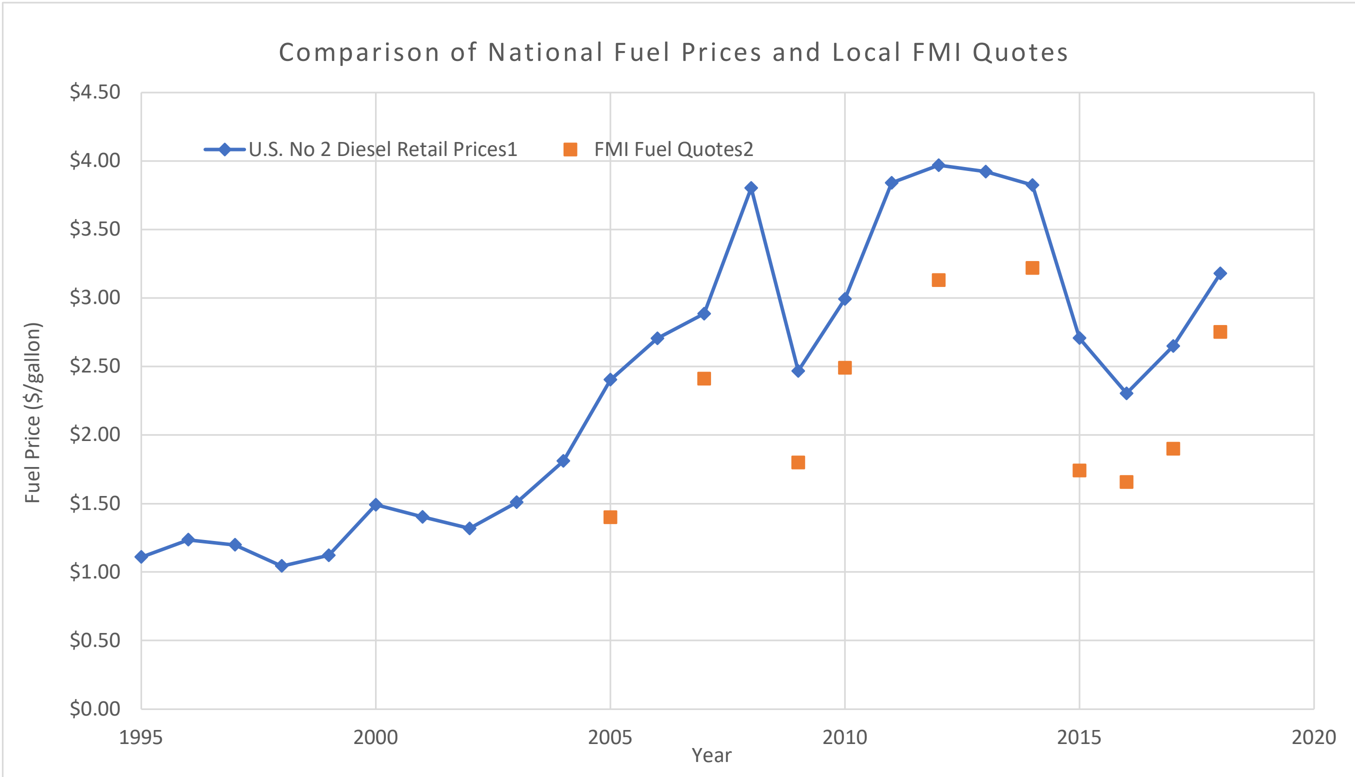
Data 1: U.S. No 2 Diesel Retail Prices (Dollars per Gallon)	
Date	**U.S. No 2 Diesel Retail Prices[1]**
1995	1.109
1996	1.235
1997	1.198
1998	1.044
1999	1.121
2000	1.491
2001	1.401
2002	1.319
2003	1.509
2004	1.81
2005	2.402
2006	2.705
2007	2.885
2008	3.803
2009	2.467
2010	2.992
2011	3.84
2012	3.968
2013	3.922
2014	3.825
2015	2.707
2016	2.304
2017	2.65
2018	3.178
2019	3.056
2020	2.551
2021	3.125
Date	**U.S. No 2 Diesel Retail Prices[1]**
Aug 2021	3.350

FMI Fuel Quotes[2]			
Site	**Date**	**Dyed, low-sulfur diesel**	**Notes**
Continental	1/21/2005	$1.40	Tom Shelley - quote from fuel broker
Chino & Tyrone	5/9/2007	$2.41	Porter Oil Quote (7500 gal capacity)
Continental	1/23/2009	$1.80	Porter Oil Quote (7500 gal capacity)
Tyrone (Little Rock)	1/14/2010	$2.49	Porter Oil Quote (7500 gal capacity)
Tyrone	7/7/2012	$3.13	Western Refining Oil
Continental	6/18/2014	$3.22	Western Refining Oil
Chino (North Lampbright)	11/5/2015	$1.74	Western Refining Oil
Chino	5/20/2016	$1.66	Western Refining Oil
Tyrone (Little Rock)	4/24/2017	$1.90	Western Refining Oil
Continental	3/12/2018	$2.75	Griffin Propane
Chino	10/10/2018	$2.75	Griffin Propane

1. U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

Correlation Between U.S. No.2 Diesel Retail Prices and FMI Fuel Quotes Since 1995

Year	U.S. No 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]
1995	1.109	
1996	1.235	
1997	1.198	
1998	1.044	
1999	1.121	
2000	1.491	
2001	1.401	
2002	1.319	
2003	1.509	
2004	1.81	
2005	2.402	$1.40
2006	2.705	
2007	2.885	$2.41
2008	3.803	
2009	2.467	$1.80
2010	2.992	$2.49
2011	3.84	
2012	3.968	$3.13
2013	3.922	
2014	3.825	$3.22
2015	2.707	$1.74
2016	2.304	$1.66
2017	2.65	$1.90
2018	3.178	$2.75
2019	3.056	
2020	2.551	
2021	3.125	

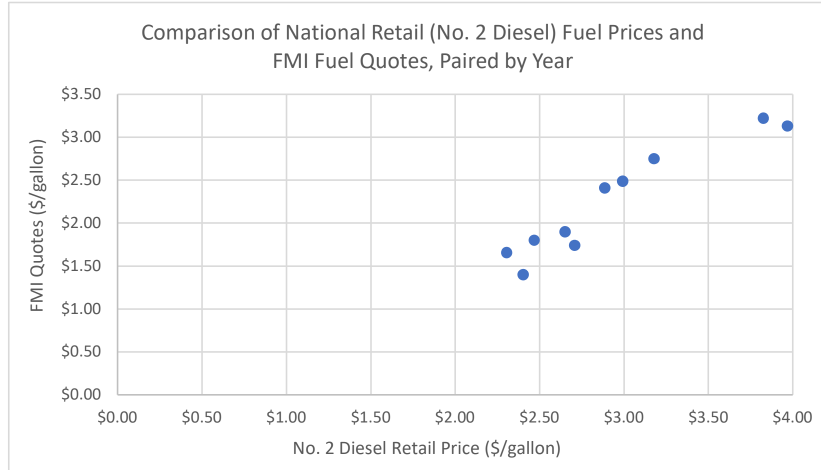


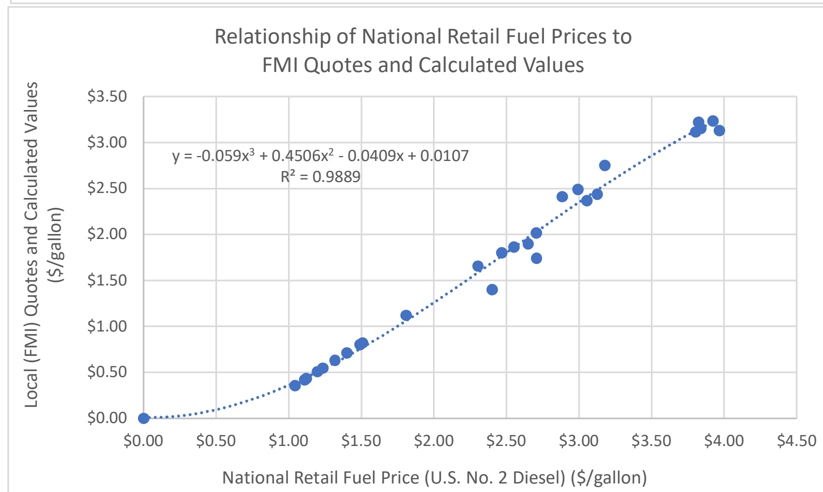
Correlatior 0.952

1. U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

Calculations and Results for Fuel Price Prediction

U.S. No. 2 Diesel Retail Prices[1]	FMI Fuel Quotes[2]	Difference Between Retail Prices and FMI Quotes	Calculated FMI Values Based on Average Difference	Calculated FMI Values and Quotes	y = -0.05904x3 + 0.450612x2 - 0.04089x + 0.010713
$0.00				*$0.00*	$0.01
$1.11			$0.42	*$0.42*	$0.44
$1.24			$0.55	*$0.55*	$0.54
$1.20			$0.51	*$0.51*	$0.51
$1.04			$0.36	*$0.36*	$0.39
$1.12			$0.43	*$0.43*	$0.45
$1.49			$0.80	*$0.80*	$0.76
$1.40			$0.71	*$0.71*	$0.68
$1.32			$0.63	*$0.63*	$0.61
$1.51			$0.82	*$0.82*	$0.77
$1.81			$1.12	*$1.12*	$1.06
$2.40	$1.40	$1.00		$1.40	$1.69
$2.71			$2.02	*$2.02*	$2.03
$2.89	$2.41	$0.47		$2.41	$2.23
$3.80			$3.11	*$3.11*	$3.13
$2.47	$1.80	$0.67		$1.80	$1.77
$2.99	$2.49	$0.50		$2.49	$2.34
$3.84			$3.15	*$3.15*	$3.16
$3.97	$3.13	$0.84		$3.13	$3.25
$3.92			$3.23	*$3.23*	$3.22
$3.83	$3.22	$0.61		$3.22	$3.14
$2.71	$1.74	$0.97		$1.74	$2.03
$2.30	$1.66	$0.65		$1.66	$1.59
$2.65	$1.90	$0.75		$1.90	$1.97
$3.18	$2.75	$0.43		$2.75	$2.54
$3.06			$2.37	*$2.37*	$2.41
$2.55			$1.86	*$1.86*	$1.86
$3.13			$2.44	*$2.44*	$2.48
	Average	$0.69			





Correlations

Between No. 2 Retail Price and FMI Quotes	0.95
Between No. 2 Retail Price and 3rd order polynomial FMI Quotes	0.99
Between New FMI quotes and 3rd order polynomial FMI Quotes	0.96
Between FMI quotes and 3rd order polynomial FMI Quotes	0.99

New Fuel Rate	U.S. No 2 Diesel Retail Prices[1]		Proposed Fuel Quote
	Aug 2021	$3.35	$2.71

1. U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

General Information		Emma Mine Stockpile Spreadsheet Worksheet #1 11/12/2021
Applicant	Emma Mine Freeport McMoRan Tyrone Inc. Tyrone, New Mexico 88065	
Disturbed Surface Area (acres)	249	
Type of Operation	Surface/Copper	
Current value of earthwork and O&M before escalation and discounting	**$7,837,334**	
EOY 2026 Mine Plan		**Stockpiles, Reservoirs, Haul Roads and Disturbed Areas**

Demolition

Item	Material	Quantity	Unit	Unit Cost ($/unit)	Direct Item Cost ($)	Reference	Means Line Item	Description
Culvert Removal	CMP	800	ft	$12.46	$9,968	R.S. Means	024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation

Total Direct Cost: $9,968

Material Handling Plan Summary Sheet

All activities for the Emma RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The column labeled ID contains the codes for the facility location, activity, material and equipment used for that particular row of work. The description lists the activity, top or outslope (if applicable), and the material. The source location lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile. Blank cells indicate that that column is not relevant to a particular activity.

Notes and Assumptions:

1 - Haul/Push Distance based on 2021 Emma CCP drawings
2 - Haul Grades based on 2021 Emma CCP drawings
3 - Grade Factors from 2021 Emma CCP drawings

ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
1002-A-a-Dz2	Grade-Outslopes-Existing Ground	EMW Waste	-	200	-28.6%	Cat D11T CD
1101-A-a-Sc2	Grade-Reclaimed Slope Area-Existing Ground	6HW Waste	-	1,820	-15.7%	Cat 657G
1301-A-f-Dz2	Grade-Collection Sump-Fill/Stockpile Material	Emma Backfill Areas	Emma Backfill Areas	200	50.0%	Cat D11T CD
1400-A-a-Dz2	Grade-Entire Footprint-Existing Ground	Soil Stockpile	-	200	1.0%	Cat D11T CD
1500-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Allowance for Other Disturbed Areas	-	200	1.0%	Cat D11T CD
1101-E-a-Rp1	Rip-Reclaimed Slope Area-Existing Ground	6HW Waste	-	200	-28.6%	Cat D11T CD Multi-shank (w/ MSR-359H)
1200-E-a-Rp1	Rip-Haul Roads-Existing Ground	Haul Roads	-	200	2.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1400-E-c-Rp1	Rip-Entire Footprint-Rough Graded Material	Soil Stockpile	-	200	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1500-E-c-Rp1	Rip-Unplanned Disturbance Area-Rough Graded Material	Allowance for Other Disturbed Areas	-	200	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1000-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	EMW Waste	- -		Cat D11T CD
1100-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	6HW Waste	- -		Cat D11T CD
1101-B-a-Dz3	Dozer Assist Scraper Grading-Reclaimed Slope Area-Existing Ground	6HW Waste	-	200	-28.6%	Cat D9T, SU Blade
1201-B-f-Dz2	Dozer Assist-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	200	2.0%	Cat D11T CD
1300-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Emma Backfill Areas	200	0.0%	Cat D11T CD
1301-B-f-Dz2	Dozer Assist-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	200	50.0%	Cat D11T CD
1500-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	200	1.0%	Cat D11T CD
1000-C-b-Sh1	Load-Cover	Soil Stockpile	EMW Waste	- -		Hitachi EX3600-5
1100-C-b-Sh1	Load-Cover	Soil Stockpile	6HW Waste	- -		Hitachi EX3600-5
1201-C-f-Sh1	Load-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	200	2.0%	Hitachi EX3600-5
1300-C-b-Sh1	Load-Cover	Soil Stockpile	Emma Backfill Areas	200	0.0%	Hitachi EX3600-5
1301-C-f-Sh1	Load-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	200	50.0%	Hitachi EX3600-5
1500-C-b-Sh1	Load-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	200	1.0%	Hitachi EX3600-5
1000-D-b-Tk4	Haul-Cover	Soil Stockpile	EMW Waste	5,900	3.6%	Komatsu 730E
1100-D-b-Tk4	Haul-Cover	Soil Stockpile	6HW Waste	4,200	4.9%	Komatsu 730E
1201-D-f-Tk4	Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	-	2.0%	Komatsu 730E
1300-D-b-Tk4	Haul-Cover	Soil Stockpile	Emma Backfill Areas	4,200	17.3%	Komatsu 730E
1301-D-f-Tk4	Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	11,380	-5.7%	Komatsu 730E
1500-D-b-Tk4	Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	4,200	9.4%	Komatsu 730E
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	EMW Waste	-	- -		Cat 16M - Final Grading
1100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6HW Waste	-	- -		Cat 16M - Final Grading
1300-A-d-Mg1	Grade-Open Pit-Placed Cover	Emma Backfill Areas	-	200	0.0%	Cat 16M - Final Grading
1500-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Allowance for Other Disturbed Areas	-	200	1.0%	Cat 16M - Final Grading
1000-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	EMW Waste	-	- -		-
1100-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	6HW Waste	-	- -		-
1200-J-e-U2a	Revegetate-Haul Roads-Final Grade	Haul Roads	-	200	2.0%	-
1300-J-e-U2a	Revegetate-Open Pit-Final Grade	Emma Backfill Areas	-	200	0.0%	-
1400-J-e-U2a	Revegetate-Entire Footprint-Final Grade	Soil Stockpile	-	200	1.0%	-
1500-J-e-U2a	Revegetate-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	200	1.0%	-
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	EMW Waste	- -		Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1100-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	6HW Waste	- -		Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1200-P-b-Comb1	Road Maintenance-Haul Roads	Soil Stockpile	Haul Roads	200	2.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1300-P-b-Comb1	Road Maintenance-Open Pit	Soil Stockpile	Emma Backfill Areas	200	0.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1301-P-b-Comb1	Road Maintenance-Collection Sump	Soil Stockpile	OP-1	200	50.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1500-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Soil Stockpile	Allowance for Other Disturbed Areas	200	1.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1002-F-e-U3	Grade Benches-Outslopes-Final Grade	EMW Waste	-	200	-28.6%	-
1101-F-e-U3	Grade Benches-Reclaimed Slope Area-Final Grade	6HW Waste	-	200	-28.6%	-
1002-G-e-U6	Construct Downdrains-Outslopes-Final Grade	EMW Waste	-	200	-28.6%	-
1101-G-e-U6	Construct Downdrains-Reclaimed Slope Area-Final Grade	6HW Waste	-	200	-28.6%	-
1002-Gb-e-U7	Construct Downdrain Dissipators-Outslopes-Final Grade	EMW Waste	-	200	-28.6%	-
1101-Gb-e-U7	Construct Downdrain Dissipators-Reclaimed Slope Area-Final Grade	6HW Waste	-	200	-28.6%	-
1002-H-e-U8a	Construct Channels w/ Riprap-Outslopes-Final Grade	EMW Waste	-	200	-28.6%	-
1101-H-e-U8a	Construct Channels w/ Riprap-Reclaimed Slope Area-Final Grade	6HW Waste	-	200	-28.6%	-
1000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	EMW Waste	-	- -		-
1100-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6HW Waste	-	- -		-
1200-M-e-U	Post-Closure O&M-Haul Roads-Final Grade	Haul Roads	-	200	2.0%	-
1300-M-e-U	Post-Closure O&M-Open Pit-Final Grade	Emma Backfill Areas	-	200	0.0%	-
1305-M-e-U	Post-Closure O&M-Upper East-Final Grade	Emma Backfill Areas	-	200	2.0%	-
1400-M-e-U	Post-Closure O&M-Entire Footprint-Final Grade	Soil Stockpile	-	200	1.0%	-
1500-M-e-U	Post-Closure O&M-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	200	1.0%	-
1301-Sa-e-U29	Chain Link Fence-Collection Sump-Final Grade	Emma Backfill Areas	-	200	50.0%	-
1301-U-e-U30	Vehicle Gates-Collection Sump-Final Grade	Emma Backfill Areas	-	200	50.0%	-

Material Handling Plan Summary Sheet

All activities for the Emma RCE are listed on this sheet and carried through the succeeding worksheets of the RCE. The column labeled ID contains the codes for the facility location, activity, material and equipment used for that particular row of work. The description lists the activity, top or outslope (if applicable), and the material. The source location lists the stockpile name (or sub-area) for the location of the activity. If borrow material is involved, it is transported from a borrow stockpile to a destination stockpile. Blank cells indicate that that column is not relevant to a particular activity.

Notes and Assumptions:

1 - Haul/Push Distance based on 2021 Emma CCP drawings
2 - Haul Grades based on 2021 Emma CCP drawings
3 - Grade Factors from 2021 Emma CCP drawings

ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
1302-X-e-U50	Shade Balls-Collection Sump- Operational Surface Area-Final Grade	Emma Backfill Areas	-	200	1.0%	-

Emma Mine
Stockpile Spreadsheet Worksheet #4
11/12/21

Earthwork Quantity Worksheet

Notes and Assumptions:

1 - Acres and volumes based on 2021 Emma CCP drawings
2 - Cover Material Swell: The 'Loose Volume' is calculated based on the acreage to be covered, cover depth, and accounts for appropriate swell factor.
3 - Has been agreed upon with State agencies that swell occurs when cover material is moved from source to haul truck but not from the truck to placement on stockpile

ID	Description	Source Location 1	Destination Location 2	Area (ac)[1]	Cover Depth (in)	Bank/Stockpile Volume (bcy)[1]	Swell Factor (%)[3]	Loose/Stockpile Volume (lcy)[2]
1002-A-a-Dz2	Grade-Outslopes-Existing Ground	EMW Waste	-	40.188	-	1,569,700	0%	1,569,700
1101-A-a-Sc2	Grade-Reclaimed Slope Area-Existing Ground	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1301-A-f-Dz2	Grade-Collection Sump-Fill/Stockpile Material	Emma Backfill Areas	Emma Backfill Areas	3.078	-	76,780	0%	76,780
1400-A-a-Dz2	Grade-Entire Footprint-Existing Ground	Soil Stockpile	-	8.3	-	-	0%	-
1500-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Allowance for Other Disturbed Areas	-	10.000	-	-	0%	-
1101-E-a-Rp1	Rip-Reclaimed Slope Area-Existing Ground	6HW Waste	-	71.2	-	-	0%	-
1200-E-a-Rp1	Rip-Haul Roads-Existing Ground	Haul Roads	-	39.066	-	-	0%	-
1400-E-c-Rp1	Rip-Entire Footprint-Rough Graded Material	Soil Stockpile	-	8.3	-	-	0%	-
1500-E-c-Rp1	Rip-Unplanned Disturbance Area-Rough Graded Material	Allowance for Other Disturbed Areas	-	10.000	-	-	0%	-
1000-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	EMW Waste	74.1	12.0	110,763	8%	119,624
1100-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	6HW Waste	71.212	12.0	106,379	8%	114,889
1101-B-a-Dz3	Dozer Assist Scraper Grading-Reclaimed Slope Area-Existing Ground	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1201-B-f-Dz2	Dozer Assist-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	-	-	28,733	0%	28,733
1300-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Emma Backfill Areas	38.7	12.0	57,818	8%	62,444
1301-B-f-Dz2	Dozer Assist-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	3.078	-	76,780	0%	76,780
1500-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	10.0	12.0	14,938	8%	16,133
1000-C-b-Sh1	Load-Cover	Soil Stockpile	EMW Waste	74.147	12.0	110,763	8%	119,624
1100-C-b-Sh1	Load-Cover	Soil Stockpile	6HW Waste	71.2	12.0	106,379	8%	114,889
1201-C-f-Sh1	Load-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	-	-	28,733	0%	28,733
1300-C-b-Sh1	Load-Cover	Soil Stockpile	Emma Backfill Areas	38.7	12.0	57,818	8%	62,444
1301-C-f-Sh1	Load-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	3.078	-	76,780	0%	76,780
1500-C-b-Sh1	Load-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	10.0	12.0	14,938	8%	16,133
1000-D-b-Tk4	Haul-Cover	Soil Stockpile	EMW Waste	74.147	12.0	110,763	8%	119,624
1100-D-b-Tk4	Haul-Cover	Soil Stockpile	6HW Waste	71.2	12.0	106,379	8%	114,889
1201-D-f-Tk4	Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	-	-	28,733	0%	28,733
1300-D-b-Tk4	Haul-Cover	Soil Stockpile	Emma Backfill Areas	38.7	12.0	57,818	8%	62,444
1301-D-f-Tk4	Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	3.078	-	76,780	0%	76,780
1500-D-b-Tk4	Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	10.0	12.0	14,938	8%	16,133
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	EMW Waste	-	74.147	12.0	119,624	0%	119,624
1100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6HW Waste	-	71.2	12.0	114,889	0%	114,889
1300-A-d-Mg1	Grade-Open Pit-Placed Cover	Emma Backfill Areas	-	38.705	12.0	62,444	0%	62,444
1500-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Allowance for Other Disturbed Areas	-	10.0	12.0	16,133	0%	16,133
1000-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	EMW Waste	-	74.147	-	5,369,700	0%	5,369,700
1100-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1200-J-e-U2a	Revegetate-Haul Roads-Final Grade	Haul Roads	-	39.066	-	28,733	0%	28,733
1300-J-e-U2a	Revegetate-Open Pit-Final Grade	Emma Backfill Areas	-	38.7	-	76,780	0%	76,780
1400-J-e-U2a	Revegetate-Entire Footprint-Final Grade	Soil Stockpile	-	8.300	-	-	0%	-
1500-J-e-U2a	Revegetate-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	10.0	-	-	0%	-
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	EMW Waste	-	-	-	-	-
1100-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	6HW Waste	-	-	-	-	-
1200-P-b-Comb1	Road Maintenance-Haul Roads	Soil Stockpile	Haul Roads	-	-	-	-	-
1300-P-b-Comb1	Road Maintenance-Open Pit	Soil Stockpile	Emma Backfill Areas	-	-	-	-	-
1301-P-b-Comb1	Road Maintenance-Collection Sump	Soil Stockpile	OP-1	-	-	-	-	-
1500-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Soil Stockpile	Allowance for Other Disturbed Areas	-	-	-	-	-
1002-F-e-U3	Grade Benches-Outslopes-Final Grade	EMW Waste	-	40.188	-	1,569,700	0%	1,569,700
1101-F-e-U3	Grade Benches-Reclaimed Slope Area-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1002-G-e-U6	Construct Downdrains-Outslopes-Final Grade	EMW Waste	-	40.188	-	1,569,700	0%	1,569,700

Earthwork Quantity Worksheet

Notes and Assumptions:

1 - Acres and volumes based on 2021 Emma CCP drawings
2 - Cover Material Swell: The 'Loose Volume' is calculated based on the acreage to be covered, cover depth, and accounts for appropriate swell factor.
3 - Has been agreed upon with State agencies that swell occurs when cover material is moved from source to haul truck but not from the truck to placement on stockpile

ID	Description	Source Location 1	Destination Location 2	Area (ac)[1]	Cover Depth (in)	Bank/Stockpile Volume (bcy)[1]	Swell Factor (%)[3]	Loose/Stockpile Volume (lcy)[2]
1101-G-e-U6	Construct Downdrains-Reclaimed Slope Area-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1002-Gb-e-U7	Construct Downdrain Dissipators-Outslopes-Final Grade	EMW Waste	-	40.188	-	1,569,700	0%	1,569,700
1101-Gb-e-U7	Construct Downdrain Dissipators-Reclaimed Slope Area-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1002-H-e-U8a	Construct Channels w/ Riprap-Outslopes-Final Grade	EMW Waste	-	40.188	-	1,569,700	0%	1,569,700
1101-H-e-U8a	Construct Channels w/ Riprap-Reclaimed Slope Area-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	EMW Waste	-	74.147	-	5,369,700	0%	5,369,700
1100-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6HW Waste	-	71.2	-	2,200,000	0%	2,200,000
1200-M-e-U	Post-Closure O&M-Haul Roads-Final Grade	Haul Roads	-	39.066	-	28,733	0%	28,733
1300-M-e-U	Post-Closure O&M-Open Pit-Final Grade	Emma Backfill Areas	-	38.7	-	76,780	0%	76,780
1305-M-e-U	Post-Closure O&M-Upper East-Final Grade	Emma Backfill Areas	-	4.726	-	-	0%	-
1400-M-e-U	Post-Closure O&M-Entire Footprint-Final Grade	Soil Stockpile	-	8.3	-	-	0%	-
1500-M-e-U	Post-Closure O&M-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	10.000	-	-	0%	-
1301-Sa-e-U29	Chain Link Fence-Collection Sump-Final Grade	Emma Backfill Areas	-	3.1	-	76,780	0%	76,780
1301-U-e-U30	Vehicle Gates-Collection Sump-Final Grade	Emma Backfill Areas	-	3.078	-	76,780	0%	76,780
1302-X-e-U50	Shade Balls-Collection Sump- Operational Surface Area-Final Grade	Emma Backfill Areas	-	0.7	-	-	0%	-

Productivity and Hours Required for Dozer Use---Earthmoving

Notes and Assumptions:
Uses volumes of outslope sections and dam breaches to calculate productivity
Uses push distances of outslope sections for grading productivity
Uses scraper push cycle time for dozer assist with scraper
Uses loader cycle time for dozer assist with loader at cover stockpiles
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

Number of Dozers per Assist = 1

													PERFORMANCE FACTORS															
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Type of Equipment to Assist (ID)**	**Type of Equipment to Assist (Name)**	**Number of Dozers per Assist**	**Loose /Stockpile Volume (cy)**	**Area (ac)**	**Productivity (cy/hr)**	**Productivity (ac/hr)**	**Total Task Time (hrs)**	**Material Factor**	**Grade Factor**	**Material Weight (lb/cy)**	**Production Method/ Blade**	**Centroid to Centroid Push Distance (ft)**	**Normal Production (cy/hr)**	**Effective Blade Width (ft)**	**Speed (mph)**	**Operator Factor**	**Work Hour (min/hr)**	**Visibility Factor**	**Elevation Factor**	**Direct Drive Trans.**	**Cut to Fill Haul Grade (%)**
1002-A-a-Dz2	Grade-Outslopes-Existing Ground	EMW Waste	-	Cat D11T CD	--	--	--	1,569,700	40.188	1,987	-	790.0	1.2	1.6	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	-29%
1301-A-f-Dz2	Grade-Collection Sump-Fill/Stockpile Material	Emma Backfill Areas	Emma Backfill Areas	Cat D11T CD	--	--	--	76,780	3.078	-	-	-	1.0	-	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	50%
1400-A-a-Dz2	Grade-Entire Footprint-Existing Ground	Soil Stockpile	-	Cat D11T CD	--	--	--	-	8	1,239	5	-	1.2	1.0	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	1%
1500-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Allowance for Other Disturbed Areas	-	Cat D11T CD	--	--	--	-	10.000	1,239	5	-	1.2	1.0	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	1%
1000-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	EMW Waste	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	119,624	74	-	-	39.1	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1100-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	6HW Waste	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	114,889	71.212	-	-	40.7	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1101-B-a-Dz3	Dozer Assist Scraper Grading-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat D9T, SU Blade	Sc2	Cat 657G Scraper	1	2,200,000	71	712	-	0.4	1.2	1.6	3,600	1.2	200	591	14	1	1.00	50	1.0	1.0	1.0	-29%
1201-B-f-Dz2	Dozer Assist-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	28,733	-	1,011	-	9.2	1.0	1.0	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	2%
1300-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Emma Backfill Areas	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	62,444	39	-	-	22.1	-	-	-	-	-	-	-	-	-	50	-	-	-	0%
1301-B-f-Dz2	Dozer Assist-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	76,780	3.078	-	-	25.5	1.0	-	3,600	1.2	200	1,649	22	3	1.00	50	1.0	1.0	1.0	50%
1500-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	16,133	10	-	-	5.7	-	-	-	-	-	-	-	-	-	50	-	-	-	1%

Productivity and Hours Required for Dust Suppression and Road Maintenance

Notes and Assumptions:
6,000 gal water truck and 14M motor grader for dust suppression and site maintenance (water truck hours and 14M hours tied to loading time for cover material)
May filter on equipement (D14) to show pertinent rows

Sheet to which to tie hrs 11 Loader Shovel
Equipment for hrs Sh1
Equipment for hrs Ld1

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Operational Maintenance Time (hrs)
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	EMW Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	39
1100-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	6HW Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	41
1200-P-b-Comb1	Road Maintenance-Haul Roads	Soil Stockpile	Haul Roads	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	-
1300-P-b-Comb1	Road Maintenance-Open Pit	Soil Stockpile	Emma Backfill Areas	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	22
1301-P-b-Comb1	Road Maintenance-Collection Sump	Soil Stockpile	OP-1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	25
1500-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Soil Stockpile	Allowance for Other Disturbed Areas	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	6

Productivity and Hours Required for Ripper---Equipped Dozer Use

Notes and Assumptions:
Uses area to calculate task time
88 ft/min = 1 mph
May filter on equipement (D14) to show pertinent rows

								PERFORMANCE FACTORS									
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Area (ac)**	**Productivity (ac/hr)**	**Task Time (hrs)**	**Ripping Length (ft)**	**Ripper Penetration (in)**	**Pocket Spacing (in)**	**Distance b/n Passes (in)**	**Number of Shank Pockets**	**Turn Time (min/pass)**	**Work Hour (min/hr)**	**Speed (mph)**	**1000 Ft Passes/Acre**	**Ripped Width Plus Distance b/n Passes (ft)**
1101-E-a-Rp1	Rip-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat D11T CD Multi-shank (w/ MSR-359H)	71.21	2.9	24.4	1,000	18	59	59	3	0.25	50	1.0	1.5	30
1200-E-a-Rp1	Rip-Haul Roads-Existing Ground	Haul Roads	-	Cat D11T CD Multi-shank (w/ MSR-359H)	39.07	2.9	13.4	1,000	18	59	59	3	0.25	50	1.0	1.5	30
1400-E-c-Rp1	Rip-Entire Footprint-Rough Graded Material	Soil Stockpile	-	Cat D11T CD Multi-shank (w/ MSR-359H)	8.30	2.9	2.8	1,000	18	59	59	3	0.25	50	1.0	1.5	30
1500-E-c-Rp1	Rip-Unplanned Disturbance Area-Rough Graded Material	Allowance for Other Disturbed Areas	-	Cat D11T CD Multi-shank (w/ MSR-359H)	10.00	2.9	3.4	1,000	18	59	59	3	0.25	50	1.0	1.5	30

Productivity and Hours Required for Truck Use

Notes and Assumptions:
Uses haul distance to calculate haul and return time (total task time includes loading, manuevering, dumping, hauling and return time) - moves from cover stockpile to destination stockpile
Volume of cover material based on area of destination
Cycles per truck = the greater of Heaped capacity or Struck capacity divided by Loader's per bucket capacity
1 mph = 88 ft/min
1 m/min = 0.03728227153424 mph
See Truck Optimization optimum number of trucks per loader
Haul Grade (%) assumes postive is uphill while the Effective Haul Grade (%) and Effective Return Grade (%) are postive for downhill and uphill
May filter on equipement (D14) to show pertinent rows

PERFORMANCE FACTORS

5	6	7	8	9	10	11	12	13	14	15	16	17
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Loading Equipment ID**	**Loose/Stockpile Volume (cy)**	**Truck Cycle Time (min)**	**Optimum Number of Trucks**	**Loader/Shovel/Excavator Net Bucket Capacity (cy)**	**Productivity (cy/hr)**	**Loader/Shovel/Excavator Task Time(hrs)**	**Truck Task Time (hrs)**
1000-D-b-Tk4	Haul-Cover	Soil Stockpile	EMW Waste	Komatsu 730E	Sh1	119,624	11.5	5	28.1	3,062.2	38.3	39.1
1100-D-b-Tk4	Haul-Cover	Soil Stockpile	6HW Waste	Komatsu 730E	Sh1	114,889	10.0	4	28.1	2,820.9	36.8	40.7
1201-D-f-Tk4	Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Mater	Haul Roads	-	Komatsu 730E	Sh1	28,733	4.1	2	28.1	3,467.3	9.2	9.2
1300-D-b-Tk4	Haul-Cover	Soil Stockpile	Emma Backfill Areas	Komatsu 730E	Sh1	62,444	10.0	4	28.1	2,820.9	20.0	22.1
1301-D-f-Tk4	Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Komatsu 730E	Sh1	76,780	18.7	8	28.1	3,011.7	24.6	25.5
1500-D-b-Tk4	Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Komatsu 730E	Sh1	16,133	10.0	4	28.1	2,820.9	5.2	5.7

5	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ID	**Struck Capacity (cy)**	**Heaped Capacity (cy)**	**Loader/Shovel Cycles per Truck**	**Total Haul Distance (ft)**	**Haul Distance Segment 1 (ft)**	**Haul Distance Segment 2 (ft)**	**Haul Distance Segment 3 (ft)**	**Haul Grade Segment 1 (%)**	**Haul Grade Segment 2 (%)**	**Haul Grade Segment 3 (%)**	**Rolling Resistance (%)**	**Haul Distance Segment 1 (meters)**	**Haul Distance Segment 2 (meters)**	**Haul Distance Segment 3 (meters)**
1000-D-b-Tk4	101.0	145.0	5.0	5,900	2,100	3,800	-	-3.8%	7.6%	0.0%	2.5%	640	1,158	-
1100-D-b-Tk4	101.0	145.0	5.0	4,200	500	700	3,000	-8.4%	1.4%	8.0%	2.5%	152	213	914
1201-D-f-Tk4	101.0	145.0	5.0	-	-	-	-	0.0%	0.0%	0.0%	2.5%	-	-	-
1300-D-b-Tk4	101.0	145.0	5.0	4,200	500	700	3,000	-8.4%	1.4%	8.0%	2.5%	152	213	914
1301-D-f-Tk4	101.0	145.0	5.0	11,380	3,780	2,750	4,850	-7.9%	4.0%	-9.5%	2.5%	1,152	838	1,478
1500-D-b-Tk4	101.0	145.0	5.0	4,200	500	700	3,000	-8.4%	1.4%	8.0%	2.5%	152	213	914

Productivity and Hours Required for Truck Use

Notes and Assumptions:
Uses haul distance to calculate haul and return time (total task time includes loading, manuevering, dumping, hauling and return time) - moves from cover stockpile to de
Volume of cover material based on area of destination
Cycles per truck = the greater of Heaped capacity or Struck capacity divided by Loader's per bucket capacity
1 mph = 88 ft/min
1 m/min = 0.03728227153424 mph
See Truck Optimization optimum number of trucks per loader
Haul Grade (%) assumes postive is uphill while the Effective Haul Grade (%) and Effective Return Grade (%) are postive for downhill and uphill
May filter on equipement (D14) to show pertinent rows

6	7	8	9	32	33	34	35	36	37
Task Description	**Source Location 1**	**Destination Location 2**	**Equipment**	**Effective Haul Grade Segment 1 (%)**	**Effective Haul Grade Segment 2 (%)**	**Effective Haul Grade Segment 3 (%)**	**Effective Return Grade Segment 1 (%)**	**Effective Return Grade Segment 2 (%)**	**Effective Return Grade Segment 3 (%)**
Haul-Cover	Soil Stockpile	EMW Waste	Komatsu 730E	1.3%	10.1%	2.5%	6.3%	5.1%	2.5%
Haul-Cover	Soil Stockpile	6HW Waste	Komatsu 730E	5.9%	3.9%	10.5%	10.9%	1.1%	5.5%
Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Mater	Haul Roads	-	Komatsu 730E	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Haul-Cover	Soil Stockpile	Emma Backfill Areas	Komatsu 730E	5.9%	3.9%	10.5%	10.9%	1.1%	5.5%
Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Komatsu 730E	5.4%	6.5%	7.0%	10.4%	1.5%	12.0%
Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Komatsu 730E	5.9%	3.9%	10.5%	10.9%	1.1%	5.5%

6	38	39	40	41	42	43	44	45	46	47	48	49
Task Description	**Haul Time (min)**	**Return Time (min)**	**Loading Time (min)**	**Truck Exchange Time (min)**	**Dump/Maneuver Time (min)**	**Work Hour (min/hr)**	**Travel Time Loaded Segment 1 (min/m)**	**Travel Time Loaded Segment 2 (min/m)**	**Travel Time Loaded Segment 3 (min/m)**	**Travel Time Empty Segment 1 (min/m)**	**Travel Time Empty Segment 2 (min/m)**	**Travel Time Empty Segment 3 (min/m)**
Haul-Cover	5.2	2.2	2.25	0.7	1.1	50	0.00111	0.00390	0.00145	0.00151	0.00105	0.00105
Haul-Cover	4.4	1.5	2.25	0.7	1.1	50	0.00214	0.00178	0.00405	0.00207	0.00105	0.00105
Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Mater	-	-	2.25	0.7	1.1	50	0.00145	0.00145	0.00145	0.00105	0.00105	0.00105
Haul-Cover	4.4	1.5	2.25	0.7	1.1	50	0.00214	0.00178	0.00405	0.00207	0.00105	0.00105
Haul-Collection Sump-Fill/Stockpile Material	8.1	6.5	2.25	0.7	1.1	50	0.00199	0.00259	0.00247	0.00201	0.00105	0.00222
Haul-Cover	4.4	1.5	2.25	0.7	1.1	50	0.00214	0.00178	0.00405	0.00207	0.00105	0.00105

Productivity and Hours Required for Front End Loader Use or Hydraulic Shovel Use

Assumptions:
Uses cover volume to calculate loading time of cover material
May filter on equipement (D14) to show pertinent rows

											PERFORMANCE FACTORS	
5	6	7	8	9	10	11	12	13	14	15	16	17
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Hauling Equipment ID**	**Loose/Stockpile Volume (cy)**	**Loader/ Shovel Cycle Time (min)**	**Per Loader/Shovel Productivity (cy/hr)**	**Loader/ Shovel Task Time (hrs)**	**Max of Loader/Shovel or Truck Task Time (hrs)**	**Net Bucket Capacity (cy)**	**Work Hour (min/hr)**
1000-C-b-Sh1	Load-Cover	Soil Stockpile	EMW Waste	Hitachi EX3600-5	Tk4	119,624	0.45	3,120.6	38.3	39.1	28.1	50
1100-C-b-Sh1	Load-Cover	Soil Stockpile	6HW Waste	Hitachi EX3600-5	Tk4	114,889	0.45	3,120.6	36.8	40.7	28.1	50
1201-C-f-Sh1	Load-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Hitachi EX3600-5	Tk4	28,733	0.45	3,120.6	9.2	9.2	28.1	50
1300-C-b-Sh1	Load-Cover	Soil Stockpile	Emma Backfill Areas	Hitachi EX3600-5	Tk4	62,444	0.45	3,120.6	20.0	22.1	28.1	50
1301-C-f-Sh1	Load-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Hitachi EX3600-5	Tk4	76,780	0.45	3,120.6	24.6	25.5	28.1	50
1500-C-b-Sh1	Load-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Hitachi EX3600-5	Tk4	16,133	0.45	3,120.6	5.2	5.7	28.1	50

Productivity for Scrapers

Notes and Assumptions:
Uses volumes of stockpile or cover for hauling and grading times
Haul & Scrape Grade (%) assumes positive is downhill
May filter on equipement (D14) to show pertinent rows

Number of scrapers used for grading cover = 1
1609.344 meters/mile

5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Loose/Stockpile Volume (cy)**	**Total Haul Distance One Way (feet)**	**Haul & Scrape Grade (%)**	**Rolling Resistance (%)**	**Effective Grade Uphill (%)**	**Effective Grade Downhill (%)**	**Load Time (min)**	**Maneuver & Spread Time (min)**	**Full Scraper Haul Speed (mph)**	**Empty Scraper Return Speed (mph)**	**Scraper R/T Cycle Task Time (min)**	**Pusher Cycle Time (min/cycle)**	**Rated Load (lb)**	**Soil Weight (lbs/cy)**	**Heaped Capacity (cy)**	**Work Hour (min/hr)**	**Cycles per Scraper per Hr**	**Productivity per Heaped Scraper (cy/hr)**	**Total Task Time (hrs)**	**Number of Scrapers**	**Task Time w All Scrapers (hrs)**
1101-A-a-Sc2	Grade-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat 657G	2,200,000	1,820.0	-15.70%	2.5%	0.0%	0.0%	0.9	0.7	28.7	33.0	2.85	1.44	104,000	3,600	44	50	18	491	4,480	1.0	4,480

Productivity and Hours Required for Motorgrader Use---Grading

Notes and Assumptions:
Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Efficiency (*Cat. Handbook Edition 47* pg 11-27)
Max. safe slope for motor graders is 2:1 (50%), proposed final grade for Tyrone cover grading on stockpiles is 33%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

ID	Task Description	Source Location 1	Destination Location 2	Grading Equipment	Area (ac)	Grading Shaping Productivity (ac/hr)	Task Time (hrs)	Grade Factor	Material Factor	Material Weight (lb/cy)	Production Method/Blade	Effective Blade Width (ft)	Pass Overlap (ft)	Speed (mph)	Work Hour (min/hr)	Operator Factor
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	EMW Waste	-	Cat 16M - Final Grading	74	2	30.4	1.0	1.2	3,600	1.20	16.00	2.00	2.50	50	0.75
1100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6HW Waste	-	Cat 16M - Final Grading	71	2	29.2	1.0	1.2	3,600	1.20	16.00	2.00	2.50	50	0.75
1300-A-d-Mg1	Grade-Open Pit-Placed Cover	Emma Backfill Areas	-	Cat 16M - Final Grading	39	2	15.9	1.0	1.2	3,600	1.20	16.00	2.00	2.50	50	0.75
1500-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Allowance for Other Disturbed Areas	-	Cat 16M - Final Grading	10	2	4.2	1.0	1.2	3,600	1.20	16.00	2.00	2.50	50	0.75

Summary Calculation of Earthmoving Costs

Summarizes costs for line items involving earthworks

Notes and Assumptions:
Productivity (based on area of overall stockpile) = Sq.ft per hour = Speed x (Eff. Blade L -Blade Overlap) x Efficiency (*Cat. Handbook Edition 47* pg 11-27)
Max. safe slope for motor graders is 2:1 (50%), proposed final grade for Emma cover grading on stockpiles is 33%, therefore use of graders an option (Cat. Handbook Edition 46 pg 11-30)
Grade Factor = -0.02(Grade %) + 1
May filter on equipement (D14) to show pertinent rows

ID	Description	Source Location 1	Destination Location 2	Equipment	Fuel Cost ($/hr)	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr)	Labor Cost ($/hr)	Number of Units (Equipment)	Time Req'd Per Unit (hrs)	Direct Fuel Cost ($)	Direct Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($)	Direct Labor Cost ($)	Total Equipment Cost ($)	Total Production Volume (CY)	Total Production Area (AC)
1002-A-a-Dz2	Grade-Outslopes-Existing Ground	EMW Waste	-	Cat D11T CD	$71.92	$233.66	$28.65	1	790.0	$56,823	$184,605	$22,635	$264,063	1,569,700	-
1101-A-a-Sc2	Grade-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat 657G	$131.03	$232.47	$28.65	1	4,479.6	$586,960	$1,041,375	$128,342	$1,756,677	2,200,000	-
1301-A-f-Dz2	Grade-Collection Sump-Fill/Stockpile Material	Emma Backfill Areas	Emma Backfill Areas	Cat D11T CD	$71.92	$233.66	$28.65	1	-	$0	$0	$0	$0	76,780	-
1400-A-a-Dz2	Grade-Entire Footprint-Existing Ground	Soil Stockpile	-	Cat D11T CD	$71.92	$233.66	$28.65	1	-	$0	$0	$0	$0	-	8.3
1500-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Allowance for Other Disturbed Areas	-	Cat D11T CD	$71.92	$233.66	$28.65	1	-	$0	$0	$0	$0	-	10.0
1101-E-a-Rp1	Rip-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$71.92	$250.85	$28.65	1	24.4	$1,757	$6,127	$700	$8,583	-	71.2
1200-E-a-Rp1	Rip-Haul Roads-Existing Ground	Haul Roads	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$71.92	$250.85	$28.65	1	13.4	$964	$3,361	$384	$4,709	-	39.1
1400-E-c-Rp1	Rip-Entire Footprint-Rough Graded Material	Soil Stockpile	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$71.92	$250.85	$28.65	1	2.8	$205	$714	$82	$1,000	-	8.3
1500-E-c-Rp1	Rip-Unplanned Disturbance Area-Rough Graded Material	Allowance for Other Disturbed Areas	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$71.92	$250.85	$28.65	1	3.4	$247	$860	$98	$1,205	-	10.0
1000-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	EMW Waste	Cat D11T CD	$71.92	$233.66	$28.65	1	39.1	$2,810	$9,128	$1,119	$13,057	119,624	-
1100-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	6HW Waste	Cat D11T CD	$71.92	$233.66	$28.65	1	40.7	$2,929	$9,517	$1,167	$13,613	114,889	-
1101-B-a-Dz3	Dozer Assist Scraper Grading-Reclaimed Slope Area-Existing Ground	6HW Waste	-	Cat D9T, SU Blade	$35.31	$203.92	$28.65	1	0.4	$14	$83	$12	$109	2,200,000	-
1201-B-f-Dz2	Dozer Assist-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Cat D11T CD	$71.92	$233.66	$28.65	1	9.2	$662	$2,151	$264	$3,077	28,733	-
1300-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Emma Backfill Areas	Cat D11T CD	$71.92	$233.66	$28.65	1	22.1	$1,592	$5,172	$634	$7,399	62,444	-
1301-B-f-Dz2	Dozer Assist-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Cat D11T CD	$71.92	$233.66	$28.65	1	25.5	$1,834	$5,957	$730	$8,521	76,780	-
1500-B-b-Dz2	Dozer Assist-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Cat D11T CD	$71.92	$233.66	$28.65	1	5.7	$411	$1,336	$164	$1,912	16,133	-
1000-C-b-Sh1	Load-Cover	Soil Stockpile	EMW Waste	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	39.1	$8,757	$19,891	$1,132	$29,780	119,624	-
1100-C-b-Sh1	Load-Cover	Soil Stockpile	6HW Waste	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	40.7	$9,130	$20,738	$1,180	$31,048	114,889	-
1201-C-f-Sh1	Load-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	9.2	$2,064	$4,688	$267	$7,019	28,733	-
1300-C-b-Sh1	Load-Cover	Soil Stockpile	Emma Backfill Areas	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	22.1	$4,962	$11,271	$641	$16,875	62,444	-
1301-C-f-Sh1	Load-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	25.5	$5,715	$12,981	$739	$19,435	76,780	-
1500-C-b-Sh1	Load-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Hitachi EX3600-5	$224.17	$509.18	$28.97	1	5.7	$1,282	$2,912	$166	$4,360	16,133	-
1000-D-b-Tk4	Haul-Cover	Soil Stockpile	EMW Waste	Komatsu 730E	$77.51	$221.35	$25.16	5	39.1	$15,139	$43,235	$4,914	$63,288	119,624	-
1100-D-b-Tk4	Haul-Cover	Soil Stockpile	6HW Waste	Komatsu 730E	$77.51	$221.35	$25.16	4	40.7	$12,626	$36,060	$4,099	$52,786	114,889	-
1201-D-f-Tk4	Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Komatsu 730E	$77.51	$221.35	$25.16	2	9.2	$1,427	$4,076	$463	$5,967	28,733	-
1300-D-b-Tk4	Haul-Cover	Soil Stockpile	Emma Backfill Areas	Komatsu 730E	$77.51	$221.35	$25.16	4	22.1	$6,863	$19,599	$2,228	$28,690	62,444	-
1301-D-f-Tk4	Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Komatsu 730E	$77.51	$221.35	$25.16	8	25.5	$15,808	$45,145	$5,131	$66,085	76,780	-
1500-D-b-Tk4	Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Komatsu 730E	$77.51	$221.35	$25.16	4	5.7	$1,773	$5,064	$576	$7,412	16,133	-
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	EMW Waste	-	Cat 16M - Final Grading	$25.75	$85.54	$30.93	1	30.4	$783	$2,600	$940	$4,323	-	74.1
1100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6HW Waste	-	Cat 16M - Final Grading	$25.75	$85.54	$30.93	1	29.2	$752	$2,497	$903	$4,152	-	71.2
1300-A-d-Mg1	Grade-Open Pit-Placed Cover	Emma Backfill Areas	-	Cat 16M - Final Grading	$25.75	$85.54	$30.93	1	15.9	$408	$1,357	$491	$2,256	-	38.7
1500-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Allowance for Other Disturbed Areas	-	Cat 16M - Final Grading	$25.75	$85.54	$30.93	1	4.2	$108	$358	$129	$595	-	10.0
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	EMW Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	39.1	$2,069	$6,378	$2,094	$10,541	-	-
1100-P-b-Comb1	Road Maintenance-Entire Stockpile	Soil Stockpile	6HW Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	40.7	$2,157	$6,650	$2,183	$10,989	-	-
1200-P-b-Comb1	Road Maintenance-Haul Roads	Soil Stockpile	Haul Roads	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	-	$0	$0	$0	$0	-	-
1300-P-b-Comb1	Road Maintenance-Open Pit	Soil Stockpile	Emma Backfill Areas	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	22.1	$1,172	$3,614	$1,186	$5,973	-	-
1301-P-b-Comb1	Road Maintenance-Collection Sump	Soil Stockpile	OP-1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	25.5	$1,350	$4,162	$1,366	$6,879	-	-
1500-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Soil Stockpile	Allowance for Other Disturbed Areas	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$52.95	$163.27	$53.60	1	5.7	$303	$934	$307	$1,543	-	-
									TOTAL	$751,854	$1,524,599	$187,465	$2,463,918	7,302,289	341

Revegetation Costs

Description:
Includes scarifying (ripping), discing, rangeland drill seeding, mulching, crimping, and daily per diem
May filter on equipement (D14) to show pertinent rows

ID	Description	Source Location 1	Destination Location 2	Area (ac)	Fuel Unit Cost ($/ac)	Reveg w/o Fuel Unit Cost ($/ac)	Fuel Direct Cost ($)	Reveg w/o Fuel Direct Cost ($)
1000-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	EMW Waste	-	74.1	$ 4.46	$ 852.45	$ 330	$ 63,207
1100-J-e-U2a	Revegetate-Entire Stockpile-Final Grade	6HW Waste	-	71.2	$ 4.46	$ 852.45	$ 317	$ 60,705
1200-J-e-U2a	Revegetate-Haul Roads-Final Grade	Haul Roads	-	39.1	$ 4.46	$ 852.45	$ 174	$ 33,302
1300-J-e-U2a	Revegetate-Open Pit-Final Grade	Emma Backfill Areas	-	38.7	$ 4.46	$ 852.45	$ 172	$ 32,994
1400-J-e-U2a	Revegetate-Entire Footprint-Final Grade	Soil Stockpile	-	8.3	$ 4.46	$ 852.45	$ 37	$ 7,075
1500-J-e-U2a	Revegetate-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	10.0	$ 4.46	$ 852.45	$ 45	$ 8,525
			TOTAL	241			$ 1,076	$ 205,808

Other Reclamation Activity Costs

Assumptions:
1 - Cost to construct drain or channel on re-graded stockpile
2 - The downdrain, ACB, well plug & abandon, and well replacement costs include fuel
May filter on equipement (D14) to show pertinent rows

ID	Description	Source Location 1	Destination Location 2	Quantity	Unit	Fuel Unit Cost ($/unit)	Unit Cost w/o Fuel ($/unit)[1,2]	Fuel Direct Cost ($)	Direct w/o Fuel Cost ($)
1002-F-e-U3	Grade Benches-Outslopes-Final Grade	EMW Waste	-	13,438	ft	$ 0.42	$ 1.60	$ 5,664.22	$ 21,455
1101-F-e-U3	Grade Benches-Reclaimed Slope Area-Final Grade	6HW Waste	-	13,200	ft	$ 0.42	$ 1.60	$ 5,563.90	$ 21,075
1002-G-e-U6	Construct Downdrains-Outslopes-Final Grade	EMW Waste	-	1,325	ft	$ -	$ 392.04	$ -	$ 519,456
1101-G-e-U6	Construct Downdrains-Reclaimed Slope Area-Final Grade	6HW Waste	-	781	ft	$ -	$ 392.04	$ -	$ 306,185
1002-Gb-e-U7	Construct Downdrain Dissipators-Outslopes-Final Grade	EMW Waste	-	2	ea	$ -	$ 15,106.89	$ -	$ 30,214
1101-Gb-e-U7	Construct Downdrain Dissipators-Reclaimed Slope Area-Final Grade	6HW Waste	-	1	ea	$ -	$ 15,106.89	$ -	$ 15,107
1002-H-e-U8a	Construct Channels w/ Riprap-Outslopes-Final Grade	EMW Waste	-	13,438	ft	$ 1.24	$ 7.02	$ 16,656.63	$ 94,286
1101-H-e-U8a	Construct Channels w/ Riprap-Reclaimed Slope Area-Final Grade	6HW Waste	-	13,200	ft	$ 1.24	$ 7.02	$ 16,361.63	$ 92,616
1301-Sa-e-U29	Chain Link Fence-Collection Sump-Final Grade	Emma Backfill Areas	-	120	ft	$ -	$ 24.65	$ -	$ 2,958
1301-U-e-U30	Vehicle Gates-Collection Sump-Final Grade	Emma Backfill Areas	-	1	ft	$ -	$ 957.01	$ -	$ 957
1302-X-e-U50	Shade Balls-Collection Sump- Operational Surface Area-Final Grade	Emma Backfill Areas	-	31,865	sf	$ -	$ 8.25	$ -	$ 262,886
							TOTAL	$ 44,246	$ 1,367,195

Emma Mine

Reclamation Summary Stockpiles, Haul Roads, Reservoirs, and Disturbed Areas

			Current Value
DIRECT COSTS	Facility and Structure Removal		$9,968
	Earthmoving		$2,463,918
	Revegetation		$206,884
	Other		$1,411,442
	Subtotal, Direct Costs		**$4,092,212**
INDIRECT COSTS	**Subtotal, Indirect Costs**	**30.0%**	**$1,227,663**
TOTAL COST			**$5,319,875**

Notes:

Indirect costs are based on 2019 agreement between FMI and agencies

Indirect costs include but are not limited to mobilization and demobilization, engineering redesign fee, contingencies, contractor profit and overhead, project management fee, and state procurement cost

Facility Characteristics

Facilities are categorized in this listing to meet the MMD reporting requirement

		1000	1100	1200	1300	1301	1305	1400	1500	
	Facility	**EMW Waste**	**6HW Waste**	**Haul Roads**	**Emma Backfill Areas**	**Collection Sump**	**Upper East**	**Soil Stockpile**	**Allowance for Other Disturbed Areas**	**Total**
	Reclaimed Acres[6]	74.15	71.21	39.07	38.70	3.08	4.73	8.30	10.00	**249.24**
	Item	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	
Direct Costs	Cover Material Excav, Haul, Grade[1]	$120,988	$112,586	$0	$61,192	$6,879	$0	$0	$15,822	**$317,467**
	Pullback or Backfill	$0	$0	$16,063	$0	$94,041	$0	$0	$0	**$110,104**
	Top/Outslope Adjustment Grading[2]	$264,063	$1,765,370	$4,709	$0	$0	$0	$1,000	$1,205	**$2,036,347**
	Scarify, Seed & Mulch, Reveg[3]	$63,537	$61,022	$33,476	$33,166	$0	$0	$7,112	$8,569	**$206,884**
	Channels & Benches[4]	$687,732	$456,909	$0	$0	$0	$0	$0	$0	**$1,144,641**
	Demolition	$0	$0	$9,968	$0	$0	$0	$0	$0	**$9,968**
	Other[5]	$0	$0	$0	$0	$266,801	$0	$0	$0	**$266,801**
	Capital Cost Totals	**$1,136,320**	**$2,395,888**	**$64,216**	**$94,358**	**$367,720**	**$0**	**$8,113**	**$25,596**	**$4,092,212**
	Capital Cost/Acre	**$15,325**	**$33,644**	**$1,644**	**$2,438**	**$119,464**	**$0**	**$977**	**$2,560**	**$16,419**
Indirect Costs	Cover Material Excav, Haul, Grade1	$36,296	$33,776	$0	$18,358	$2,064	$0	$0	$4,747	**$95,240**
	Pullback or Backfill	$0	$0	$4,819	$0	$28,212	$0	$0	$0	**$33,031**
	Top/Outslope Adjustment Grading[2]	$79,219	$529,611	$1,413	$0	$0	$0	$300	$362	**$610,904**
	Scarify, Seed & Mulch, Reveg[3]	$19,061	$18,307	$10,043	$9,950	$0	$0	$2,134	$2,571	**$62,065**
	Channels & Benches[4]	$206,320	$137,073	$0	$0	$0	$0	$0	$0	**$343,392**
	Demolition	$0	$0	$2,990	$0	$0	$0	$0	$0	**$2,990**
	Other[5]	$0	$0	$0	$0	$80,040	$0	$0	$0	**$80,040**
	Indirect Cost Totals	**$340,896**	**$718,766**	**$19,265**	**$28,308**	**$110,316**	**$0**	**$2,434**	**$7,679**	**$1,227,663**
	Indirect Cost/Acre	**$4,598**	**$10,093**	**$493**	**$731**	**$35,839**	**$0**	**$293**	**$768**	**$4,926**
	Total Cost	**$1,477,216**	**$3,114,654**	**$83,481**	**$122,666**	**$478,036**	**$0**	**$10,547**	**$33,275**	**$5,319,875**
	Total Cost Cover	$157,284	$146,362	$0	$79,550	$8,943	$0	$0	$20,568	$412,707
	Pullback or Backfill	$0	$0	$20,882	$0	$122,253	$0	$0	$0	$143,135
	Total Cost Top/Outslope Adjustment	$343,282	$2,294,981	$6,121	$0	$0	$0	$1,301	$1,567	$2,647,251
	Total Cost Earthwork	$500,566	$2,441,343	$27,004	$79,550	$131,195	$0	$1,301	$22,135	$3,203,093
	Capital Cost Re-Veg	$82,598	$79,329	$43,519	$43,116	$0	$0	$9,246	$11,140	$268,949
	Capital Cost Other[5]	$0	$0	$0	$0	$346,841	$0	$0	$0	$346,841
	Total Cost/Acre	**$19,923**	**$43,737**	**$2,137**	**$3,169**	**$155,303**	**$0**	**$1,271**	**$3,328**	**$21,345**
	Total Cost/Acre Cover	**$2,121**	**$2,055**	**$0**	**$2,055**	**$2,905**	**$0**	**$0**	**$2,057**	$1,656
	Pullback or Backfill	**$0**	**$0**	**$535**	**$0**	**$39,717**	**$0**	**$0**	**$0**	$574
	Total Cost/Acre Top/Outslope Adjustment	**$4,630**	**$32,227**	**$157**	**$0**	**$0**	**$0**	**$157**	**$157**	$10,621
	Total Cost/Acre Earthwork	**$6,751**	**$34,283**	**$691**	**$2,055**	**$42,622**	**$0**	**$157**	**$2,214**	$12,852
	Capital Cost/Acre Re-Veg	**$1,114**	**$1,114**	**$1,114**	**$1,114**	**$0**	**$0**	**$1,114**	**$1,114**	$1,079
	Capital Cost/Acre Other[5]	**$0**	**$0**	**$0**	**$0**	**$112,681**	**$0**	**$0**	**$0**	$1,392

1 Cover Material includes dozer assist, load, haul, grade cover, and water truck and motor grader for road maintenance and dust control during reclamation

2 Top/Outslope Adjustment Grading includes rough grading and ripping before placing cover

3 Revegetation includes scarifying, discing, drill speeding, mulching, crimping, per diem, mobilization, seeding, and mulching

4 Channels & Benches includes channels, downdrains, benches

5 Other includes well installation/closure, well replacement, berm construction, fencing and signage, and seepage collection/interceptor trench installation

6 Capital costs before O&M

Truck Optimization

Notes and Assumptions

This sheet calculates the most efficient number of trucks (up to 10 or maximum) per loader or shovel for loading cover material at borrow stockpiles. See the calculation sheet for more information.

May filter on equipement (D14) to show pertinent rows

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Loading Equipment ID	Work Hour (min/hr)	Loader/ Shovel/ Excavator/ Cycles per Truck	Loader/Shovel/ Excavator Cycle Time (min)	Loader/Shovel/ Excavator Time Per Truck (min)	Truck Cycle Time Per Truck (min)	Max Number Trucks Per Loader/Shovel/ Excavator	Loader/ Shovel/ Excavator Cost ($/hr)	Loader Net Bucket Capacity (cy)	Haul Volume (cy)	Productivity for X Trucks (cy/hr)									
															Max Trucks Round Up	Max Trucks Round Down	9	8	7	6	5	4	3	2
1000-D-b-Tk4	Haul-Cover	Soil Stockpile	EMW Waste	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	11.46	5.10	$ 538.15	28.09	119,623.81	3,674.66	3,062.22	5,511.99	4,899.54	4,287.10	3,674.66	3,062.22	2,449.77	1,837.33	1,224.89
1100-D-b-Tk4	Haul-Cover	Soil Stockpile	6HW Waste	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	9.96	4.42	$ 538.15	28.09	114,889.41	3,526.17	2,820.93	6,347.10	5,641.87	4,936.64	4,231.40	3,526.17	2,820.93	2,115.70	1,410.47
1201-D-f-Tk4	Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	4.05	1.80	$ 538.15	28.09	28,732.60	3,467.28	1,733.64	15,602.78	13,869.14	12,135.49	10,401.85	8,668.21	6,934.57	5,200.93	3,467.28
1300-D-b-Tk4	Haul-Cover	Soil Stockpile	Emma Backfill Areas	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	9.96	4.42	$ 538.15	28.09	62,443.72	3,526.17	2,820.93	6,347.10	5,641.87	4,936.64	4,231.40	3,526.17	2,820.93	2,115.70	1,410.47
1301-D-f-Tk4	Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	18.65	8.29	$ 538.15	28.09	76,780.08	3,388.12	3,011.66	3,388.12	3,011.66	2,635.20	2,258.75	1,882.29	1,505.83	1,129.37	752.92
1500-D-b-Tk4	Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	9.96	4.42	$ 538.15	28.09	16,133.33	3,526.17	2,820.93	6,347.10	5,641.87	4,936.64	4,231.40	3,526.17	2,820.93	2,115.70	1,410.47

Truck Optimization

Notes and Assumptions

This sheet calculates the most efficient number of trucks (up to 10 or maximum) per loader or shovel for loading cover material at borrow stockpiles. See the calculation sheet for more information.

May filter on equipement (D14) to show pertinent rows

Task Description	Source Location 1	Destination Location 2	Equipment	Task Time for X Trucks (hr): Max Trucks Round Up	Max Trucks Round Down	9	8	7	6	5	4	3	2	Loader/ Shovel Task Time (hr)	Truck Cost ($/hr)
Haul-Cover	Soil Stockpile	EMW Waste	Komatsu 730E	32.55	39.06	21.70	24.42	27.90	32.55	39.06	48.83	65.11	97.66	38.33	$ 246.51
Haul-Cover	Soil Stockpile	6HW Waste	Komatsu 730E	32.58	40.73	18.10	20.36	23.27	27.15	32.58	40.73	54.30	81.45	36.82	$ 246.51
Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	Haul Roads	-	Komatsu 730E	8.29	16.57	1.84	2.07	2.37	2.76	3.31	4.14	5.52	8.29	9.21	$ 246.51
Haul-Cover	Soil Stockpile	Emma Backfill Areas	Komatsu 730E	17.71	22.14	9.84	11.07	12.65	14.76	17.71	22.14	29.51	44.27	20.01	$ 246.51
Haul-Collection Sump-Fill/Stockpile Material	EMW Waste	Emma Backfill Areas	Komatsu 730E	22.66	25.49	22.66	25.49	29.14	33.99	40.79	50.99	67.98	101.98	24.60	$ 246.51
Haul-Cover	Soil Stockpile	Allowance for Other Disturbed Areas	Komatsu 730E	4.58	5.72	2.54	2.86	3.27	3.81	4.58	5.72	7.63	11.44	5.17	$ 246.51

Task Description	Cost of Using X Trucks per Loader ($): Max Trucks Round Up	Max Trucks Round Down	9	8	7	6	5	4	3	2	Lowest Cost ($)	Optimum Number of Trucks Per Loader/Shovel/Excavator	Optimum Number of Trucks Per Loader/ Shovel/ Excavator Within Max
Haul-Cover	$ 77,328.38	$ 69,171.79	$ 105,677.74	$ 96,227.95	$ 86,778.17	$ 77,328.38	$ 69,171.79	$ 74,427.46	$ 83,186.92	$ 100,705.83	$ 69,171.79	5	5.00
Haul-Cover	$ 65,192.13	$ 62,076.65	$ 101,495.28	$ 92,419.50	$ 83,343.71	$ 74,267.92	$ 65,192.13	$ 62,076.65	$ 69,382.53	$ 83,994.27	$ 62,076.65	4	4.00
Haul-Oak Grove Wash Fill Removal-Fill/Stockpile Material	$ 9,494.58	$ 13,004.68	$ 25,382.87	$ 23,113.12	$ 20,843.36	$ 18,573.60	$ 16,303.85	$ 14,034.09	$ 11,764.34	$ 9,494.58	$ 9,494.58	2	2.00
Haul-Cover	$ 35,432.68	$ 33,739.38	$ 55,163.86	$ 50,231.07	$ 45,298.27	$ 40,365.47	$ 35,432.68	$ 33,739.38	$ 37,710.21	$ 45,651.86	$ 33,739.38	4	4.00
Haul-Collection Sump-Fill/Stockpile Material	$ 67,828.85	$ 63,996.73	$ 67,828.85	$ 63,996.73	$ 65,956.70	$ 68,570.00	$ 72,228.62	$ 77,716.55	$ 86,863.11	$ 105,156.21	$ 63,996.73	8	8.00
Haul-Cover	$ 9,154.60	$ 8,717.11	$ 14,252.46	$ 12,978.00	$ 11,703.53	$ 10,429.07	$ 9,154.60	$ 8,717.11	$ 9,743.03	$ 11,794.89	$ 8,717.11	4	4.00

Scraper Optimization

Notes and Assumptions

This sheet calculates the most efficient number of scrapers (up to 10 or maximum) per dozer. The dozer assists scrapers for rough grading at waste rock stockpiles. See the calculation sheet for more information.
May filter on equipement (D14) to show pertinent rows

											Task Time for X Scrapers (hr)											Cost of Using X Scrapers per Dozer ($)							
ID	**Task Description**	**Source Location 1**	**Destination Location 2**	**Equipment**	**Scraper R/T Task Time (min)**	**Pusher Cycle Time (min/cycle)**	**Max Number of Scrapers per Dozer**	**Dozer Type**	**Dozer Cost ($/hr)**	**Task Time for one Scraper (hr)**	**Max Scrapers Round Up**	**Max Scrapers Round Down**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**Scrapers Cost ($/hr)**	**Max Scrapers Round Up**	**Max Scrapers Round Down**	**9**	**8**	**7**	**6**	**5**	**4**
1101-A-a-Sc	Grade-Reclaimed	6HW Waste	-	Cat 657G	2.85	1.44	1.98	-	-	4,479.64	2,239.82	4,479.64	497.74	559.95	639.95	746.61	895.93	#######	#######	#######	$ 261.12	$ 1,169,716.97	$ 1,169,716.97	###########	###########	###########	###########	###########	###########

imization

ssumptions

ılculates the most efficient number of scrapers (up to 10 or maximum) per
ers for rough grading at waste rock stockpiles. See the calculation sheet f

equipement (D14) to show pertinent rows

Task Description	Source Location 1	Destination Location 2	Equipment	3	2	1	Lowest Cost ($)	Optimum Number of Scrapers Per Dozer	Optimum Number of Scrapers Per Dozer Within Max
Grade-Reclaimed	6HW Waste	-	Cat 657G	###########	###########	###########	$ 1,169,716.97	1.00	1.00

Emma Mine
O&M Worksheet #1
11/12/2021

Vegetation Maintenance Costs - Full site

Based on observations of previously reclaimed areas, the annual vegetation failure is conservatively estimated to be 2% failure every year for a total of 12 years, starting the year reclamation is completed.
Vegetation maintenance begins at each facility sub-area/location the year that reclamation is completed for that facility sub-area/location.
May filter on equipement (D14) to show pertinent rows
Assumptions/Inputs:

Reclamation Start = January 1, 2027
Reclamation End = December 31, 2043
No. Years Reclamation = 17
No. Years Veg Maint = 12
% loss per year = 2%

ID	Description	Source Location 1	Destination Location 2	Total Area (ac)	Approx. Year Reclamation Start	Approx. Date Veg Maintenance Start	Approx. Date Veg Maintenance Complete	Number of Years of Veg Maintenance	% Loss Per Year	Veg Maint Area (ac)	Fuel Unit Cost ($/ac)	Veg Maint Unit Cost ($/ac)	Fuel Cost ($)	Veg Maint Cost ($)	Maint. Description
1000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	EMW Waste	-	74.1	Jan-28	Dec-30	Dec-42	12	2%	17.8	$4.46	$852.45	$79	$15,170	2% of veg fails every year for 12 years
1100-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6HW Waste	-	71.2	Jan-28	Dec-29	Dec-41	12	2%	17.1	$4.46	$852.45	$76	$14,569	2% of veg fails every year for 12 years
1200-M-e-U	Post-Closure O&M-Haul Roads-Final Grade	Haul Roads	-	39.1	Jan-28	Dec-30	Dec-42	12	2%	9.4	$4.46	$852.45	$42	$7,993	2% of veg fails every year for 12 years
1300-M-e-U	Post-Closure O&M-Open Pit-Final Grade	Emma Backfill Areas	-	38.7	Jan-28	Dec-30	Dec-42	12	2%	9.3	$4.46	$852.45	$41	$7,919	2% of veg fails every year for 12 years
1305-M-e-U	Post-Closure O&M-Upper East-Final Grade	Emma Backfill Areas	-	4.7	Jan-26	Dec-26	Dec-38	12	2%	1.1	$4.46	$852.45	$5	$967	2% of veg fails every year for 12 years
1400-M-e-U	Post-Closure O&M-Entire Footprint-Final Grade	Soil Stockpile	-	8.3	Jan-31	Dec-31	Dec-43	12	2%	2.0	$4.46	$852.45	$9	$1,698	2% of veg fails every year for 12 years
1500-M-e-U	Post-Closure O&M-Unplanned Disturbance Area-Final Grade	Allowance for Other Disturbed Areas	-	10.0	Jan-28	Dec-30	Dec-42	12	2%	2.4	$4.46	$852.45	$11	$2,046	2% of veg fails every year for 12 years
			TOTAL O&M AREA	246	**AC**				**TOTAL VEG MAINT AREA**	59	**AC**	**TOTAL**	$263	$50,361	

Operations & Maintenance -Full Site Reclamation begins Jan-27 (Year 0)

EROSION CONTROL [1]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$2,919	$2,919	$2,919	$/day
Fuel Base	$345	$345	$345	
Time:	0.50	0.38	0.25	day/yr
Equiment Annual:	$1,460	$1,095	$730	$/yr
Fuel Annual:	$172	$129	$86	$/yr

Year	Annual Current Equipment Cost ($)	Annual Current Fuel. Cost ($)	Notes
1	$28	$3	Weighted based on total reclaimed area
2	$28	$3	Weighted based on total reclaimed area
3	$28	$3	Weighted based on total reclaimed area
4	$450	$53	Weighted based on total reclaimed area
5	$1,410	$167	Weighted based on total reclaimed area
6	$1,460	$172	Weighted based on total reclaimed area
7	$1,460	$172	
8	$1,460	$172	
9	$1,460	$172	
10	$1,460	$172	
11	$1,460	$172	
12	$1,460	$172	
13	$1,460	$172	
14	$1,460	$172	
15	$1,460	$172	
16	$1,460	$172	
17	$1,460	$172	
18	$1,460	$172	
19	$1,460	$172	
20	$1,095	$129	
21	$1,095	$129	
22	$1,095	$129	
23	$1,095	$129	
24	$1,095	$129	
25	$1,095	$129	
26	$1,095	$129	
27	$1,095	$129	
28	$1,095	$129	
29	$1,095	$129	
30	$1,095	$129	
31	$1,095	$129	
32	$1,095	$129	
33	$1,095	$129	
34	$1,095	$129	
35	$1,095	$129	
36	$1,095	$129	
37	$1,095	$129	
38	$1,095	$129	
39	$1,095	$129	
40	$730	$86	
41	$730	$86	
42	$730	$86	
43	$730	$86	
44	$730	$86	
45	$730	$86	
46	$730	$86	
47	$730	$86	
48	$730	$86	
49	$730	$86	
50	$730	$86	
51	$730	$86	
52	$730	$86	
53	$730	$86	
54	$730	$86	
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56	$730	$86	
57	$730	$86	
58	$730	$86	
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66	$730	$86	
67	$730	$86	
68	$730	$86	
69	$730	$86	
70	$730	$86	
71	$730	$86	
72	$730	$86	
73	$730	$86	
74	$730	$86	
75	$730	$86	
76	$730	$86	
77	$730	$86	
78	$730	$86	
79	$730	$86	
80	$730	$86	
81	$730	$86	
82	$730	$86	
83	$730	$86	
84	$730	$86	
85	$730	$86	
86	$730	$86	
87	$730	$86	
88	$730	$86	
89	$730	$86	
90	$730	$86	
91	$730	$86	
92	$730	$86	
93	$730	$86	
94	$730	$86	
95	$730	$86	
96	$730	$86	
97	$730	$86	
98	$730	$86	
99	$730	$86	
100	$730	$86	
Capital Cost	$88,788	$10,485	

Total Capital Cost Erosion Control, Road Maintenance, Tailing Cover Maintenance, and Groundwater Monitoring **$1,995,743** **$96,151**

ROAD MAINTENANCE [2]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$875	$875	$875	$/event
Fuel Base	$222	$222	$222	
Time:	4.00	4.00	4.00	events/yr
Equipment Annual:	$3,502	$3,502	$3,502	$/yr
Fuel Annual:	$889	$889	$889	$/yr

Year	Annual Current Euipment Cost ($)	Annual Current Fuel. Cost ($)	Notes
1	$67	$17	Weighted based on total reclaimed area
2	$67	$17	Weighted based on total reclaimed area
3	$67	$17	Weighted based on total reclaimed area
4	$1,080	$274	Weighted based on total reclaimed area
5	$3,384	$859	Weighted based on total reclaimed area
6	$3,502	$889	Weighted based on total reclaimed area
7	$3,502	$889	
8	$3,502	$889	
9	$3,502	$889	
10	$3,502	$889	
11	$3,502	$889	
12	$3,502	$889	
13	$3,502	$889	
14	$3,502	$889	
15	$3,502	$889	
16	$3,502	$889	
17	$3,502	$889	
18	$3,502	$889	
19	$3,502	$889	
20	$3,502	$889	
21	$3,502	$889	
22	$3,502	$889	
23	$3,502	$889	
24	$3,502	$889	
25	$3,502	$889	
26	$3,502	$889	
27	$3,502	$889	
28	$3,502	$889	
29	$3,502	$889	
30	$3,502	$889	
31	$3,502	$889	
32	$3,502	$889	
33	$3,502	$889	
34	$3,502	$889	
35	$3,502	$889	
36	$3,502	$889	
37	$3,502	$889	
38	$3,502	$889	
39	$3,502	$889	
40	$3,502	$889	
41	$3,502	$889	
42	$3,502	$889	
43	$3,502	$889	
44	$3,502	$889	
45	$3,502	$889	
46	$3,502	$889	
47	$3,502	$889	
48	$3,502	$889	
49	$3,502	$889	
50	$3,502	$889	
51	$3,502	$889	
52	$3,502	$889	
53	$3,502	$889	
54	$3,502	$889	
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56	$3,502	$889	
57	$3,502	$889	
58	$3,502	$889	
59	$3,502	$889	
60	$3,502	$889	
61	$3,502	$889	
62	$3,502	$889	
63	$3,502	$889	
64	$3,502	$889	
65	$3,502	$889	
66	$3,502	$889	
67	$3,502	$889	
68	$3,502	$889	
69	$3,502	$889	
70	$3,502	$889	
71	$3,502	$889	
72	$3,502	$889	
73	$3,502	$889	
74	$3,502	$889	
75	$3,502	$889	
76	$3,502	$889	
77	$3,502	$889	
78	$3,502	$889	
79	$3,502	$889	
80	$3,502	$889	
81	$3,502	$889	
82	$3,502	$889	
83	$3,502	$889	
84	$3,502	$889	
85	$3,502	$889	
86	$3,502	$889	
87	$3,502	$889	
88	$3,502	$889	
89	$3,502	$889	
90	$3,502	$889	
91	$3,502	$889	
92	$3,502	$889	
93	$3,502	$889	
94	$3,502	$889	
95	$3,502	$889	
96	$3,502	$889	
97	$3,502	$889	
98	$3,502	$889	
99	$3,502	$889	
100	$3,502	$889	
Capital Cost	$337,319	$85,666	

GROUNDWATER MONITORING [3]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$1,194	$1,194	$1,194	$/day
Aqueous Chemistry Base:	$550	$550	$550	$/day
Time:	9.0	9.0	9.0	days/yr
Equipment Annual:	$10,746.36	$10,746	$10,746	$/yr
Aqueous Chemistry Annual:	$4,950	$4,950	$4,950	$/yr

Year	Annual Current Cost ($)	Notes
1	$15,696	
2	$15,696	
3	$15,696	
4	$15,696	
5	$15,696	
6	$15,696	
7	$15,696	
8	$15,696	
9	$15,696	
10	$15,696	
11	$15,696	
12	$15,696	
13	$15,696	
14	$15,696	
15	$15,696	
16	$15,696	
17	$15,696	
18	$15,696	
19	$15,696	
20	$15,696	
21	$15,696	
22	$15,696	
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24	$15,696	
25	$15,696	
26	$15,696	
27	$15,696	
28	$15,696	
29	$15,696	
30	$15,696	
31	$15,696	
32	$15,696	
33	$15,696	
34	$15,696	
35	$15,696	
36	$15,696	
37	$15,696	
38	$15,696	
39	$15,696	
40	$15,696	
41	$15,696	
42	$15,696	
43	$15,696	
44	$15,696	
45	$15,696	
46	$15,696	
47	$15,696	
48	$15,696	
49	$15,696	
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67	$15,696	
68	$15,696	
69	$15,696	
70	$15,696	
71	$15,696	
72	$15,696	
73	$15,696	
74	$15,696	
75	$15,696	
76	$15,696	
77	$15,696	
78	$15,696	
79	$15,696	
80	$15,696	
81	$15,696	
82	$15,696	
83	$15,696	
84	$15,696	
85	$15,696	
86	$15,696	
87	$15,696	
88	$15,696	
89	$15,696	
90	$15,696	
91	$15,696	
92	$15,696	
93	$15,696	
94	$15,696	
95	$15,696	
96	$15,696	
97	$15,696	
98	$15,696	
99	$15,696	
100	$15,696	
Direct Cost	$1,569,636	

[1] Erosion Control
Equipment - EquipmentWatch
Labor -2021 NM Department of Labor Type H (Heavy Engineering) labor rates.

	#	$/hour	$/day		
Labor Foreman (outside)	1	$24.63	$197.04		
Laborers	2	$23.88	$382.08		
Equipment Operators (med)	1	$28.77	$230.16		
Truck Drivers (heavy)	2	$24.57	$393.12		
		equipment $/hr	**fuel $/hr**	**equipment $/day**	**fuel $/day**
Cat 966H	1	$66.00	$10.46	$528.01	$83.68
Cat 725	2	$74.29	$16.31	$1,188.71	$261.03

	Equipment Cost	Fuel Cost	
Total Direct Cost	**$2,919**	**$345**	**$/day**

[2] Road Maintenance Crew
Equipment - EquipmentWatch
Labor -2021 NM Department of Labor Type H (Heavy Engineering) labor rates.

	Equipment Cost ($/hr)	Fuel Cost ($/hr)	Labor Rate ($/hr)	Equipment Subtotal 4 hrs/month ($/month)	Fuel Subtotal 4 hrs/month ($/month)
Cat 14M Motor Grader	$88.60	$22.47	$30.93	$478	$124
6,000-gal Water Truck	$74.67	$30.49	$24.65	$397	$99

	Equipment Cost	Fuel Cost	
Total Direct Cost	**$875**	**$222**	**$/month**

[3] Groundwater Monitoring
Equipment - EquipmentWatch
Labor -2021 NM Department of Labor Type H (Heavy Engineering) labor rates.

	#	$/hour	$/day (4 hrs/day)
Labor Foreman (outside)	1	$24.63	$98.52
Laborers	1	$23.88	$95.52
		$/year	**$/day**
Rental Equipment	1	$8,000.00	$888.89
Misc. Field Equipment	1	$1,000.00	$111.11
Aqueous Chemistry Years 0-19	6	$4,950.00	$550.00
Aqueous Chemistry Years 20-39	6	$4,950.00	$550.00
Aqueous Chemistry Years 40-99	6	$4,950.00	$550.00

	Equipment & Fuel Cost	Aqueous Chemistry Cost
Total Direct Cost Years 0-1	**$1,194**	**$550**
Total Direct Cost Years 2-7	**$1,194**	**$550**
Total Direct Cost Years 8-29	**$1,194**	**$550**

Emma Mine

Operations and Maintenance Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$0
	Earthmoving		$0
	Vegetation		$50,624
	Other		$2,091,895
	Subtotal, Direct Costs		**$2,142,519**
INDIRECT COSTS	**Subtotal, Indirect Costs**	**17.5%**	**$374,941**
TOTAL COST			**$2,517,459**

Notes:

Indirect costs are based on 2019 agreement between FMI and agencies

Indirect costs include but are not limited to mobilization and demobilization, engineering redesign fee, contingencies, contractor profit and overhead, project management fee, and state procurement cost

Riprap and Gravel Unit Cost

Earthwork
Loading per cy

Task Description	Equipment	Load, Dump, Maneuver Time (min)	Work Time (min)	Loads/ hr	Net Bucket (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Loader+Oper Cost ($/hr)	Load+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
Load riprap	Cat 992K	0.65	50	76.92	14.00	1076.92	19.49	52.82	231.84	28.97	260.81	0.24	0.05	0.29
Load filter	Cat 992K	0.65	50	76.92	14.00	1076.92	19.49	52.82	231.84	28.97	260.81	0.24	0.05	0.29
Transfer riprap for placing	Cat 992K	0.65	50	76.92	14.00	1076.92	19.49	52.82	231.84	28.97	260.81	0.24	0.05	0.29
Transfer filter for placing	Cat 992K	0.65	50	76.92	14.00	1076.92	19.49	52.82	231.84	28.97	260.81	0.24	0.05	0.29

Hauling

Task Description	Equipment	Exchange Time (min)	Delivery Travel Time[1] (min)	Unload and Maneuver Time (min)	Return Travel Time[1] (min)	Load Time (min)	Total Time (min)	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck+Op Cost ($/hr)	Truck + Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
Haul riprap from source to site	Komatsu 730E	0.70	5.31	1.10	2.63	6.73	16.48	50	3.03	145	440	28.60	77.51	221.35	25.16	246.51	0.56	0.18	0.74
Haul filter from source to site	Komatsu 730E	0.70	5.31	1.10	2.63	6.73	16.48	50	3.03	145	440	28.60	77.51	221.35	25.16	246.51	0.56	0.18	0.74

Placing

Task Description	Equipment	Distance	Grade	Exchange Time (min)	Delivery Travel Time (min)	Unload and Maneuver Time (min)	Return Travel Time (min)	Load Time (min)	Total Time (min)	Work Time (min)	Loads/ hr	Heaped Capacity (cy/load)	Production Rate (cy/hr)	Fuel Use Gal per Hour	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost ($/hr)	Truck + Op Cost ($/hr)	Truck+Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
Place riprap	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74	0.87	6.67	50	7.50	19	141.01	6.02	16.31	74.29	24.65	98.94	0.70	0.12	0.82
Place filter	Cat 725	400.00	-30%	0.70	3.25	1.10	0.74	0.87	6.67	50	7.50	19	141.01	6.02	16.31	74.29	24.65	98.94	0.70	0.12	0.82

Grading

Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Operator Factor	Work Time (min)	Visibility Factor[2]	Elevation Factor	Transmission Factor	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer +Op Cost ($/hr)	Dozer +Op Cost ($/cy)	Fuel Cost ($/cy)	Total Cost ($/cy)
Finish grade -Filter	Cat D6T, SU Blade	304.38	1.0	1.02	3500	1.0	50	727	1	50	1	1.00	1.00	17.75	64.33	28.65	92.98	0.31	0.06	0.36
Finish grade - Riprap	Cat D6T, SU Blade	230.34	0.8	1.02	3700	1.0	50	727	1	50	1	1.00	1.00	17.75	64.33	28.65	92.98	0.40	0.08	0.48

Riprap & Filter Production Rates

Equipment	Equipment Cost ($/hr)	Fuel Cost ($/hr)	# Equipment	Operator ($/hr)	# Operator	Total Equipment Cost ($/hr)	Total Fuel Cost ($/hr)
Cat 988H	$ 121.23	$ 24.74	1	$ 28.97	1	$ 150.20	$ 24.74
Cat 769D	$ 100.18	$ 22.52	3	$ 24.65	3	$ 374.48	$ 67.56
1 Deck Screening Plant (5X16, 48X60)	$ 74.61	$ 13.14	1	$ 23.88	1	$ 98.49	$ 13.14
3 Deck Screening Plant (5X16, 42X60)	$ 110.28	$ 13.14	1	$ 23.88	1	$ 134.16	$ 13.14
Cat 980H	$ 85.07	$ 14.50	2	$ 28.97	2	$ 228.08	$ 29.00
Cat 992K	$ 231.84	$ 52.82	0	$ 28.97	0	$ -	$ -
Cat 966H	$ 66.00	$ 10.46	1	$ 28.97	1	$ 94.97	$ 10.46
Off-Hwy Water Tanker Truck,6,000-gal.	$ 74.67	$ 30.49	1	$ 24.65	1	$ 99.32	$ 30.49
Supervisor	$ -	-	0	$ 24.63	1	$ 24.63	$ -

Direct Costs

	Equipment	Fuel	
	$ 1,204	$ 189	$/hr
	8	8	hr/work day
	$ 9,635	$ 1,508	$/day

Production

400	tons input/hr (total)
0.30	% waste
0.70	% rip rap and gravel/filter
280	tons produced/hr (net)
560,000	lb/hr
3,650	lb/cy
153	cy/hr
8	hr/day (net (60 min/hr))
1,227	cy/day net production

Production	$ 7.85	$ 1.23	$/cy
Filter Delivery and placement	$ 2.05	$ 0.45	$/cy
Rip Rap Delivery and placement	$ 2.15	$ 0.47	$/cy

ASSUMPTIONS

Work Day
8 hrs
50 min hour

Equipment Rates
Source: 2020 EquipmentWatch
Corrected for 50 min work hour
Includes overhaul labor, parts & time

Production
Primary plant fed directly by two 769D haul trucks, 300 to 400 yd haul
400 tons input/hr (per Rusty McCauley, equipment peak production is 900 tons/hr)
30% - 60% waste depending on smallest rip rap size used. (per Rusty McCauley, consistent w/ Mc+C63Cain Springs waste rate of 43% - 1" minus)
3650 lb/cy (Caterpillar Performance Handbook p. 27-4, consistent with 1.8 tons/cy riprap unit weight)

Equipment & Labor	Rate ($/hr)	Comment
One 988H Loader with Operator (bucket = 8.3 cy)	$ 150.20	Used to load stockpiled material to 769D trucks and 777 haul trucks
Three 769D haul trucks with drivers (22 cy, 36 ton payload each)	$ 374.48	Option: Two used to directly feed primary screening plant, one used to move material from end of conveyor
One 1 Deck Portable Screening Plant w/ 5x16 screen & 48"x60' conveyor + 1 Operator	$ 98.49	Primary screening plant, grizzly used to split oversized, 6" - 12" and 6" minus (2 conveyers) One operator required in tower to run screening plant
One 3 Deck Portable Screening Plant w/ 5x16 screen & 42"x60' conveyor + 1 Operator	$ 134.16	One operator required in tower to run screening plant Fed with 6" minus, Produce 6" - 6", 1.5" - 3", 3/8" - 1.5", 3/8 minus One operator required in tower to run screening plant
Two Cat 980H Loaders with Operator (bucket = 7.5 cy)	$ 228.08	Used move material to conveyors or load trucks
Zero Cat 992K Loaders with Operator (bucket = 16 cy)	$ -	Unused loader option
One Cat 966H Loader with Operator (bucket = 5.5 cy)	$ 94.97	Used to move material from end of conveyors & load trucks
One Water Truck with Driver (10,000 gal)	$ 99.32	Dust suppression
One Foreman	$ 24.63	

	Equipment	Fuel	Total	
Total Unit Cost	$ 12.05	$ 2.14	$ 14.20	$/cy

1. Riprap and filter haul uses site-wide borrow haul time average

Bench Grading Unit Cost

Bench Grading - 3:1 Stockpiles

Task Description	Equipment	Productivity (cy/hr)	Productivity (hrs/ft)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/ Blade Factor	Centroid to Centroid Push Distance (feet)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	# Passes	Speed (miles/hr)	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)	
Excavate	Cat D11T CD	1660	-	1.2	1.0	3600	1.0	87	3396	0.75	50	1.0	1.0	1.0	-	-	9.26	0.0056	$71.92	$233.66	$28.65	$262.31	$1.46	$0.40	
Finish Grade	Cat D6T XL, SU Blade	-	0.0012	1.2	1.0	3600	1.0	-	-	0.75	50	1.0	1.0	1.0	3	1.0	-	0.0012	$17.45	$86.02	$28.65	$114.67	$0.13	$0.02	
																							$1.60	$0.42	**$2.02 Total**

Bench Grading -Tailings

Task Description	Equipment	Productivity (cy/hr)	Productivity (hrs/ft)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/ Blade Factor	Centroid to Centroid Push Distance (feet)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	# Passes	Speed (miles/hr)	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)	
Excavate	Cat D11T CD	1660	-	1.2	1.0	3600	1.0	87	3396	0.75	50	1.0	1.0	1.0	-	-	9.26	0.0056	$71.92	$233.66	$28.65	$262.31	$1.46	$0.40	
Finish Grade	Cat D6T XL, SU Blade	-	0.0012	1.2	1.0	3600	1.0	-	-	0.75	50	1.0	1.0	1.0	3	1.0	-	0.0012	$17.45	$86.02	$28.65	$114.67	$0.13	$0.02	
																							$1.60	$0.42	**$2.02 Total**

Channel Unit Cost

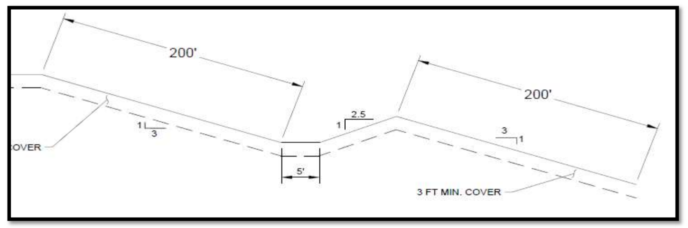
Earthwork

	Task Description	Equipment	Volume[3] (cy/ft)	Productivity (cy/hr)	Material Factor	Grade Factor	Material Weight (lb/cy)	Production Method/ Blade Factor	Centroid to Centroid Push Distance (feet)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Bench Equipment Cost ($/ft)	Bench Fuel Cost ($/ft)	
Channels	Excavate	Cat D11T CD	0.78	905	1.20	1.0	3600	1.00	175	1851	0.75	50	1.00	1.00	1.00	0.0009	71.92	233.66	28.65	262.31	0.23	0.06	
Channels	Waste	Cat D11T CD	0.78	806	1.20	1.0	3600	1.00	200	1649	0.75	50	1.00	1.00	1.00	0.0010	71.92	233.66	28.65	262.31	0.25	0.07	
																					0.48	0.13	0.61 Total

Filter	0.22	cy/ft	$ 2.16	$ 0.37	
Rip Rap	0.44	cy/ft	$ 4.37	$ 0.74	
Total Unit Cost			$7.02	$1.24	$8.26 $/ft

CHANNELS

Dimensions:		
Left Side Slope:[1]	3.00	H:1V
Left Side Slope:[1]	2.50	H:1V
Depth:[1]	2.00	ft
Left Side Slope Length:[1]	3.61	
Right Side Slope Length:[1]	3.20	
Bottom Width:	5.00	ft
Left Anchor[1]	0.00	ft
Right Anchor[1]	0.00	ft
Perimeter:[1]	11.81	ft
Excavation Area:[1]	21.00	sf
Filter Area[2]	5.90	sf
Riprap Area	11.81	sf



1. Assigned based on previous use at other FMI New Mexico operations
2. Bench cross width* 6" filter thickness or 12" riprap thickness
3. Volume (cy) =Area(sf)*Length(ft)/27

Downdrain Unit Cost

Rough Grade

Task Description	Equipment	Productivity (cy/hr)	Material Factor	Grade Factor	Soil Weight (lb/cy)	Production Method/Blade Factor	Centroid to Centroid Push Distance (ft)	Normal Production (cy/hr)	Operator Factor	Work Hour (min/hr)	Visibility Factor	Elevation Factor	Transmission Factor	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Equipment w/o Fuel Cost ($/ft)	Fuel Cost ($/ft)	Total Excavation Cost ($/ft)
Excavate	Cat D11T CD	1394	1.2	1.6	3600	1.0	175	1851	0.75	50	1.0	1.0	1.0	6.7	0.0048	$71.92	$233.66	$28.65	$262.31	$1.26	$0.34	$1.60
Waste	Cat D11T CD	1242	1.2	1.6	3600	1.0	200	1649	0.75	50	1.0	1.0	1.0	6.7	0.0054	$71.92	$233.66	$28.65	$262.31	$1.41	$0.39	$1.80
								.												$2.67	$0.73	$3.40

Finish Grade & Place ACB

	Area (sf/ft)	Unit Cost ($/sf)	$/ft
Downdrain ACBs			
40T[1]	31	$7.72	$239.31
Installation[1]	31	$4.82	$149.33
		ACB Cost/ft	**$388.64**

Total Downdrain Cost ($/ft)	**$392.04**

Place ACB

Dissipater ACBs	Area (sf)	Unit Cost ($/sf)	$/sf
70T[1]	320	$11.08	$3,545.68
Installation[1]	320	$4.82	$1,541.46
40T[1]	506	$7.72	$3,906.20
Installation[1]	506	$4.82	$2,437.43
		ACB Cost per Dissipater	**$11,430.77**

Install Cutoff Wall

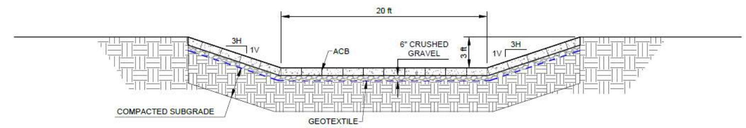
Cutoff Wall (cast in place concrete)	cubic yard	$/cubic yard	**$/dissipater[3]**
RSMeans (2020)	14	$ 262.58	**$3,676.12**

Total Dissipator Cost ($/each)	**$15,106.89**

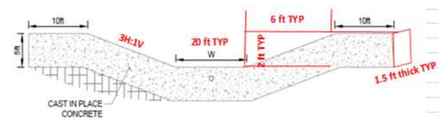
DOWNDRAIN Dimensions:			
Left Side Slope:	3	H:1V	
Right Side Slope:	3	H:1V	
Depth:	3	ft	
Perimeter:	38	ft	
Excavation Area	180	sf	
ACB Area[2]	31	sf	38.973666 1.248712

DISSIPATERS	**ACB[2]**				**Cutoff Wall[2,4]**		
	Surface Area 1	**Surface Area 2**	**Surface Area 3**	**Total**	**Cross-Sectional Area**	**Thickness**	**Volume**
	(sf)	**(sf)**	**(sf)**	**(sf)**	**(sf)**	**(ft)**	**(cy)**
	253	320	253	825	260	1.5	14

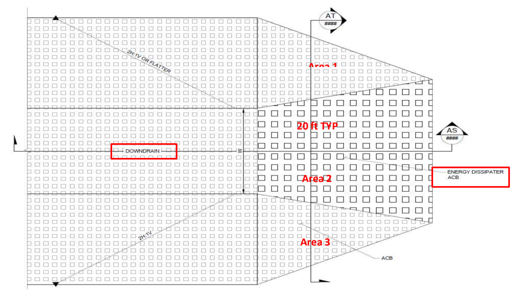
1. Quote from Contech ES 2019, adjusted for inflation; Downdrain ACB installation includes fine grade base/subgrade soils (assuming subgrade at + 0.5 ft); equipment is D6 LGP dozer with Power Angle Tilt Blade (PAT) and GPS Blade Control
2. Assigned based on previous use at other FMI New Mexico operations
3. One cutoff wall per dissipator
4. Typical flow depth is 2'; concrete depth is 5' (diagram is not drawn to scale); concrete thickness is 1.5'



NOT TO SCALE 2 C-008 TYPICAL DOWNDRAIN DETAIL



N.T.S. AX 022A TYPICAL CUTOFF WALL SECTION



N.T.S. 8 022A TYPICAL TOE ENERGY DISSIPATOR PLAN DETAIL

Revegetation Unit Cost

Revegetation consists of 5 operations - scarifying, discing, drill seeding, mulching, and crimping.
Cost information is obtained from EquipmentWatch (EQW), if available, or RS Means 2021 rates.

Tractor used for each operation is Deere 7430		**Cost**	**Unit**	**Information or Calculation**
EQW base rate for tractor rental	$	3,677.82	$ per month	EQW for Deere 7430
EQW base rate for tractor rental	$	20.90	$ per hour	= ($/month)/176
EQW field labor rate per hour of operation	$	2.62	$ per hour	EQW for Deere 7430, which includes mechanic's wage of $23.09 (NMDOL, 2019)
EQW lube material cost	$	2.83	$ per hour	EQW for Deere 7430
EQW field parts cost	$	0.48	$ per hour	EQW for Deere 7430
EQW tire material cost	$	0.80	$ per hour	EQW for Deere 7430
EQW fuel burn rate		5.98	gallons per hour	EQW for Deere 7430
Local fuel cost	$	2.71	$ per gallon	Local quote
Fuel cost	$	16.21	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
NM Department of labor equipment operator rate	$	24.57	$ per hour	NM Department of Labor (NMDOL)
Total tractor cost	**$**	**68.40**	**$ per hour**	**Sum of $ per hour costs shown in boxes**

Tractor coverage/rate of operation, fuel cost per acre

Tractor/equipment net width		12	feet	Assigned as a typical net width of coverage for each pass
Tractor/equipment travel speed		2.5	miles per hour	Assigned as approximate average speed of equipment (3 mph for 50 min/hr)
For 1 acre, total traveling distance		3630	feet per acre	= (43560 sf/ac)/(net width)
Time of travel over 1 acre		0.275	hour per acre	= [(traveling distance feet/acre)/(5280 ft/mile)]/(travel speed)
Fuel cost per acre	**$**	**4.46**	**$ per acre**	**Already included in total tractor cost…** **Fuel cost/acre = (fuel cost/hour) x (travel time hour/acre)**

Operation

<u>*Scarifying*</u>				
Base rate for ripper rental	$	898.90	per month	EQW Ripper, Miscellaneous MSR-189H, to 260 HP
Base rate for ripper rental	$	5.11	$ per hour	= ($/month)/176
Field labor rate per hour of operation	$	0.59	$ per hour	EQW for ripper, incl mechanic's wage $23.09 (NMDOL, 2019)
Lube material cost	$	0.15	$ per hour	EQW for ripper
Field Parts & Ground Engaging Component Cost	$	0.93	$ per hour	EQW for ripper
Total cost with tractor+operator included	**$**	**75.18**	**per hour**	**= total tractor cost + (rake without tractor, with ratio)**
<u>*Discing*</u>				
Disc harrow attachment, for tractor	$	670.65	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.81	per hour	= ($/month)/176
Field Parts & Ground Engaging Component Cost	$	0.93	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor included	**$**	**73.14**	**per hour**	**= total tractor cost + (disc harrow, with ratio)**
<u>*Drill seeding (assume similar to discing)*</u>				
Disc harrow attachment, for tractor	$	670.65	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.81	per hour	= ($/month)/176
Field Parts & Ground Engaging Component Cost	$	0.93	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor+operator included	**$**	**73.14**	**per hour**	
<u>*Mulching*</u>				
Mulcher, diesel powered, trailer mounted	$	2,167.95	per month	EQW for trailer mounted mulcher (Finn B260)
Mulcher, diesel powered, trailer mounted	$	12.32	per hour	= ($/month)/176
Field labor rate per hour of operation	$	1.29	$ per hour	EQW for trailer mounted mulcher (Finn B260), incl mechanic's wage $23.09 (NMDOL, 2019)
Lube material cost	$	1.64	$ per hour	EQW for trailer mounted mulcher (Finn B260)
Field parts cost	$	0.15	$ per hour	EQW for trailer mounted mulcher (Finn B260)
Tire material cost	$	0.60	$ per hour	EQW for trailer mounted mulcher (Finn B260)
Fuel burn rate		4.13	gallons per hour	EQW for trailer mounted mulcher (Finn B260)
Local fuel cost	$	2.71	$ per gallon	Local quote
Fuel cost	$	11.19	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
NM Department of labor equipment operator rate	$	24.57	$ per hour	NM Department of Labor (NMDOL)
Total cost with tractor+operator included	**$**	**120.16**	**per hour**	
<u>*Crimping (assume similar to discing)*</u>				
Disc harrow attachment, for tractor	$	670.65	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.81	per hour	= ($/month)/176
Field Parts & Ground Engaging Component Cost	$	0.93	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor+operator included	**$**	**73.14**	**per hour**	
<u>*Summary for operations*</u>				
Total cost for all operations combined (hour)	$	414.77	per hour	Each of the 5 operations is done individually as part of revegetation (includes fuel cost)
Total cost for all operations combined w/o fuel(acre)	$	109.61	per acre	---
Total cost for all operations combined w/ fuel(acre)	$	114.06	per acre	Total is based on "tractor coverage/rate of operation" = (total cost of operations/hour) x (hours of travel time/acre)

Materials (From Rocky Mountain Reclamation)

Seed	$	222.85	per acre	From supplier (Rocky Mountain Reclamation)
Hay mulch	$	519.99	per acre	From supplier (Rocky Mountain Reclamation): Mulch is applied at a rate of 2 tons per acre

<u>Summary for operations + materials</u>

Total revegetation unit cost	$	856.91	per acre	Total is for all operations (combined) + seed material + hay mulch material + fuel

APPENDIX C

Emma Water Management and Treatment Plan

TECHNICAL MEMORANDUM

DATE November 12, 2021 **Project No.** 21476949-009-TM-0

TO Mandy Lilla
Freeport-McMoRan Tyrone, Inc.

CC Bridgette Hendricks

FROM Karen Budgell, Todd Stein **EMAIL kbudgell@golder.com**

ADDENDUM FOR EMMA PIT CLOSURE/CLOSEOUT PLAN WATER MANAGEMENT PLAN

Golder Associates USA Inc. (Golder) has prepared this supplement to the water treatment component of the Tyrone Closure Closeout Plan (CCP) to incorporate the Emma Project area and proposed Emma Pit. The proposed Emma Pit is located directly south of the Tyrone Mine which is approximately 10 miles southwest of Silver City in Grant County, New Mexico. The site is owned by Freeport-McMoRan Tyrone Inc. (Tyrone) and includes an existing open pit copper mine, haul road, and associated facilities to support mining operations. This Technical Memorandum (TM) describes the cost basis for the closure mine water treatment and management system for the Emma CCP. The Emma CCP includes 100 years of management and treatment for the Emma Pit water and uses the same management and treatment systems as the Tyrone CCP[1] and the TM is prepared as an appendix to the Emma CCP.

1.0 EMMA PIT DESIGN AND COST BASIS

The basis for developing the Emma CCP water collection and treatment costs for the 100-year closure period includes the flow and water quality. Since this water will be co-treated with the Tyrone contact water, the effluent goals do not change.

The Emma Pit water is comprised of groundwater inflow and stormwater including direct precipitation and runoff. Flow estimates were developed from recent groundwater flow modeling conducted by Daniel B. Stephens & Associates, Inc. (DBS&A)[2]. For the purposes of evaluating the impact of the Emma Pit flows on the capital equipment sizing and costs (CAPEX), the maximum projected inflow to the pit is 34.8 gpm. For the purposes of developing the annual operations and maintenance costs (OPEX), the average inflow to the pit, estimated at 20.1 gpm over the 100-year period, is used for calculating chemical usage, residuals produced, power requirements, labor, and other elements of operations and maintenance (O&M) costs.

The water quality parameters used for factoring the treatment costs include sulfate and total dissolved solids (TDS) and have been projected over the 100-year period from geochemical modeling recently completed by Life

[1] Golder. 2020. 2013 Tyrone Mine Closure/Closeout Plan Update – Basis of Cost Estimate for Water Management and Treatment - Freeport-McMoRan Tyrone Operations, Tyrone, New Mexico. April 28.

[2] DBS&A. 2021. Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project (See DP-396 Modification Application). Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. October 22.

Cycle Geo, LLC (LCG)[3]. Table 1 shows the predicted yearly sulfate and TDS concentrations for the Emma Pit inflow water. Both the average and maximum values are shown although these values are relatively consistent. The difference between the average and maximum for both sulfate and TDS vary as follows:

- Maximum greater than 10% over the average value – 5 years out of 100 years
- Maximum between 5 and 10% higher than the average value – 11 years out of 100 years
- Maximum between 3 and 4% higher than the average value – 5 years out of 100 years
- Maximum between 1 and 2% higher than the average value 79 years out of 100 years.

Table 1: Emma Pit 100-Year Post Closure Chemistry

Year After Closure	Base Case					Year After Closure	Base Case				
	pH	Max Sulfate (mg/L)	Avg Sulfate (mg/L)	Max TDS (mg/L)	Avg TDS (mg/L)		pH	Max Sulfate (mg/L)	Avg Sulfate (mg/L)	Max TDS (mg/L)	Avg TDS (mg/L)
1	8.1	464	321	812	562	51	6.8	3,807	3,762	5,848	5,775
2	8.1	300	287	525	503	52	6.8	3,882	3,830	5,968	5,885
3	8.1	312	289	546	507	53	6.8	3,961	3,909	6,094	6,011
4	8.2	262	249	460	437	54	6.2	3,998	3,970	6,147	6,106
5	8.2	261	253	457	444	55	6.4	4,103	4,050	6,319	6,232
6	8.1	289	270	500	472	56	5.9	4,171	4,113	6,433	6,333
7	8.1	339	311	575	536	57	5.9	4,221	4,163	6,502	6,409
8	8.1	380	360	641	610	58	5.9	4,279	4,203	6,594	6,470
9	8.1	427	403	716	679	59	5.5	4,181	4,141	6,431	6,366
10	8.0	549	493	893	812	60	5.4	4,258	4,215	6,556	6,486
11	8.0	746	635	1,182	1,021	61	5.5	4,360	4,302	6,718	6,626
12	7.9	1,113	892	1,712	1,393	62	5.3	4,421	4,381	6,820	6,754
13	7.9	1,212	1,157	1,861	1,778	63	5.2	4,476	4,434	6,913	6,846
14	7.9	1,473	1,281	2,245	1,965	64	5.2	4,574	4,523	7,073	6,990
15	7.9	1,641	1,554	2,495	2,366	65	5.2	4,674	4,624	7,236	7,154
16	7.8	1,788	1,709	2,713	2,595	66	5.1	4,768	4,708	7,390	7,294
17	7.8	1,920	1,849	2,910	2,805	67	5.1	4,904	4,837	7,608	7,501
18	7.8	2,010	1,956	3,047	2,966	68	5.1	5,013	4,957	7,783	7,694
19	7.8	2,223	2,107	3,362	3,191	69	5.1	5,117	5,044	7,949	7,836
20	7.8	2,259	2,238	3,422	3,389	70	5.0	5,152	5,093	8,016	7,921
21	7.8	2,315	2,287	3,512	3,469	71	5.0	5,210	5,136	8,118	7,999
22	7.8	2,364	2,336	3,591	3,546	72	5.0	5,314	5,253	8,286	8,187

[3] LCG. 2021. Water Quality Predictions for the Proposed Emma Pit. Report prepared for Freeport-McMoRan Tyrone, Inc., Submitted as Attachment IA-3 to the DP-396 Permit Renewal and Modification Application. October 22.

Year After Closure	Base Case					Year After Closure	Base Case				
	pH	Max Sulfate (mg/L)	Avg Sulfate (mg/L)	Max TDS (mg/L)	Avg TDS (mg/L)		pH	Max Sulfate (mg/L)	Avg Sulfate (mg/L)	Max TDS (mg/L)	Avg TDS (mg/L)
23	7.8	2,408	2,385	3,665	3,626	73	5.0	5,442	5,378	8,492	8,388
24	7.8	2,460	2,433	3,748	3,705	74	4.9	5,566	5,486	8,692	8,566
25	7.8	2,519	2,488	3,842	3,793	75	4.9	5,629	5,547	8,800	8,671
26	7.8	2,564	2,540	3,916	3,877	76	4.9	5,699	5,626	8,919	8,801
27	7.8	2,609	2,579	3,989	3,941	77	4.9	5,857	5,775	9,172	9,041
28	7.8	2,657	2,632	4,070	4,027	78	4.9	5,979	5,902	9,369	9,245
29	7.8	2,701	2,679	4,143	4,106	79	4.9	6,086	6,013	9,542	9,424
30	7.8	2,748	2,726	4,220	4,183	80	4.9	6,179	6,081	9,693	9,537
31	7.8	2,802	2,775	4,306	4,262	81	4.9	6,246	6,163	9,808	9,674
32	7.8	2,855	2,827	4,393	4,347	82	4.9	6,271	6,197	9,848	9,730
33	7.9	2,906	2,880	4,477	4,436	83	4.8	6,253	6,150	9,823	9,660
34	7.9	2,958	2,932	4,563	4,519	84	4.8	6,298	6,205	9,901	9,751
35	7.9	2,984	2,957	4,603	4,558	85	4.8	6,405	6,338	10,074	9,966
36	7.9	3,029	2,997	4,677	4,624	86	4.8	6,515	6,405	10,252	10,077
37	7.5	3,134	3,081	4,829	4,753	87	4.8	6,595	6,513	10,386	10,255
38	7.5	3,210	3,172	4,954	4,890	88	4.8	6,738	6,640	10,619	10,461
39	7.5	3,280	3,245	5,070	5,011	89	4.8	6,857	6,773	10,811	10,676
40	7.5	3,329	3,293	5,148	5,089	90	4.8	7,095	6,959	11,195	10,977
41	6.9	3,406	3,370	5,263	5,209	91	4.8	7,275	7,157	11,486	11,296
42	6.8	3,470	3,436	5,355	5,302	92	4.8	7,306	7,188	11,539	11,350
43	6.8	3,548	3,507	5,482	5,416	93	4.8	7,354	7,235	11,618	11,428
44	6.8	3,608	3,557	5,580	5,490	94	4.8	7,314	7,226	11,560	11,418
45	6.8	3,620	3,584	5,586	5,526	95	4.8	7,427	7,299	11,744	11,538
46	6.8	3,669	3,617	5,662	5,576	96	4.8	7,416	7,299	11,730	11,542
47	6.8	3,725	3,677	5,747	5,669	97	4.7	7,488	7,393	11,849	11,697
48	6.8	3,754	3,717	5,791	5,730	98	4.7	7,638	7,520	12,094	11,903
49	6.8	3,793	3,733	5,848	5,745	99	4.7	7,840	7,711	12,420	12,213
50	6.8	3,766	3,725	5,789	5,719	100	4.7	8,430	7,839	13,366	12,421

The average value is used for the development of OPEX and quantifying residuals on an annual basis since it is an annualized value. As shown in the bullets above, the maximum values are not much higher than the average and do not require upsizing of equipment to manage the maximum loads.

The locations of the Emma Pit dewatering system, existing water management ponds at Tyrone, pipelines, and pumping systems are considered in the following section to determine whether the Emma Pit water should be managed in the evaporation treatment system (ETS) at Tyrone or the lime-based Tyrone Treatment System

(TTS). Next, flow and sulfate and TDS loads to the appropriate treatment system (ETS or TTS) are evaluated to confirm that the planned system can manage this additional source water from Emma and the increases to the CAPEX and OPEX for the treatment system can be developed.

2.0 TREATMENT SYSTEM EVALUATION

The strategy at Tyrone for water management and treatment includes sending all water to a short-term evaporative treatment system (ST ETS) for years 1 through 9. Once process waters, leach solutions, and other site waters from Tyrone operations are managed, then the long-term treatment systems are brought online for years 10 through 100. For long-term operations, the Tyrone CCP strategy is to send all water to the long-term ETS (LT ETS) for years 10 through 14 and then for years 15 through 100 segregating the water sources and sending water defined as high sulfate/high TDS water to the LT ETS and the lower sulfate/TDS water sources to the TTS. In the long term the high sulfate sources are typically lower flows, and the lower sulfate sources are higher flows so that this strategy recovers the majority of the collected water and treats the water for removal of sulfate and metals prior to discharge. The use of the LT ETS for the high sulfate and low flow sources reduces the chemical requirements and secondary waste produced. The Emma Pit water has relatively lower sulfate and TDS is the early years, but the sulfate and TDS are expected to increase over time. The low TDS sources that are directed to the TTS are those water sources with TDS less than 10,000 mg/L and sulfate less than 7,500 mg/L. The Emma Pit water has a TDS of less than 10,000 mg/L until year 85. Due to the degradation of water quality over time it may be beneficial to pipe the Emma Pit water to a system connected to the LT ETS.

The other factor considered when determining where to manage the Emma Pit water within the Tyrone closure water management and treatment facilities is where the Emma Pit water can be combined with the Tyrone water and whether new pipelines are required. The Emma Pit water would be connected to the 1C Seepage and 7A Seepage Collection Systems which will be piped to the TTS. Transfer of water to the TTS could be through the Emma pipeline which will be installed during operations and will be nearly new at closure (approximately 1 year old). Transfer of water to the LT ETS would require installation of a new pipeline and pump system connected to the 1B PLS Collection Tank. Therefore, the CAPEX and OPEX for management of the Emma Pit inflow water is assumed to be collection and transfer, in the existing Emma pipeline, to the TTS.

The TTS includes the following unit processes for treatment of sulfate and metals as shown in Figure 1:

- Lime High Density Sludge (HDS)
- Membranes (Microfiltration and Reverse Osmosis [RO])
- Sludge Dewatering and disposal of dewatered sludge in lined cell`
- Management of RO brine in the ETS and disposal of salt in a lined cell

The treated water is compliant with a TDS discharge limit of 1,000 mg/L and a sulfate limit of 600 mg/L along with specific limits on associated metals.

3.0 CAPEX AND OPEX

The costs for treatment of the Emma Pit inflow water have been developed by extending the costs developed for the Tyrone CCP to include the Emma Pit flows and TDS/sulfate loads. The ST ETS and the LT ETS systems have sufficient capacity for the Emma Pit flows; therefore, no increase to the system is required. Only OPEX for the ST ETS and LT ETS systems increases. The TTS is sized for a maximum influent flow of 1,600 gpm and an average flow of 1,120 gpm. The maximum projected flow with the Emma Pit water and internal recycle streams is 1,305 gpm which is less than the maximum design flow of the TTS. The system was sized to allow for some downtime for maintenance and other similar factors and therefore has the capacity to absorb a flow increase of 1.6% from Emma Pit and a sulfate/TDS load increase of 3.5% without increasing the capital costs for the water treatment equipment.

The CCP cost impact of the Emma Pit water at the treatment systems is based on the following:

- 2019 costs from the latest agency approved Tyrone CCP were utilized.
- For years 1 through 9 all water is treated at the ST ETS, for years 10 through 14 all water is treated at the LT ETS, and for years 15 through 100 Emma Pit water is treatment at the TTS.

Table 2 provides a summary of the Emma Pit CCP cost estimates. The cost by year summary is provided as Attachment 1.

Table 2: Emma Pit CCP Cost Summary

CAPEX Elements	**Emma CCP Cost Summary**
Sludge Disposal Facility for TTS	$ 4,563
Subtotal, Capital	$ 4,563
Indirect Costs, Capital	*$ 1,369*
Total, Capital	**$ 5,932**
OPEX Elements - Commodities (Reagents, Analytical, Power)	
Short-Term ETS	$ 170,630
Long-Term ETS	$ 21,869
Tyrone Water Treatment System (TTS)	$ 2,781,874
Water Collection/Conveyance for TTS	$ 131,039
Subtotal, O&M Commodities	$ 3,105,412
Indirect Costs, O&M Commodities	*$ 543,447*
Total, O&M Commodities	**$ 3,648,859**
OPEX Elements - Replacement O&M, Routine Maintenance, Labor	
Water Collection/Conveyance for TTS	$ 523,601
Sludge Disposal Facility for TTS	$ 164,906
Salt Disposal Facility for ETS	$ 1,751
Subtotal, Replacement O&M, Routine Maintenance, Labor	$ 690,257
Indirect Costs, Replacement O&M, Routine Maintenance, Labor	*$ 120,795*
Total, O&M Labor, Routine Maintenance	**$ 811,052**
Total, O&M	**$ 4,459,911**
Total, Capital and O&M in Current Costs	**$ 4,465,844**

The assumptions with the development of the CAPEX include the following:

- The equipment at the ST ETS, LT ETS and TTS have sufficient treatment capacity for the Emma Pit water; and therefore, do not require an increase to CAPEX.

- Capital cost for the Sludge Disposal Facility is increased by approximately 3.2% which is the percentage of sludge from the total sulfate load increase from Emma Pit waters.
- Increases to the pipeline infrastructure are not required since the collection pipeline for the Emma pit water will be near new at the start of the post-closure period.

The assumptions with the development of the OPEX include the following:

- Reagent usage is adjusted based on the additional sulfate contribution at the TTS.
- Annual power usage for ETS systems and water conveyance is increased based on a flow percentage contribution (i.e., if Emma Pit flows add 1% of the ETS flow, the power usage increases by 1%).
- Sludge Disposal Facility O&M is increased based on calculated sludge contribution ($/cy). Labor increase due to sludge handling is accounted for in the $/cy costs.
- No analytical sampling is included in this cost.
- Replacement O&M and routine maintenance for sprayers, pumps and pipeline are equalized over the 100-year period using 1.8% for replacement O&M and 1.5% for routine maintenance just like the Tyrone CCP.
- No increase in labor is required due to the addition of Emma Pit water.

4.0 CLOSING

Management of the Emma Pit inflow water with the Tyrone contact water allows for the use of the Emma Pit dewatering system pump and Emma pipeline that will be installed during operations at Emma for the closure/post-closure period. The cotreatment of Emma Pit water at the Tyrone TTS is manageable with the existing equipment sizing as the increase flow is just over 1.8% of the overall influent to the TTS and is below the total maximum design flow of the system. There is sufficient capacity designed into the system to allow for maintenance downtime and treatment at short term maximum projected flow rates. Similarly, the Emma Pit water increases the sulfate load by 3.5%. The cotreatment allows for efficient use of labor, power, and other resources and centralizes the treatment and discharge location providing further economies.

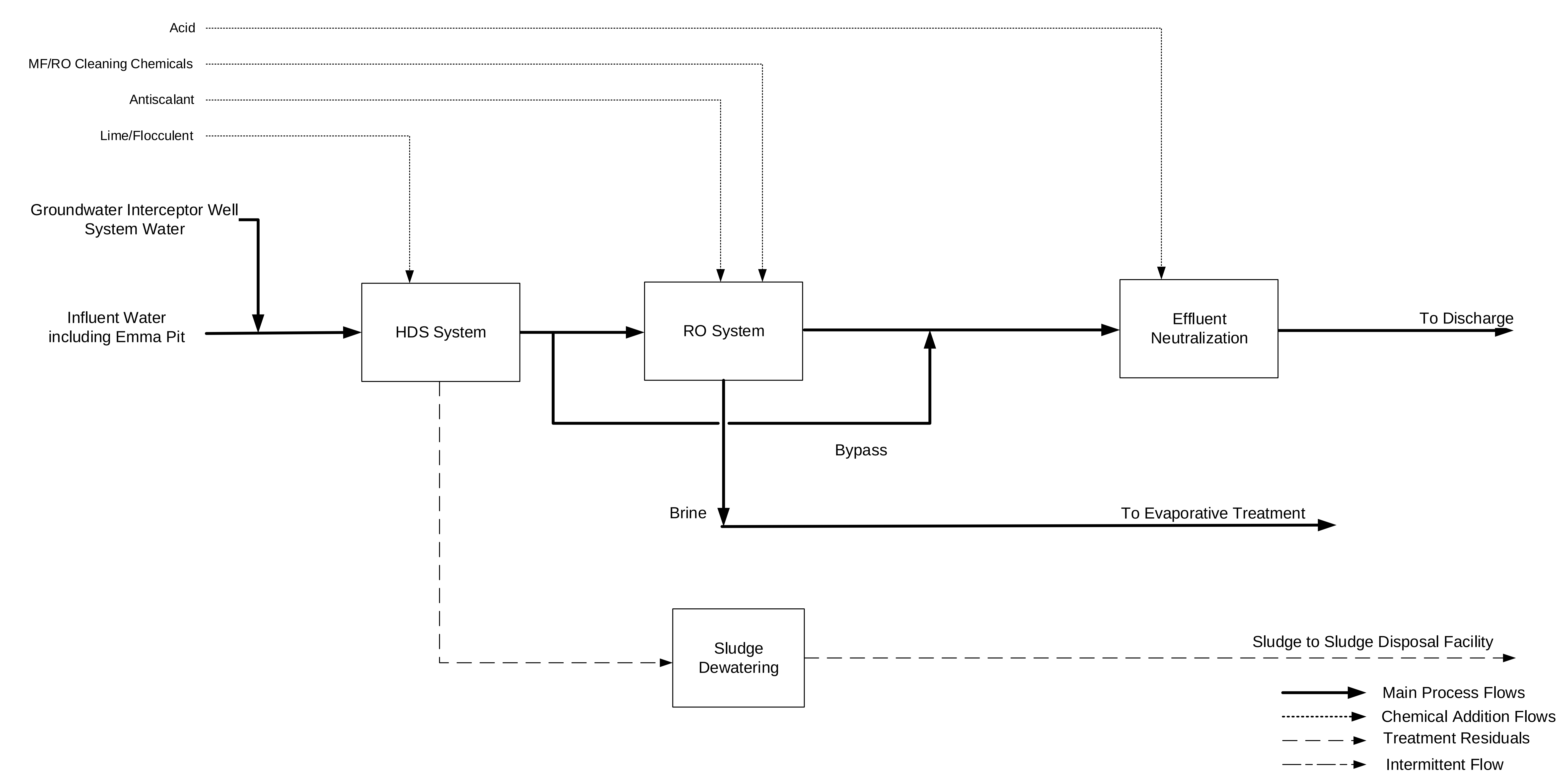
Please contact the undersigned with any questions.

Karen Budgell, PE
Senior Engineer

Todd Stein
Senior Consultant

FIGURE 1

TTS Block Flow Diagram



GOLDER
MEMBER OF WSP

Denver, Colorado

CLIENT/PROJECT

Freeport-McMoRan
Tyrone Mine

TITLE

WATER TREATMENT SYSTEM BLOCK FLOW DIAGRAM (YEARS 15 THROUGH 100)

DRAWN	EAT	DATE	June 11, 2019	JOB NO.	21476949
CHECKED	BH	SCALE	Not to Scale	DWG. NO.	N/A
REVIEWED	TS	FILE NO.		FIGURE NO.	1

ATTACHMENT 1

Emma Pit CCP Cost by Year

GOLDER
MEMBER OF WSP

Date: REV 0 November 12, 2021
Project No.: 21476949
Subject: Summary Cash Flow for Emma Pit CCP in Current Costs
Project Short Tyrone Mine Closure Closeout Plan Updated with Emma Pit

Year after Closure	Total			Year after Closure	Total		
	Capital Cost, Total	O&M Total	Total Cost		Capital Cost, Total	O&M Total	Total Cost
0	$ -	$ -	**$ -**	51	$ -	$ 43,954	**$ 43,954**
1	$ -	$ 30,202	**$ 30,202**	52	$ -	$ 44,465	**$ 44,465**
2	$ -	$ 32,218	**$ 32,218**	53	$ -	$ 45,051	**$ 45,051**
3	$ -	$ 29,095	**$ 29,095**	54	$ -	$ 45,506	**$ 45,506**
4	$ -	$ 25,966	**$ 25,966**	55	$ -	$ 46,100	**$ 46,100**
5	$ -	$ 22,829	**$ 22,829**	56	$ -	$ 46,568	**$ 46,568**
6	$ -	$ 19,693	**$ 19,693**	57	$ -	$ 46,945	**$ 46,945**
7	$ -	$ 16,632	**$ 16,632**	58	$ -	$ 47,241	**$ 47,241**
8	$ -	$ 13,496	**$ 13,496**	59	$ -	$ 46,781	**$ 46,781**
9	$ -	$ 10,360	**$ 10,360**	60	$ -	$ 47,334	**$ 47,334**
10	$ -	$ 1,220	**$ 1,220**	61	$ -	$ 47,981	**$ 47,981**
11	$ -	$ 1,278	**$ 1,278**	62	$ -	$ 48,569	**$ 48,569**
12	$ -	$ 8,163	**$ 8,163**	63	$ -	$ 48,965	**$ 48,965**
13	$ -	$ 8,532	**$ 8,532**	64	$ -	$ 49,625	**$ 49,625**
14	$ 5,932	$ 8,560	**$ 14,492**	65	$ -	$ 50,376	**$ 50,376**
15	$ -	$ 27,481	**$ 27,481**	66	$ -	$ 51,006	**$ 51,006**
16	$ -	$ 28,630	**$ 28,630**	67	$ -	$ 51,964	**$ 51,964**
17	$ -	$ 29,678	**$ 29,678**	68	$ -	$ 52,858	**$ 52,858**
18	$ -	$ 30,476	**$ 30,476**	69	$ -	$ 53,501	**$ 53,501**
19	$ -	$ 31,600	**$ 31,600**	70	$ -	$ 53,867	**$ 53,867**
20	$ -	$ 32,583	**$ 32,583**	71	$ -	$ 54,188	**$ 54,188**
21	$ -	$ 32,947	**$ 32,947**	72	$ -	$ 55,056	**$ 55,056**
22	$ -	$ 33,311	**$ 33,311**	73	$ -	$ 55,987	**$ 55,987**
23	$ -	$ 33,676	**$ 33,676**	74	$ -	$ 56,792	**$ 56,792**
24	$ -	$ 34,036	**$ 34,036**	75	$ -	$ 57,247	**$ 57,247**
25	$ -	$ 34,446	**$ 34,446**	76	$ -	$ 57,836	**$ 57,836**
26	$ -	$ 34,838	**$ 34,838**	77	$ -	$ 58,943	**$ 58,943**
27	$ -	$ 35,131	**$ 35,131**	78	$ -	$ 59,889	**$ 59,889**
28	$ -	$ 35,524	**$ 35,524**	79	$ -	$ 60,713	**$ 60,713**
29	$ -	$ 35,875	**$ 35,875**	80	$ -	$ 61,220	**$ 61,220**
30	$ -	$ 36,227	**$ 36,227**	81	$ -	$ 61,835	**$ 61,835**
31	$ -	$ 36,595	**$ 36,595**	82	$ -	$ 62,085	**$ 62,085**
32	$ -	$ 36,980	**$ 36,980**	83	$ -	$ 61,737	**$ 61,737**
33	$ -	$ 37,380	**$ 37,380**	84	$ -	$ 62,145	**$ 62,145**
34	$ -	$ 37,761	**$ 37,761**	85	$ -	$ 63,135	**$ 63,135**
35	$ -	$ 37,948	**$ 37,948**	86	$ -	$ 63,632	**$ 63,632**
36	$ -	$ 38,252	**$ 38,252**	87	$ -	$ 64,441	**$ 64,441**
37	$ -	$ 38,877	**$ 38,877**	88	$ -	$ 65,384	**$ 65,384**
38	$ -	$ 39,552	**$ 39,552**	89	$ -	$ 66,369	**$ 66,369**
39	$ -	$ 40,100	**$ 40,100**	90	$ -	$ 67,760	**$ 67,760**
40	$ -	$ 40,456	**$ 40,456**	91	$ -	$ 69,228	**$ 69,228**
41	$ -	$ 41,027	**$ 41,027**	92	$ -	$ 69,464	**$ 69,464**
42	$ -	$ 41,524	**$ 41,524**	93	$ -	$ 69,811	**$ 69,811**
43	$ -	$ 42,051	**$ 42,051**	94	$ -	$ 69,742	**$ 69,742**
44	$ -	$ 42,422	**$ 42,422**	95	$ -	$ 70,284	**$ 70,284**
45	$ -	$ 42,624	**$ 42,624**	96	$ -	$ 70,286	**$ 70,286**
46	$ -	$ 42,872	**$ 42,872**	97	$ -	$ 70,985	**$ 70,985**
47	$ -	$ 43,320	**$ 43,320**	98	$ -	$ 71,931	**$ 71,931**
48	$ -	$ 43,620	**$ 43,620**	99	$ -	$ 73,353	**$ 73,353**
49	$ -	$ 43,735	**$ 43,735**	100	$ -	$ 74,304	**$ 74,304**
50	$ -	$ 43,675	**$ 43,675**	**Total**	**$ 5,932**	**$ 4,459,911**	**$ 4,465,844**

APPENDIX D

Characterization of Suitable Soils and Overburden and Soil Salvage Plan for the Emma Expansion Project

REPORT

Characterization of Suitable Soils and Overburden and Soil Salvage Plan for the Emma Project

Freeport-McMoRan Tyrone Inc.

Submitted to:

Mandy Lilla

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21476949-002-R-Rev0

November 12, 2021

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FIGURES

APPENDICES

1.0 INTRODUCTION

Freeport-McMoRan Tyrone, Inc. (Tyrone) is an open pit copper mine located just off State Highway 90, approximately 10 miles southwest of Silver City in Grant County, New Mexico (Figure 1). Tyrone is permitted as an existing mine (Permit No. GR010RE) with the New Mexico Mining and Minerals Division (MMD) and discharge permit DP-1341 issued by the New Mexico Environment Department (NMED).

Tyrone is proposing to modify both the existing Tyrone Mine Permit Boundary and the current Mining Area Design Limit to include the proposed Emma Project. The proposed Emma Project is located along the southern boundary of the Tyrone Mine and will include the development of a new open pit and one nondischarging waste rock stockpile, a soil stockpile, construction of new haul roads (Southern Emma Haul Roads), and installation of various infrastructure to support the project (Figure 2). The proposed Emma Project will increase the mine permit area and design limits by approximately 336 acres and portions of the project within the expanded are considered new units to an existing mine under the New Mexico Mining Act (NMMA NMAC 19.10.5.508).

Within the currently approved Tyrone Permit Boundary and Design Limit, Tyrone also proposes to construct a haul road (Northern Emma Haul Road), a nondischarging stockpile (6HW Waste), and a portion of the EMW Waste Stockpile and infrastructure to support the Emma Project. These disturbances are considered to be part of the existing Mine/Stockpile Unit under the New Mexico Mining Act (NMMA NMAC 19.10.5).

The construction of the proposed Emma Pit, EMW Waste Stockpile, 6HW Waste Stockpile, Soil Stockpile, new haul roads and infrastructure will disturb approximately 204 acres (Figure 2). The 6HW Waste stockpile is located on existing disturbed land and the Northern Haul Road is primarily located on previously disturbed or reclaimed areas. The proposed 54-acre EMW Waste Stockpile will be constructed with non-potentially acid-generating (NPAG) waste rock (overburden) from the Emma Pit. The 8.3-acre Soil Stockpile will be constructed of suitable soil materials that will be salvaged as part of the development of the project. The eventual cover system for the Emma Project will be constructed using the NPAG waste rock and salvaged soil resources with the intent to establish wildlife habitat that meets the higher revegetation standard required for new mining units (NMAC 19.10.5.508.E).

Golder Associates USA Inc. (Golder), a member of WSP, was retained by Tyrone to inventory and evaluate native soil resources and characterize NPAG waste rock for the Emma Project. This report provides the results of the soil and overburden investigation including details of the field sampling of native soils, laboratory testing of soil samples and NPAG overburden from drill core samples, review of chemical and physical characterization data for soils and overburden, and a site-specific soil map and salvage plan.

1.1 Objectives

Golder prepared this report on behalf of Tyrone to identify, characterize and inventory salvageable native soil materials for the planned disturbance areas for use as a topdressing during reclamation and to mitigate rocky seedbeds. The primary focus of the soil survey and overburden testing is to:

- Describe and map soils to determine the thickness of pedogenic soils (i.e., A & B soil horizons) that could be salvaged as a reclamation cover material.
- Test representative soil and overburden samples to determine their physical and chemical suitability as a reclamation cover material according to MMD guidance (MMD 1996).

- Provide initial characterization data and suitability analyses for the NPAG overburden scheduled to go to the EMW Waste and 6HW Waste stockpiles.
- Develop a plan to salvage native soil materials effectively and safely in areas that will be disturbed by mining.

Note that for the soil survey, soils were keyed to their taxonomic order or suborder. The primary focus of the survey was to understand the soils as a potential reclamation substrate.

2.0 STUDY AREA DESCRIPTION

2.1 Climate

The Emma Project is located in a semiarid region in southwestern New Mexico, with elevations ranging from about 6,000 to 6,300 feet above mean sea level. The climate is warm and dry, with mean annual precipitation of about 16 inches (400 millimeters [mm]) and a mean annual temperature near 50˚F (10˚C). Precipitation falls mainly as rain, but snow may occur from November to March. Most of the precipitation in the area falls during July through October in the form of rain during short, intense, thunderstorms. Approximately 60 percent of the precipitation falls during the summer months. Precipitation is characterized mostly by small magnitude events ranging from less than 0.1 to 0.25 inches (2.5 to 6.4 mm) per day. Larger magnitude rainfall events (greater than one inch) also occur in the summer months, but at a much lower frequency.

2.2 Parent Materials

Native soils in the Emma project area are primarily formed in parent materials comprised of Precambrian and Tertiary igneous rocks, as well as Quaternary deposits. The following parent material discussion is adapted from the hydrogeology report by DBS&A (2021).

Most of the land surface in the proposed permit area consists of Precambrian granite composed of varying amounts of biotite, microcline, oligoclase, and quartz. Iron oxides, silica veins, and disseminated pyrite are also present within the granite. Sulfides have been completely oxidized in the near surface environment to a depth of about 200-300 feet and increase with depth. Aplite, similar in composition to the Precambrian granite, is also found throughout the pit area.

The Tertiary age rocks in the Emma permit area are igneous and usually porphyritic textured. These rocks include granodiorite exposed to the west and quartz monzonite exposed in the northern portion of the proposed area of the pit. The granodiorite is composed of biotite, orthoclase, plagioclase, and quartz while the quartz monzonite is composed of biotite, hornblende, oligoclase, orthoclase, and quartz. There are also several quartz monzonite porphyry dikes that strike primarily east to west.

The Tertiary-Quaternary Gila Conglomerate exposed to the east of Emma consists of consolidated and unconsolidated conglomerates with interbedded sandstones, basalts, andesites, and rhyolites. Quaternary alluvium also overlies the older rock units and is present in the Upper Oak Grove Wash and Cherry Creek drainages.

2.3 Soils

Grant County soils were mapped at an Order 3 level by the Forest Service and Soil Conservation Service (Parnham et al. 1983). Third-order soil surveys are low intensity surveys used for large-scale natural resource planning where land uses do not require detailed soil information. DBS&A (1997) completed a more detailed (second-order) soil and vegetation survey for the Tyrone Mine, describing the distribution and general properties of soils in association with the dominate plant communities in the permit area at a map scale suitable for closure/closeout planning. The 1997 soil survey described and characterized soils from a range of geomorphic settings (e.g., flood-plain, alluvial fan, mountain slopes) and provenances (e.g., Little Burro Mountains, Big Burro Mountains). The survey did not extend south of the Tyrone/Thompson county road nor did it provide any recommendations as to salvaging pedogenic soil horizons. Soil and vegetation mapping was generalized across the mine site and identified the primary soils as coarse-loamy and sandy Haplustolls and Torrifluvents, loamy-skeletal, clayey-skeletal, and fine Aridic Haplustalfs and Haplustolls.

2.4 Vegetation

Site-specific soil and vegetation surveys were conducted at Tyrone in 1997 as part of the initial closure/closeout studies (DBS&A 1997). The distribution of the existing vegetation is locally complex and reflects the influence of both environmental gradients and land management practices. The vegetation communities in the proposed Emma permit area are locally and regionally extensive. Three major plant communities are present in the Emma Project area. These include the alluvial grassland, piedmont scrub savanna, and mountain slope mixed evergreen woodland plant communities described below.

Alluvial Grasslands: This plant community occupies the nearly level to gently sloping floodplains and alluvial terraces of Oak Grove Wash and its tributaries in the proposed permit area. The existing vegetation is dominated by tarragon (*Artemisia drunculoides*), a variety of annual forbs and a low density of warm season grasses including sideoats and blue grama (*Bouteloua curtipendula* and *B. gracilis*) and purple three-awn (*Aristida purpurea*). Apache plume (*Fallugia paradoxa*) and California bricklebush (*Brickellia californica*) are important shrubs with Emory Oak (*Quercus emoryi*) the dominant tree along the active floodplain.

Piedmont Scrub Savannas: The scrub savanna plant community occurs on the gently sloping to steep pediments and fan terrace deposits from the Big Burro Mountains along eastern portions of the Emma project area. The scrub savanna vegetative community is characteristic of the transition between an open grassland and mixed evergreen woodland. Deeper soils in valleys tend to be dominated by sideoats, blue, and hairy grama (*B. hisuta*) and other warm-season grasses. Important shrubs include beargrass (*Nolina microcarpa*), broom snakeweed (*Gutierrezia sarothorae*), and catclaw mimosa (*Mimosa biuncifera*). In areas with slightly steeper slopes and shallower soils, Pinyon pine (*Pinus edulis*), one-seed (*Juniperus monosperma*) and alligator junipers (*J. deppeana*), and Emory oak become more prevalent.

Mountain Slope Mixed Evergreen Woodlands: This plant community occupies the strongly sloping to very steep backslopes and ridges of the Big Burro Mountains on shallow soils formed in residuum and colluvium. Vegetation within the mountain slope mixed evergreen woodland is dominated by a relatively open stand of pinyon pine and evergreen oaks with one-seed and alligator juniper subdominant. Mixed grama and associated grasses are dominant in the sparsely vegetated understory with mountain mahogany (*Cercocarpus montanus*), point-leaf manzanita (*Arctostaphylos pungens*), and beargrass being important shrub components. Ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*) are locally important subordinates that may occur in sheltered topographic positions.

3.0 METHODS

The soil and overburden investigation including details of the field sampling of native soils, laboratory analysis of soil samples and NPAG overburden from drill core samples, review of chemical and physical characterization data for soils and overburden. This information was assembled to develop a site-specific soil map and salvage plan (Sections 4 and 5 respectively).

3.1 Soil Survey

For the soil survey, test pit locations were selected prior to field work to achieve a good spatial distribution of samples across the site adjacent to existing exploration access roads. Sample locations were also selected to identify, describe, and characterize the dominant soil-landscapes of the project area to develop an appropriate soil map legend. Adjustments were made in the field if sample locations were not representative of the primary soil-landscape for a test pit or the site had been disturbed by exploration activities.

Test pits were excavated using a backhoe to maximum depth of 4 feet to expose the soil profile. Each soil pedon was described according to National Soil Survey Standards (Soil Survey Division Staff 1993), with respect to its landscape position (slope, aspect), pedogenic soil horizons, geological composition, soil texture, structure, color, roots and rock fragment volume and size classes (i.e., gravel, cobble, and stone). Other important accessory characteristics such as clay films and surface rock were noted. Field pH measurements using a Hellige-Truog soil reaction kit and reaction with a 10% solution of hydrochloric acid (HCl) were also performed. Composite samples of the A and B soil horizons were collected from selected test pits. After describing and sampling the soil pedon, all excavations were backfilled with the excavated material and compacted using the excavator bucket. The surfaces were then smoothed to match preexisting land conditions.

Additional surface soil samples were collected by Tyrone's Environmental Department along the Northern Emma Haul Road alignment in early September 2021. These samples (S1 through S4) were primarily collected for total sulfur analysis to determine whether they were nondischarging (less than 0.2 percent total sulfur) under the Material Handling Plan for the Emma Project (Life Cycle Geo 2021). Two of these samples (S2 and S4) were selected for additional soil suitability testing.

For each sample, a 5- to 10-kilogram (kg) sample was collected for fine-earth characterization (particles < 2 mm in diameter) and the larger rock fragments (> 75 mm) were removed. Samples were placed directly in gallon-sized plastic bags. The sample identification and collection date were recorded on each bag. Once soil mapping was complete, representative samples for the soil map units (see Section 4.1) were selected for laboratory testing. Samples were shipped at ambient temperature to the contracted laboratory under chain of custody.

Soils were also observed along several road cut exposures and in shallow, hand-excavated test pits throughout the survey area. These observations were used to better understand the range of characteristics and soil development of the native soils (e.g., thickness of A horizon, rock content, etc.). Preliminary soil mapping during the field survey was accomplished by making observations of the soils, vegetation, slope, aspect, and physiography. Figure 3 illustrates the distribution of soil survey test pits and observations.

3.2 Selection of Overburden Samples

Unmineralized overburden samples were selected to capture a range of geological units found in the leached zone within the Emma pit boundary. These samples represent NPAG overburden materials that would be directed to the EMW and 6HW Waste stockpiles during mining and potentially used as cover material during reclamation.

Golder reviewed eleven core logs from 2018 and 2019 exploratory drill holes. Drill holes were spatially distributed across the proposed Emma Pit to the extent practicable (Figure 4). The core logs provide detailed geological descriptions of each 10-foot interval including lithology, copper mineralization and ore code (i.e., leach cap, oxide, or sulfide), presence of pyrite, and copper content. Golder selected sample core intervals representing NPAG overburden (those with no observable copper mineralization or evidence of pyrite) in the upper geological profile between 10 and 150 feet below the ground surface for chemical and physical characterization. Tyrone's geologist collected 1-gallon samples of drill core pulp (2018 cores) or cuttings (2019 cores) and shipped the samples at ambient temperature to the contracted laboratory under chain of custody for testing.

3.3 Laboratory Methods

Soil and drill hole core samples collected for fine earth analysis were air-dried and passed through a 2 mm sieve at the laboratory. The less than 2 mm soil fraction was analyzed for the parameters listed Table 1. Selected soil samples and all core samples were analyzed for acid-base accounting and ammonium bicarbonate-diethylenetriaminepentaacetic acid (AB-DTPA) extractable metals.

Soil and overburden samples were analyzed by Energy Laboratories, Inc. in Billings, Montana. The primary references for the analytical techniques include Agricultural Handbook No. 60 (Salinity Laboratory Staff [SLS] 1954) and Methods of Soil Analysis (ASA 1982).

Table 1: Laboratory Testing

Analysis/Parameter	Source-Method
Saturated Paste pH	USDA Handbook 60; Method 2 and 21a
Electrical Conductivity, saturated paste	USDA Handbook 60; Method 3a and 4b
Particle Size Analysis including very fine sand	Gee and Bauder (1986)
Rock Fragment (>2mm)	Dry sieve (No. 10)/gravimetric
Saturation percentage	USDA Handbook 60, Method 27a
Hot water extractable Boron	ASA 1982, Method 10-3
Hot water extractable Selenium	ASA 1982, Method 75-4.1
Organic Matter (Carbon)	ASA 1982, Method 29-3.5.2
N as Nitrate	ASA 1982, Method 33-8.1
Phosphorous (Olsen)	ASA 1982, Method 24-5.4
Potassium	ASA 1982, Method 13-3.5
Acid-Base Account (with sulfur forms)*	Modified Sobek et al. (1978)
AB-DTPA extractable metals* (As, Cd, Cu, Fe, Pb, Mn, Mo, Ni and Zn)	ASA 1982, Method 3-5.2 EPA Method 6010/6020

Note: * test performed on selected soil samples and all overburden drill core samples

4.0 RESULTS

Golder conducted a soil survey field investigation between July 26 and 29. The field investigation was performed by Doug Romig, Certified Professional Soil Scientist, with assistance from Caitlin DeCastro, Botanist. The soil investigation involved the examination of 18 soil profiles in shallow backhoe-excavated pits in the project area (Figure 3). Appendix A provides descriptions of the soil pedons from the soil survey. Twenty-two additional observations were taken along road cuts and shallow hand excavations to confirm the soil-landscape relationships.

4.1 Soil Map Units

The distribution of soils at the Emma Project is controlled by the climate, geology, age of the land surfaces, vegetation, and physiography of the area. Soil map units was initially drawn on aerial photographs in the field as is standard to most soil surveys. Soil boundaries in the project area corresponded well with changes in landscape position and vegetation communities. Reliable relationships between photographic features and map unit properties were established and easily observed in the field. The most important features used to draw map unit boundaries for soil salvage were landform, slope gradient and aspect, vegetation, and surface rock content.

To assist with delineating the boundaries of the soil map units, Golder conducted a slope analysis of the project site. The slope analysis evaluated existing topography for the permit area and classified slopes into four classes: 0-8 percent, 8-15 percent, 15-35 percent and greater than 35 percent (Figure 5). These slope classes corresponded well with the soil map units and the anticipated soil salvage operations (i.e., not salvaging on very steep slopes). Initial soil delineations completed in the field were modified based on the slope the four slope classes. In total, four soil map units were defined based primarily upon the thickness of native soil horizons and slope gradients with two miscellaneous soil map units for rock outcrops (ROs) and disturbed areas (Figure 6). Finalized polygons were digitized in ArcGIS to determine the aerial extent of each soil map unit and determine the potential volume of salvageable soil materials for the project. The following subsections provide general descriptions of the six soil map units.

4.1.1 Gently Sloping Mollisols (GSM)

The GSM map unit consists of moderately deep to very deep and well drained Mollisols (grassland soils) formed in recent and older alluvium derived from volcanic rocks. The fine earth fraction (< 2 mm) is moderately coarse- to medium-textured with low to moderate rock content (10 to 25% gravels). Rocks on the soil surface are small (< 1 inch), grussy gravels. Buried soil horizons may be encountered at depth. These soils occur on nearly level to gently sloping alluvial valleys in the eastern and southern portions of the Emma permit area. Slope gradients range from 3 to 15 percent. Vegetation associated with the Mollisols in the alluvial valleys is primarily comprised of warm-season grasses and low density of shrubs.

The targeted salvage depth for this soil unit is 36 inches, though in some locations 6 to 7 feet may be suitable. Minor inclusions of shallower Mollisols above soft bedrock occur along intermediate ridges in the GSM soil map unit: these inclusions may only be salvageable to about 20 inches (i.e., soil profile ESS-M3). Pedon ESS-M1 is representative of the GSM soil map unit in the Emma survey area (Table 2). The soil was described in a small upland alluvial valley just south of the expected limits of the Emma pit. The slope is slightly concave with a 5 percent slope to the southeast.

Table 2: Abbreviated Soil Description for Pedon ESS-M1

<table>
<tr><td rowspan="3">
</td><td>A</td><td>0-6”</td><td>black (10YR 2/1 moist) loam; moderate fine granular structure; many very fine and fine roots; 10 percent gravel; neutral pH and no reaction to weak acid</td></tr>
<tr><td>Ab</td><td>6-19”</td><td>very dark brown (10YR 2/2 moist) sandy clay loam, buried A horizon; moderate medium granular to subangular blocky structure; common very fine and fine roots; 10 percent gravel; neutral pH and no reaction to weak acid</td></tr>
<tr><td>2Bt</td><td>19-34”</td><td>black (10YR 2/1 moist) sandy clay loam; very hard subangular blocky to massive structure; few very fine to fine roots; 10 percent gravel; neutral pH and no reaction to weak acid</td></tr>
<tr><td colspan="4"></td></tr>
</table>

4.1.2 Fluvents (FLUV)

The FLUV map unit consists of very deep, well drained soils formed in resent alluvium derived from volcanic rocks. The fine earth fraction (< 2 mm) is coarse- to moderately coarse--textured with low moderate rock content (0 to 25 percent gravels). The soil profiles are stratified alluvium. These soils occur in northern portions of the Emma survey area on nearly level stream terraces along of Oak Grove Wash and its tributaries. Slope gradients are less than 5 percent. Vegetation associated with the Fluvents in the stream terraces is scattered dropseeds (*Sporobolus* spp.), tarragon (*Artemisia dranuculoides*) and annual weedy forbs with or without an overstory of Emory oak.

The targeted salvage depth for the FLUV soil unit is 36 inches, though is some locations additional material to 6 or 7 feet may be suitable. Pedon ESS-E2 is representative of the Fluvents in the Emma survey area (Table 3). The soil was described on a stream terrace in Oak Grove Wash within the Emma haul road alignment. The slope is 2 percent to the east.

Table 3: Abbreviated Soil Description for Pedon ESS-E2

A	0-6”	dark brown (10YR 3/3 moist); loam; single grain structure; moderate very fine to medium roots; no coarse fragments; moderately alkaline with slight effervescence.
C1	6-15”	very dark grey (10YR 3/6 moist); fine sandy loam; single grain structure; few fine to medium roots; no coarse fragments; neutral pH and no reaction to weak acid.
C2	15-40”	very dark greyish brown (10YR ¾ moist); coarse loamy sand; single grain structure; very few very fine to fine roots; 25 percent gravel and 2 percent cobble; neutral pH and no reaction to weak acid.
Ab	40”+	dark grey (7.5YR 4/4 moist); bottom of the pit - no additional description taken

4.1.3 Sloping to Steep Lithic (SSL) Soils

The SSL map unit consists of well-drained, shallow soils formed in colluvium and residuum above weathering granite and granodiorite. The fine earth fraction (< 2 mm) is coarse- to moderately coarse-textured with moderate to moderately high rock content (25 to 70 percent gravels and cobbles). Surface lag is predominantly gravels and cobbles that are frequently grussy. These soils have thin A horizons (3 to 6 inches) and weak B horizons (minor clay accumulation or color/structure changes) with weathered bedrock occurring at an average depth of 21 inches but ranging between 12 and 35 inches below the soil surface. Soils would classify as Alfisols or Mollisols in the ustic soil moisture regime.

These soils dominate the central portion of the survey area on the dissected hills and steep mountain slopes. Slope gradients range between 15 and 35 percent. The plant community on SSL soils is a relatively open mixed evergreen woodland with scattered shrubs and a modest understory of predominately warm-season grass species.

The targeted salvage depth for the SSL soil unit is 21 inches. Pockets of deeper alluvium (up to 4 feet thick) may occur in small, low gradient, upland drainages. The map unit has about 5 percent RO and very steep lithic soil inclusions that may limit salvage operations in some locations. Pedon ESS-A2 is representative of the SSL soils in the Emma survey area (Table 4). The soil was described on a convex, shoulder slope with a 15 percent grade to the south.

Table 4: Abbreviated Soil Description for Pedon ESS-A2

A	0-5”	very dark brown (7.5YR 2.5/2 moist); sandy loam; weak fine granular structure; many fine to very fine roots; 20 percent gravel; 5 percent cobble; slightly acidic pH and no reaction to weak acid.
BA	5-16”	strong brown (7.5 YR 4/6 moist); Coarse sandy loam; weak subangular blocky structure; few fine to very fine roots; 50 percent gravel; 30 percent cobble; moderately acidic and no reaction to weak acid.
Cr	16”+	weather granite

4.1.4 Very Steep Lithic (VSL) Soils

This map unit consists of well-drained, shallow soils formed in local colluvium and residuum above weathering granite and granodiorite. The fine earth fraction (< 2 mm) is coarse- to moderately coarse-textured with moderate to moderately high rock content (25 to 70 percent gravels and cobbles). Surface lag is predominantly gravels and cobbles that are frequently grussy. Like the SSL soils, very steep lithic (VSL) soils have thin A horizons and weak

B horizons (minor clay accumulation or color/structure changes) with weathered bedrock occurring within 12 to 20 inches of the soil surface. The VSL soils would likely classify as Alfisols in the ustic soil moisture regime.

These soils occur on very steep dissected mountain slopes primarily in the northern portion of the Emma soil survey area. Slope gradients are greater than 35 percent. The plant community on the VSL soils is a dense mixed evergreen woodland with significant shrub cover and a sparse understory of herbaceous species.

Because these native soils are thin and occur on very steep slope gradients, it is difficult to salvage the soils effectively and safely in this map unit. For this reason, Golder does not recommend soil salvage in the VSL soil map unit. Pedon ESS-A5 is representative of the VSL soil map unit in the Emma survey area (Table 5). The soil was described very steep north-facing backslope. The slope is slightly convex at a grade of 40 percent.

Table 5: Abbreviated Soil Description for Pedon ESS-A5

	A	0-6”	dark brown (7.5 YR 3/4); coarse sandy loam; weak granular structure; roots: moderate very fine to fine, few medium and coarse; 35 percent gravel; slightly acidic and no reaction to weak acid.
	BA	6-22”	strong brown (7.5 YR 4/6); coarse sandy loam; weak subangular blocky structure; few very fine to coarse roots; 65 percent gravel; 2 percent cobble; slightly acidic; no reaction to weak acid.
	Cr	22”+	weathered granite
			

4.1.5 Rock Outcrop (RO)

This miscellaneous map unit is composed of exposed bedrock along ridges and small cliffs with little or no soil (Photo 1). The ROs are primarily associated with Tertiary quartz monzonite exposure in the north portion of the proposed pit and along several east to west porphyry dikes in the central and southern portions of the Emma project area. The soil map unit is localized and small in aerial extent. Because the map unit is primarily large stones and boulders, soil salvaging in these areas is not recommended.

Photo 1: Rock Outcrop in the Emma Project Area

4.1.6 Disturbed Areas

This miscellaneous map unit delineates mine-related disturbances including previous reclaimed areas in and above Oak Grove Wash. To avoid any potential contamination of the salvage native soil materials, Golder does not recommend salvaging materials in this map unit.

4.2 NPAG Overburden Materials

Eleven drill hole samples were selected for chemical and physical characterization of the NPAG overburden at Emma. The selected NPAG drill hole core samples represent a range of overburden geological lithologies identified by Tyrone’s geologists. Precambrian granite (PCgr) and aplite are the dominant rock types at Emma with some drill holes intersecting quartz monzonite porphyry (Qmp), Tertiary granodiorite (Tgd) and Rhyolite dike. Drill hole samples were primarily taken from the first 100 feet of core, though a few samples represent deeper intervals. These materials represent overburden materials that would be stockpile in the 6HW Waste and EMW Waste stockpiles per the Material Handling Plan for the Emma Project (Life Cycle Geo 2021). These granitic overburden materials are thought to be similar in composition to the Little Rock Precambrian granite stockpiled in the 9A/9AX Stockpile.

4.3 Chemical and Physical Characterization Data

In total, fourteen soil and eleven NPAG overburden samples were tested for chemical and physical characterization. Laboratory reports from Energy Laboratories, Inc. are provided in Appendix B.

Native soils at Emma are moderately coarse-textured (sandy loams) to medium-textured (loams) with a low to moderate amount of coarse fragment (Table 6). Soil pedon ESS-A3, however, had higher amounts of clay associated with an argillic (Bt) horizon. Organic matter ranged from 0.9 to 3.0 percent. Nitrate and phosphorus concentrations were low to moderate but considered adequate to support native and adapted plant species. Potassium levels were moderate to high for semi-arid soils. Emma soils are non saline (< 2.0 deciSeimens per meter [dS/m]) and ranged from very strongly acid (pH = 4.7) to neutral (pH = 6.8). Selenium and boron levels were generally at or below detection limits. Acid-base accounts (ABAs) for selective Emma soil samples are positive, ranging from 5 to 11 t $CaCO_3$/kt, with low total sulfur and therefore present little potential to generate acidity (Table 8).

The NPAG overburden samples were collected from archived drill hole cores and subjected to a similar testing regime as the Emma soil samples. Table 7 provides physical and fertility data for the Emma NPAG overburden. Materials are primarily moderately coarse-textured sandy loams with a relatively narrow range in particle size distribution for the fine-earth fractions. Pulped samples from 2018 core samples were medium-textured silt loams are not considered representative of the waste that would be generated during mining. For the unprocessed samples, saturation percentage is consistent and increases with clay content, suggesting that the samples are mineralogically similar. Rock content of the core samples was not evaluated. Organic matter, nitrogen, and phosphorous concentrations are low while potassium levels are considered high.

Table 9 provides chemical characterization data of the NPAG overburden samples. The overburden materials are non to very slightly saline (EC 0.6 to 2.4 dS/m) and moderately acid to slightly alkaline (pH 6.0 to 7.7). All overburden samples had positive ABAs (4 to 16 t $CaCO_3$/kt), low total sulfur concentrations, and are considered suitable under MMD's guidelines (MMD 1996). Selenium and boron levels are also at or below detection limits.

Selected soil and overburden samples were also analyzed for metal extraction by AB-DTPA (Table 10). Extracted metals are generally at low concentrations in the soils and overburden samples except for copper and iron. Nearly half the samples had high availability of extractable copper and all samples had high extractable iron availability (Tiedemann and Lopez 1982; MMD 1996). It is important to note that extraction using the chelating AB-DTPA is aggressive in comparison to a saturated paste extraction as the method was originally developed as a deficiency test to determine the concentration of essential trace elements for crop production. As such, AB-DTPA extractions generally yields higher concentrations of elements than a comparable water extraction. The AB-DTPA extractable copper and iron concentrations are similar to the range of these elements observed in soil solutions from undisturbed soils (Kabata-Pendias 2001). Native soils in the Emma project area also support a viable woodland plant community indicating the high metal availability is not limiting plant growth.

Table 6: Physical and Fertility Characteristics of Native Soils at Emma

Sample ID	Depth Interval (in)	Soil Map Unit	USDA Texture[1]	Sand	Silt	Clay	Very Fine Sand	Coarse Fragments	Saturation Percent	Organic Matter	Organic Carbon	Nitrate as N	P	K
				% wt					%			mg/kg		
ESS-M1	0-34	GSM	L	30	46	24	0	22	37.2	1.8	1	3	28	226
ESS-M2	0-11	GSM	SL	57	36	7	1	11	22.1	1.4	0.8	6	5	97
ESS-E2	0-40	FLUV	SL	69	23	8	7	14	27.1	1.3	0.8	15	10	223
ESS-A2	0-16	SSL	SL	56	29	15	5	55	26.1	1.6	1	7	4	110
ESS-A3	0-16	SSL	CL	44	25	31	5	56	45.8	3	1.8	6	9	335
ESS-A4	0-22	SSL	SCL	56	21	23	4	41	31.1	1.3	0.7	2	7	122
ESS-A5	0-28	VSL	SCL	56	24	20	5	50	39.4	1.8	1.1	5	12	233
ESS-I3	0-20	SSL	SCL	50	21	29	8	8	52	0.9	0.5	<1	5	199
ESS-I4	0-33	SSL	SL	70	21	9	6	48	27.3	2	1.2	6	5	109
ESS-I5	0-6	VSL	L	50	39	11	7	40	30	2.8	1.6	15	5	210
S2	--	VSL	SL	68	20	12	2	14	27.5	1.9	1.1	19	26	281
S4	--	VSL	SL	66	21	13	2	30	27.4	0.4	0.2	1	11	161

Notes: 1) L = loam; S = sand or sandy; C = clay

% wt = percent by weight; mg/kg = milligrams per kilogram

Table 7: Physical and Fertility Characteristics of NPAG Overburden

Drill Hole	Depth Interval (ft)	Geology[1]	USDA Texture[2]	Sand	Silt	Clay	Very Fine Sand	Saturation Percent	Organic Matter	Organic Carbon	Nitrate as N	P	K
				% wt				%			mg/kg		
2018-07	20-30	PCgr/Aplite	SiL	10	74	16	8	40.1	0.4	0.2	<1	5	344
2018-10	20-30	PCgr/Aplite	SiL	6	79	15	5	39.3	0.2	0.1	<1	4	512
2018-13	100-110	PCgr	Si	8	81	11	7	36.9	0.2	0.1	1	6	354
2019-02	20-30	Qmp	SL	69	27	4	4	19.6	0.4	0.2	<1	5	58
	130-140	PCgr	SL	68	25	7	8	26.4	0.2	0.1	<1	4	134
2019-06	40-50	PCgr	SL	60	33	7	5	28.1	0.3	0.2	<1	5	107
	70-80	Aplite/PCgr	SL	68	28	4	6	20.2	0.2	0.1	<1	5	86
	130-140	Rhyolite Dike	SL	64	32	4	1	21.7	0.2	0.1	<1	5	132
2019-07	10-20	Tgd/Aplite	SL	72	22	6	8	25.9	0.3	0.2	<1	4	73
	30-40	Tgd/Aplite	SL	60	26	14	6	35.9	<0.2	<0.1	<1	4	221
2019-14	40-50	PCgr	SL	62	34	4	1	25.9	0.5	0.3	<1	5	115

Notes: 1) PCgr= Precambrian granite, Qmp = Quartz monzonite porphyry, Tgd = Tertiary granodiorite

2) Texture may not be representative for pulped 2018 drill core samples; L = loam; S = sand or sandy; C = clay, Si = silt

% wt = percent by weight; mg/kg = milligrams per kilogram

Table 8: Chemical Characteristics of Selected Native Soils

Soil Pedon	Depth Interval (in)	Soil Map Unit	Saturated Paste		Sulfur Forms					Acid Base Account			Hot Water Extr.	
			pH	EC	HCl	HNO_3	H_2O	Residual	Total	Acid Pot.	Neut. Pot.	ABP	Selenium	Boron
			s.u.	dS/m	%					t $CaCO_3$/kt			mg/kg	
ESS-M1	0-34	GSM	6.1	0.4	--	--	--	--	--	--	--	--	<0.1	<0.1
ESS-M2	0-11	GSM	6.3	0.5	<0.01	0.01	<0.01	<0.01	0.01	0	5	5	<0.1	<0.1
ESS-E2	0-40	FLUV	6.1	0.9	--	--	--	--	--	--	--	--	<0.1	0.1
ESS-A2	0-16	SSL	5.5	0.6	<0.01	<0.01	<0.01	0.02	0.04	1	3	2	<0.1	<0.1
ESS-A3	0-16	SSL	6.5	0.8	--	--	--	--	--	--	--	--	<0.1	0.2
ESS-A4	0-22	SSL	5.4	0.3	<0.01	<0.01	0.01	0.03	0.05	1	4	3	<0.1	<0.1
ESS-A5	0-28	VSL	5.4	0.8	<0.01	<0.01	<0.01	<0.01	0.02	<1	5	5	<0.1	<0.1
ESS-I3	0-20	SSL	6.8	0.6	<0.01	0.01	<0.01	<0.01	0.02	<1	11	10	<0.1	<0.1
ESS-I4	0-33	SSL	5.4	0.6	<0.01	<0.01	<0.01	<0.01	0.02	<1	11	11	<0.1	<0.1
ESS-I5	0-6	VSL	6.3	0.9	--	--	--	--	--	--	--	--	<0.1	0.1
S1	--	FLUV	--	--	--	--	--	--	0.10	--	--	--	--	--
S2	--	VSL	6.1	1.8	<0.01	0.02	<0.01	0.01	0.03	0	7	7	0.2	<0.1
S3	--	SSL	--	--	--	--	--	--	0.16	--	--	--	--	--
S4	--	VSL	4.7	0.4	<0.01	<0.01	<0.01	<0.01	0.02	0	5	5	<0.1	<0.1

Notes: dS/m = deciSiemens per meter; s.u. = standard units; t CaCO3/kt = tons of $CaCO_3$ per kiloton; mg/kg = milligrams per kilogram

-- test not completed on sample

Table 9: Chemical Characteristics of NPAG Overburden Samples

Drill Hole	Depth Interval (ft)	Geology[1]	Saturated Paste		Sulfur Forms					Acid Base Account			Hot Water Extr.	
			pH	EC	HCl	HNO_3	H_2O	Residual	Total	Acid Pot.	Neut. Pot.	ABP	Selenium	Boron
			s.u.	dS/m	%					t $CaCO_3$/kt			mg/kg	
2018-07	20-30	Aplite/PCgr	7.5	1.1	<0.01	<0.01	<0.01	<0.01	0.02	0	8	8	<0.1	0.1
2018-10	20-30	Aplite/PCgr	6	2.4	<0.01	0.07	0.01	0.03	0.11	3	8	5	<0.1	0.1
2018-13	100-110	Aplite/PCgr	7.6	1	<0.01	<0.01	<0.01	<0.01	0.02	0	13	12	<0.1	<0.1
2019-02	20-30	Qmp	7.5	0.8	<0.01	<0.01	<0.01	<0.01	0.02	0	9	8	<0.1	<0.1
	130-140	PCgr	7.6	0.9	<0.01	<0.01	<0.01	0.01	0.02	0	5	4	<0.1	<0.1
2019-06	40-50	PCgr	7.1	0.7	<0.01	<0.01	<0.01	0.01	0.02	0	10	10	<0.1	<0.1
	70-80	Aplite/PCgr	7.2	0.9	<0.01	<0.01	<0.01	<0.01	0.02	0	9	9	<0.1	<0.1
	130-140	Rhyolite Dike	7.6	0.9	<0.01	<0.01	<0.01	0.01	0.02	0	5	4	<0.1	<0.1
2019-07	10-20	Tgd/Aplite	7.7	1.1	<0.01	<0.01	<0.01	<0.01	0.01	0	16	15	<0.1	<0.1
	30-40	Tgd/Aplite	7.7	0.6	<0.01	<0.01	<0.01	<0.01	0.01	0	13	13	<0.1	<0.1
2019-14	40-50	PCgr	7.3	1.8	<0.01	<0.01	<0.01	0.02	0.02	0	16	16	<0.1	<0.1

Notes: 1) PCgr= Precambrian granite, Qmp = Quartz monzonite porphyry, Tgd = Tertiary granodiorite
ABP = Acid Base Potential
dS/m = deciSiemens per meter; s.u. = standard units; t CaCO3/kt = tons of $CaCO_3$ per kiloton; mg/kg = milligrams per kilogram

Table 10: Extractable Metals in NPAG Overburden and Selected Native Soil Samples

Drill Hole or Soil Pedon	Depth Interval (ft)	Geology/ Soil Map Unit	AB-DTPA Extraction								
			As	Cd	Cu	Fe	Pb	Mn	Mo	Ni	Zn
			mg/kg								
2018-07	20-30	Aplite	0.03	<0.1	66.7	89	17.4	34.9	1.6	0.4	50.1
2018-10	20-30	Aplite/PCgr	<0.02	<0.1	78.4	109	1.9	2.9	1.5	0.2	14
2018-13	100-110	Aplite/PCgr	0.03	<0.1	96.3	109	1	15.9	1.2	0.5	47.9
2019-02	20-30	Qmp	0.05	0.1	33.1	38	4.5	14.2	0.4	<0.1	16.7
	130-140	PCgr	0.04	<0.1	3	48	13.3	11.6	0.4	0.2	6.3
2019-06	40-50	PCgr	<0.02	0.1	29.2	54	1.5	57.6	1.1	0.1	14.4
	70-80	Aplite/PCgr	<0.02	<0.1	8.1	46	1.8	20.9	0.4	<0.1	5.7
	130-140	Rhyolite Dike	<0.02	<0.1	6	46	4.9	18.4	0.4	<0.1	3.5
2019-07	10-20	Tgd/Aplite	<0.02	0.3	2.9	43	2	16	0.4	<0.1	41.4
	30-40	Tgd/Aplite	<0.02	0.3	5.6	33	56.3	24.2	6.6	<0.1	10.3
2019-14	40-50	PCgr	<0.02	<0.1	20.5	44	0.6	10	1.1	<0.1	4.3
ESS-M2	0-11	GSM	0.07	<0.1	51.4	31	4.2	5.3	<0.1	0.1	3.5
ESS-A2	0-16	SSL	0.14	<0.1	13.4	38	3.3	22.9	<0.1	0.6	6.1
ESS-A4	0-22	SSL	0.12	0.4	112	71	6.3	10.5	0.6	0.4	14.6
ESS-A5	0-28	VSL	0.05	0.3	59.6	41	3.1	12.1	<0.1	0.7	13.9
ESS-I3	0-20	SSL	0.12	<0.1	24.9	35	6.5	6.3	0.2	0.6	5.1
ESS-I4	0-33	SSL	0.06	0.5	53.6	58	10.1	13.9	<0.1	0.6	30.9
S2	-	VSL	0.04	0.5	34.2	20	1.0	32.2	< 0.1	0.4	23.7
S4	-	VSL	<0.02	0.2	161	21	0.1	30.2	<0.1	0.2	21.2

Notes: AB-DTPA = ammonium bicarbonate-diethylenetriaminepentaacetic acid; mg/kg = milligrams per kilogram

4.4 Reclamation Suitability of Emma Soils and Overburden

Native soils and NPAG overburden materials in the Emma project area are considered suitable as a reclamation cover material (RCM) and have no inherent chemical or physical limitations for the growth of native and adapted reclamation plant species. On the basis of the laboratory data, the chemical characteristics of the soil and overburden samples indicate they are suitable with respect to pH, salinity, nutrient levels, and extracted metal concentrations. The ABA data suggests the soil and overburden materials are non acid-generating having total sulfur concentrations below the 0.2 percent sulfur threshold (Life Cycle Geo 2021). Native soils are predominately moderately-coarse textured with moderate to moderately high volumes of rock fragments. Similarly, the fine earth fraction of the NPAG overburden is also moderately-coarse textured and rock content is projected to be similar to the Little Rock Precambrian granite after blasting.

Comparison of soil suitability data for the Emma NPAG overburden and the Little Rock Precambrian granite (Golder 2017, 2020a,b) suggests the granitic materials are quite similar with respect to their geology as well as their physical and chemical characteristics. The overburden lithologies at Emma designated for the EMW Waste and 6HW Waste stockpiles are expected to be approximately 65% Precambrian granite, 20% Tertiary monzonite porphyry, and 15% other relatively minor lithologies including aplite, hornfels, and diabase dikes (Life Cycle Geo 2021). Composition of the Little Rock overburden materials in the 9A/9AX Waste stockpiles, based on geologic maps presented in the Little Rock Closure/Closeout Plan (Golder 2020a), is predominantly Precambrian granite with a moderate amount of Tertiary intrusive rocks. Chemical and physical data from the NPAG overburden drill core are very similar to Precambrian granite samples collected from the soil cover at the United States Natural Resources (USNR) Test Plots (Golder 2017) and bulk samples collected at the 9A/9AX Waste stockpiles (Golder 2020b). In summary, the Precambrian granite overburden materials from the Little Rock Mine are similar to the Emma NPAG overburden as both are net-neutralizing, non acid-generating, non saline, and have neutral to alkaline pH values and low amounts of nitrogen and phosphorous.

Because of these similarities, Golder anticipates that the Emma NPAG overburden will support native vegetation comparable to areas where the Little Rock Precambrian granite was used as a RCM. These reclaimed sites include the Copper Leach Stockpile at Little Rock, the reclaimed USNR site, and the Little Rock Precambrian granite Test Plots at the USNR site. With respect to the later, vegetation monitoring at the USNR Test Plots after five growing seasons has demonstrated that the Little Rock Precambrian Granite is a suitable RCM with the ability to support vegetation (Golder 2021). Overall, the trajectory of the vegetation communities on these reclaimed sites with Precambrian granite soil covers is positive with respect to overall plant density, canopy cover, diversity, and shrub density.

5.0 SOIL SALVAGE PLAN

As part of the proposed operations for the Emma project, Tyrone plans to salvage the pedogenic A and B horizons of native soils from areas scheduled to be disturbed with mine development. Because most of the soils are shallow and have thin A horizons, Tyrone proposes to mix the entire soil profile during salvage operations. In addition, the very steep slopes in some of the permit area limit the practicality of operating equipment for soil salvage. Any underlying C or R soil horizons will be salvaged and incorporated into the EMW Waste and 6HW Waste stockpiles which will also be utilized as a RCM in the future.

Tyrone intends to salvage as much native soil material as can be safely and practicably recovered. The total potential volume of salvageable suitable soil materials is the product of the area of each soil map unit within the projected disturbance in both the Existing Unit and New Unit disturbance boundaries and the assigned target depth of the suitable soil material in that unit (Figure 6). The average target depth for the individual soil units was used to estimate the potential salvageable volume of native soils for the project (21 inches for the SSL soils and 3 feet for the GSM and FLUV soils). Thus, the estimated maximum volume of salvageable soil materials for the Emma Project is approximately 547,600 banked cubic yards (CY, rounded up) (Table 11). Due to safety concerns with operating heavy equipment on slopes steeper than 3H:1V, Tyrone will not conduct soil salvage operations on the complex and very steep slopes of VSL soil map unit. For this calculation, it is also assumed that no soil salvage operations will be performed in the disturbed areas in the Existing Unit.

Soil salvage will be performed ahead of mining activities as to not adversely impact the quantity and quality of native soil resources. Prior to soil salvage, large diameter trees and shrubs will be grubbed. To the extent that it does not interfere with soil salvage operations, small diameter woody plants, herbaceous vegetation and roots would be salvaged to minimize the loss of organic matter of the soil materials. Soil salvage will be completed by dozers that will remove the recommended depth and push to load out areas where front-end loaders will load hauls trucks. Soil salvage will be undertaken throughout the year when soils are dry. Soil salvage will not be conducted in the days following snow or heavy rain events until the soils are sufficiently dry to avoid compaction. To minimize compaction, equipment traffic patterns in salvage areas will also be minimized.

Table 11: Estimated Volume of Salvageable Soils

Soil Map Unit	Acres	Salvage Depth (ft)	Volume (banked CY)
FLUV	30.2	3	146,168
GSM	7.5	3	36,155
SSL	174.2	1.6	365,272
VSL	75.9	0	-
RO	13.1	0	-
DIST	7.3	0	-
Total	**308.1**		**547,594**

Note: banked CY = cubic yards of in-place soil not accounting for swell associated with salvage

Salvaged native soil materials will be stored in the Soil Stockpile immediately west of the Emma Pit for future reclamation use (Figure 2). The surfaces of the Soil Stockpile will be shaped after construction with overall slopes of 2.7 to 3H:1V or shallower to minimize soil loss. To further minimize erosion and the establishment of undesirable weeds, the Soil Stockpile will be seeded with the interim seed mix listed in Table 12. Interim seeding would be conducted prior to growing season. Berms may be constructed as needed (either on or near the stockpile) to prevent outslope erosion from overland flow. Best Management Practices such as berms of brush and coarse rock from grubbing the vegetation at the soil stockpile and haul road sites will be used to capture sediment and reduce soil loss from the stockpile.

Based on the reclamation plan, 12 inches of salvaged soil materials will be redistributed across approximately 206 acres including backfilled portions of the Emma Pit and the top surface and slopes of the 6HW Waste and EMW Waste stockpiles. Thus, the required volume of salvaged soil materials to complete the proposed reclamation plan is approximately 320,720 CY. Not accounting for swell during salvage operations, the volume of soil materials to be salvaged exceeds the anticipated volume of soil materials required by the reclamation plan.

Table 12: Interim Seed Mix for Stockpiled Soil Materials

Scientific Name	Common Name	PLS/ac[1]
Grasses		
Bouteloua curtipendula	Sideoats grama	1.00
Bouteloua gracilis	Blue grama	0.20
Pleuraphis jamesii	Galleta	0.75
Schizachyrium scoparium	Little bluestem	0.40
Eragrostis intermedia	Plains lovegrass	0.05
Shrubs		
Artemisia ludoviciana	White sagebrush	0.05
Atriplex canescens	Four-wing saltbush	0.30
Ericamerica nauseosus	Rubber rabbitbrush	0.10
Forbs		
Dalea candida	White prairie clover	0.10
Ratibida columnifera	Prairie coneflower	0.15
	Total	**3.10**

Notes: [1] – Rate is in pounds of pure live seed (PLS) per acre; Substitutions may change seeding rates.

6.0 REFERENCES

Agronomy Society of America (ASA). 1982. Monograph 9: Methods of Soil Analysis. Soil Sci. Soc. Am., Madison, WI.

Daniel B Stephens & Associates, Inc. (DBS&A). 1997. Closure/ Closeout Plan. Prepared for Phelps Dodge Tyrone, Inc., Tyrone, New Mexico. December 19, 1997.

DBS&A. 2021. Hydrogeologic Report for the Proposed Emma Expansion Project. Prepared for Freeport-McMoRan Tyrone Inc. October 22, 2021.

Gee, G.W., and J.W. Bauder. 1986. Particle-size Analysis. In: Methods of Soil Analysis. Part 1-Physical and Mineralogical Methods, 2nd Edition. A. Klute (ed). Agron. 9. Soil Sci. Soc. Am., Madison, WI.

Golder Associates Inc. (Golder). 2017. United States Natural Resources (USNR) Test Plot – Annual Report No. 1. Little Rock and Tyrone Mines. Prepared for Freeport-McMoRan Tyrone, LLC. March 8, 2017.

Golder. 2020a. Updated Closure/Closeout Plan for the Little Rock Mine Submitted to: Freeport-McMoRan Tyrone Inc. June 11, 2020.

Golder. 2020b. Characterization and Volumetrics of Gila Conglomerate and Precambrian Granite Reclamation Cover Materials, Freeport-McMoRan Tyrone Operations.

Golder 2021. 2020 Quantitative Vegetation and Erosion Monitoring: Little Rock Mine, United States Natural Resources (USNR) Test Plots. Submitted to: Freeport-McMoRan Tyrone Inc. April 28, 2021.

Kabata-Pendias, A. 2001. Trace elements in soils and plants. CRC press.

Life Cycle Geo. 2021. Material Characterization and Handling Plan for Two Nondischarging Facilities: Emma Project. Submitted to Freeport-McMoRan Tyrone, Inc. October 22, 2021.

New Mexico Mining and Minerals Division (MMD). 1996. Draft Closeout Plan Guidelines for Existing Mines. Mining Act Reclamation Bureau, Santa Fe, NM. April 30, 1996.

Parnham, T.L., R. Paetzold, and C.E. Souders. 1983. Soil Survey of Grant County, New Mexico, Central and Southern Parts. USDA-Soil Conservation Service, U.S. Gov. Print. Office Washington DC.

Salinity Laboratory Staff (SLS). 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agricultural Handbook No. 60. USDA-Agricultural Research Service. US Government Printing Office, Washington, D.C.

Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. EPA-600/2-78-054.

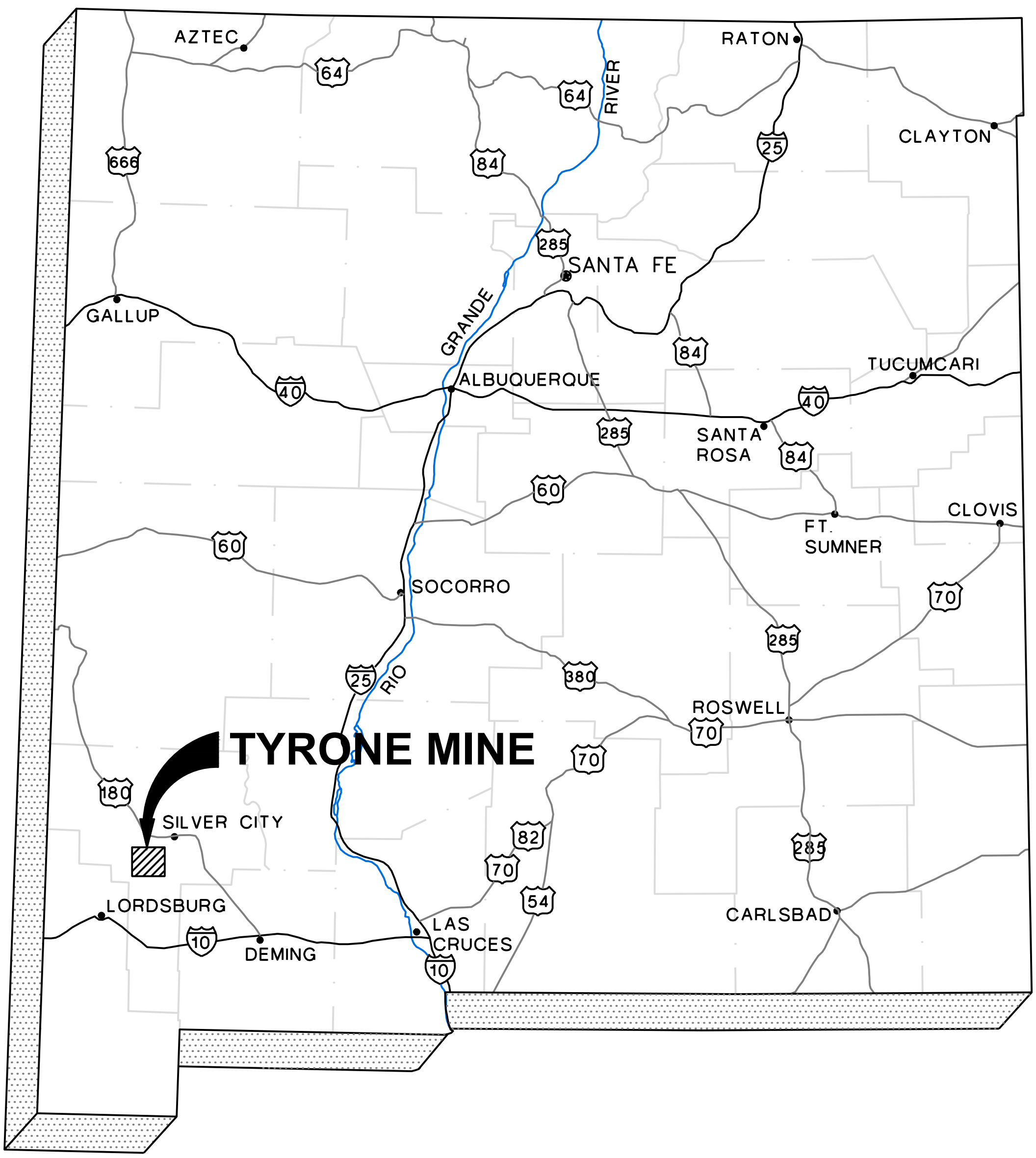
Soil Survey Division Staff. 1993. Soil Survey Manual. Handbook No. 18, 2nd ed. USDA-Soil Conservation Service. US Government Printing Office, Washington, D.C.

Tiedemann, A.R., and C.F. Lopez. 1982. Soil nutrient assessments of mine spoils. In: Aldon, EF and WR Oaks (ed.). Symposium on Reclamation of mined lands in the Southwest. Soil Cons. Soc, New Mexico Chapter. Albuquerque, NM. Oct. 20-22, 1982.

Figures

STATE OF NEW MEXICO

NOT TO SCALE



CLIENT

FREEPORT-MCMORAN

TYRONE INC.

PROJECT

EMMA PROJECT

CONSULTANT

GOLDER

MEMBER OF WSP

YYYY-MM-DD	09/17/21
PREPARED	SIB
DESIGN	TS
REVIEW	TS
APPROVED	TS

TITLE

MINE LOCATION MAP

PROJECT No.	PHASE	Rev.	FIGURE
21476949		0	1

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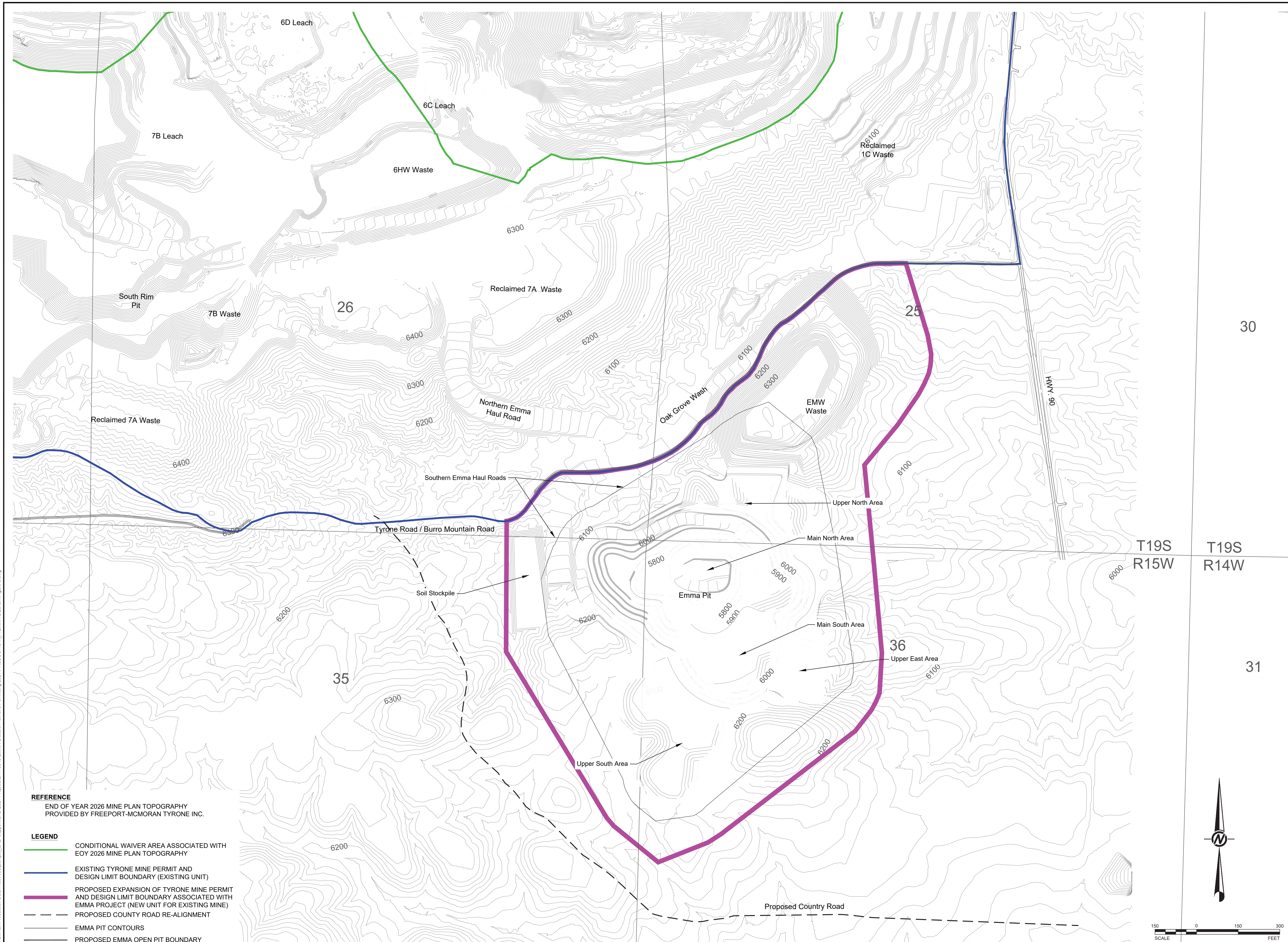

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
0	2021-10-04	-	SIB		DR	TS

CLIENT
FREEPORT-MCMORAN
TYRONE INC.

CONSULTANT
GOLDER MEMBER OF WSP
GOLDER ASSOCIATES
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RICHMOND, VA 23227
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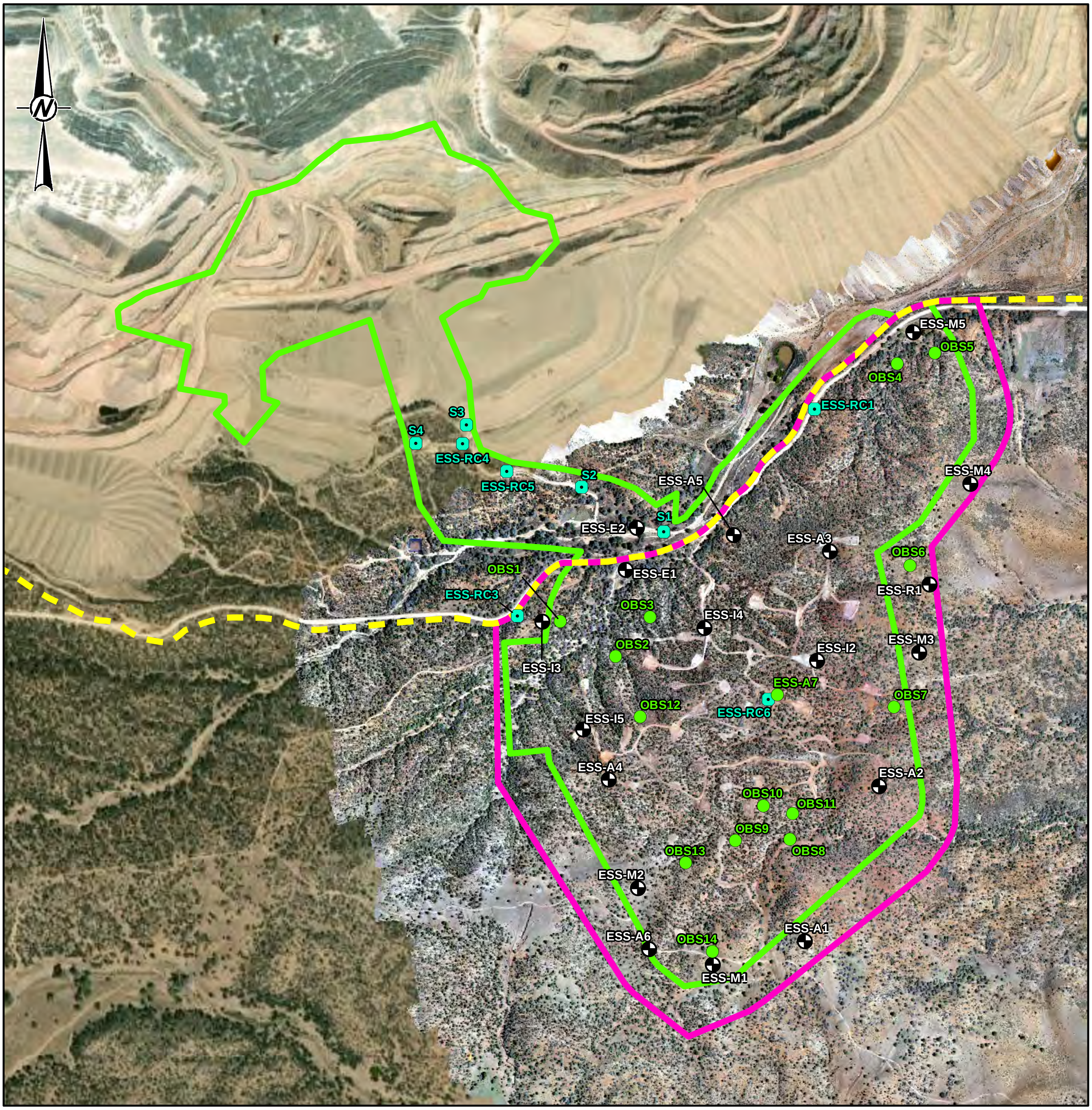
PROJECT
EMMA PROJECT

TITLE
LAYOUT OF EMMA FACILITY AT THE END OF YEAR 2026

PROJECT NO. 21-476949 | REV. 0 | FIGURE 2



LEGEND

- PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
- DISTURBANCE BOUNDARY
- EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)
- OBSERVATIONS
- ROAD CUTS
- TEST PITS

0 600 1,200 2,400 Feet

REFERENCE(S)

1. AERIAL IMAGERY AT SITE: FMI FLYOVER, AUGUST 2021.
2. AERIAL IMAGERY IN SURROUNDING AREAS: ESRI PROVIDED BASE MAP SERVICE. VIVID, MAXAR. IMAGERY COLLECTED 10/21/2020.

CLIENT
FREEPORT MCMORAN TYRONE INC.
GRANT COUNTY, NEW MEXICO

PROJECT
EMMA EXPANSION PROJECT, CLOSURE CLOSEOUT PLAN, SOIL AND OVERBURDEN CHARACTERIZATION

TITLE
LOCATION OF EMMA SOIL SURVEY TEST PITS AND OBSERVATIONS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-11
DESIGNED	RHG
PREPARED	RHG
REVIEWED	DR
APPROVED	TS

PROJECT NO.
21476949

FIGURE
3

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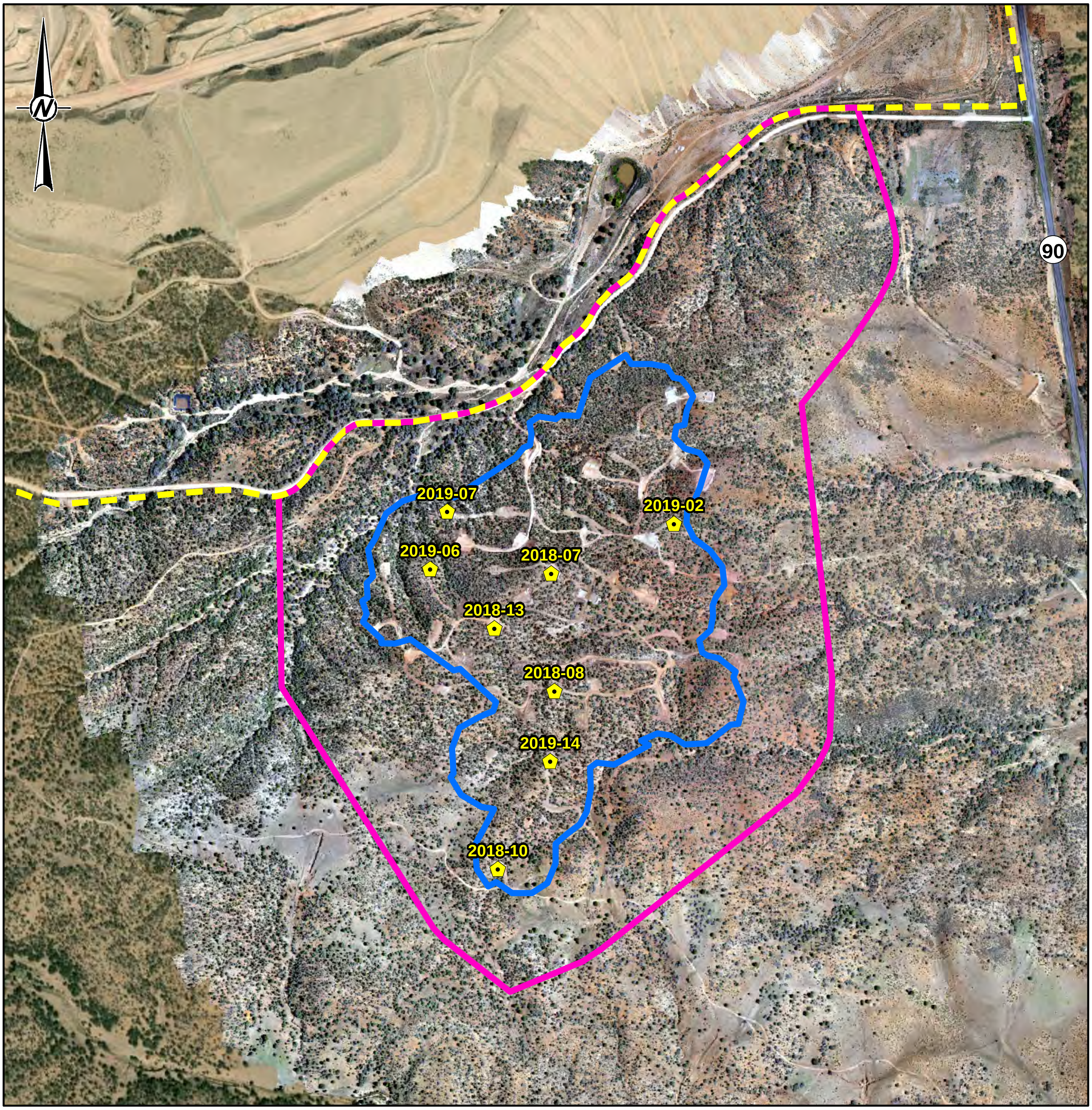

LEGEND

- PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
- EMMA PIT DISTURBANCE AREA
- EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)
- DRILL HOLES

0 500 1,000 2,000 Feet

REFERENCE(S)

1. AERIAL IMAGERY AT SITE: FMI FLYOVER, AUGUST 2021.
2. AERIAL IMAGERY IN SURROUNDING AREAS: ESRI PROVIDED BASE MAP SERVICE. VIVID, MAXAR. IMAGERY COLLECTED 10/21/2020.

CLIENT
FREEPORT MCMORAN TYRONE INC.
GRANT COUNTY, NEW MEXICO

PROJECT
EMMA EXPANSION PROJECT, CLOSURE CLOSEOUT PLAN, SOIL AND OVERBURDEN CHARACTERIZATION

TITLE
DRILL HOLE LOCATIONS FOR EMMA OVERBURDEN CHARACTERIZATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-11
DESIGNED	RHG
PREPARED	RHG
REVIEWED	DR
APPROVED	TS

PROJECT NO.
21476949

FIGURE
4

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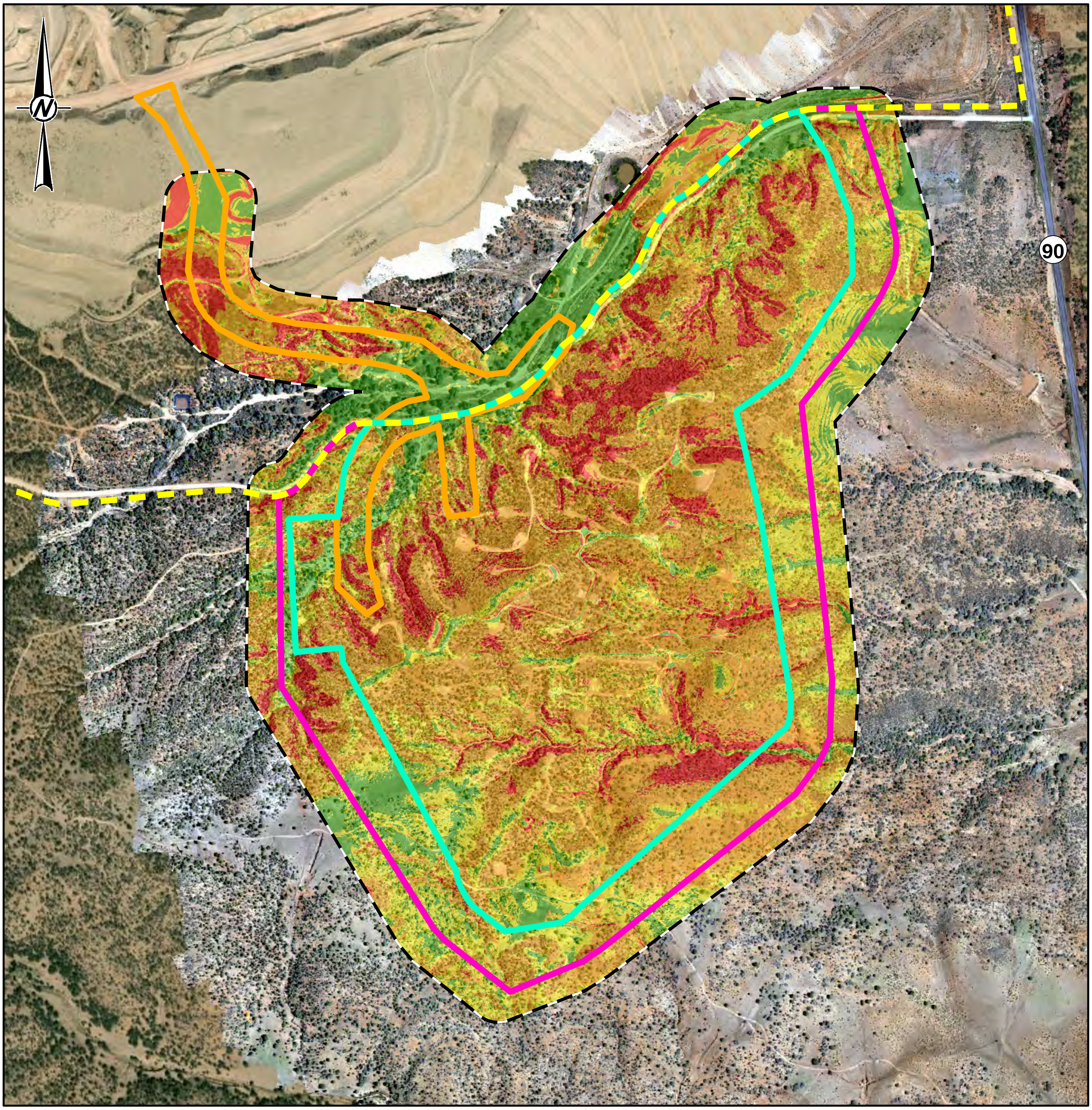


LEGEND

PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)

EMMA HAUL ROADS

NEW UNIT DISTURBANCE AREAS

EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)

200' BUFFER

SLOPE

< 8%

8% - 15%

15% - 35%

> 35%

0 500 1,000 2,000 Feet

REFERENCE(S)

1. AERIAL IMAGERY AT SITE: FMI FLYOVER, AUGUST 2021.
2. AERIAL IMAGERY IN SURROUNDING AREAS: ESRI PROVIDED BASE MAP SERVICE. VIVID, MAXAR. IMAGERY COLLECTED 10/21/2020.
3. TOPOGRAPHIC DATA: USGS LIDAR, 2018.

CLIENT
FREEPORT MCMORAN TYRONE INC.
GRANT COUNTY, NEW MEXICO

PROJECT
EMMA EXPANSION PROJECT, CLOSURE CLOSEOUT PLAN, SOIL AND OVERBURDEN CHARACTERIZATION

TITLE
SLOPE ANALYSIS OF THE EMMA PROJECT AREA

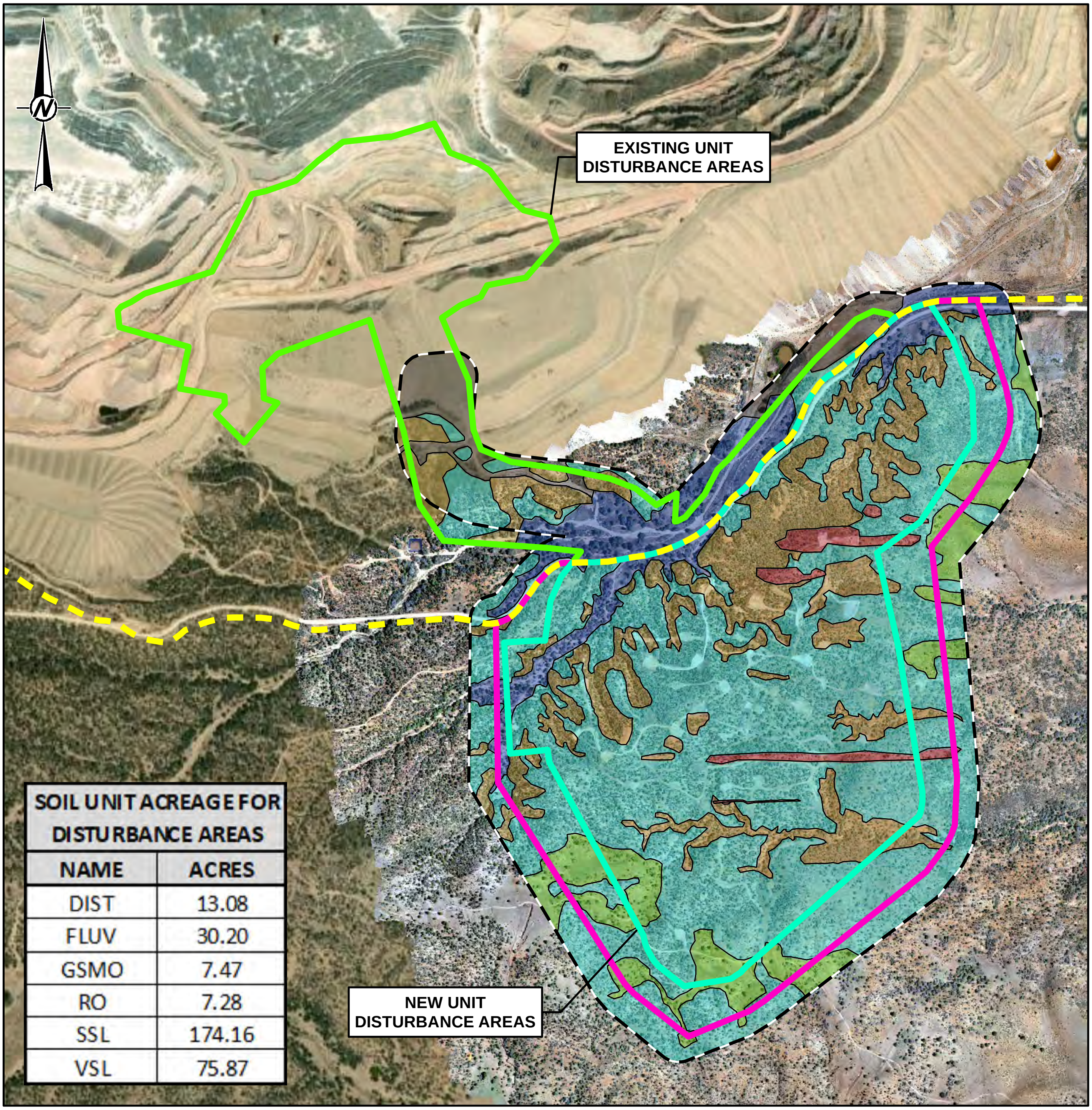
CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-11
DESIGNED	RHG
PREPARED	RHG
REVIEWED	DR
APPROVED	TS

PROJECT NO.
21476949

FIGURE
5



SOIL UNIT ACREAGE FOR DISTURBANCE AREAS	
NAME	ACRES
DIST	13.08
FLUV	30.20
GSMO	7.47
RO	7.28
SSL	174.16
VSL	75.87

LEGEND

- PROPOSED EXPANSION OF TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY ASSOCIATED WITH EMMA PROJECT (NEW UNIT FOR EXISTING MINE)
- EXISTING TYRONE MINE PERMIT AND DESIGN LIMIT BOUNDARY (EXISTING UNIT)
- 200' BUFFER

SOIL UNITS

- DIST
- FLUV
- GSMO
- RO
- SSL
- VSL

0 600 1,200 2,400 Feet

REFERENCE(S)

1. AERIAL IMAGERY AT SITE: FMI FLYOVER, AUGUST 2021.
2. AERIAL IMAGERY IN SURROUNDING AREAS: ESRI PROVIDED BASE MAP SERVICE. VIVID, MAXAR. IMAGERY COLLECTED 10/21/2020.
3. TOPOGRAPHIC DATA: USGS LIDAR, 2018.

CLIENT
FREEPORT MCMORAN TYRONE INC.
GRANT COUNTY, NEW MEXICO

PROJECT
EMMA EXPANSION PROJECT, CLOSURE CLOSEOUT PLAN, SOIL AND OVERBURDEN CHARACTERIZATION

TITLE
SOIL MAP UNITS FOR THE EMMA PROJECT AREA

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-11
DESIGNED	RHG
PREPARED	RHG
REVIEWED	DR
APPROVED	TS

PROJECT NO.
21476949

FIGURE
6

APPENDIX A

Soil Pedon Summaries

Table A-1: Gently Sloping Mollisols and Fluvents

Pedon	Horizon	Depth (in)	USDA Texture Class[1]	Salvage Depth	Grade	Sand (%)	Clay (%)	Coarse Fragments (%)[2]				Soil Color	pH	Reaction[3]
								GR	CO	ST	Total			
Gently Sloping Mollisols														
ESS-M2	A	0-6"	L	~60"	5%	35	25	10	0	0	10	11 YR 2/1	8	eo
	Ab	6-19"	SCL			65	22	10	0	0	10	10 YR 2/2	7	eo
	2Bt	19-34"	SCL			50	30	10	0	0	10	10 YR 2/1	7	eo
ESS-M2	A	0-6"	SL	~11"	5%	65	15	25	0	0	0	10 YR 3/2	7	eo
	AC	6-11"	SL			65	13	40	5	0	45	10 YR 3/3	7	eo
	R	11"+	-											
ESS-M3	A	0-13"	SL	~20"	12%	70	13	10	3	0	13	10 YR 2/2	6.5	eo
	AC	13-20"	SCL			70	22	12	6	0	18	10 YR 3/3	6.5	eo
	Cr	20"+	-											
ESS-M4	A1	0-14"	SL	~36"	7%	65	18	5	0	0	5	10 YR 2/2	6.5	eo
	A2	14-29"	SCL			60	23	5	0	0	5	10 YR 2/2	7	eo
	AB	29"+	SL			65	19	10	0	0	10	10 YR 3/2	7	eo
	-	90"	SL			70	14	10	0	0	10	10 YR 3/3	7	eo
ESS-R1	A	0-7"	SL	~17"	7%	65	13	>5	0	0	>5	10 YR 2/2	6	eo
	Bt	7-17"	coSL			70	16	10	10	0	20	10 YR 3/6	6.5	eo
	Cr	17-24"	-											
Fluvents														
ESS-E1	A	0-12"	LS	~24"	2%	-	-	25	0	0	25	-	-	-
ESS-E2	A	0-6"	L	~36"	2%	50	10	0	0	0	0	10 YR 3/3	8	esl
	C1	6-15"	fSL			60	12	0	0	0	0	10 YR 3/6	7	eo
	C2	15-40"	LcoS			80	8	25	2	0	0	10 YR 3/4	7	eo
	Ab	40"+	-											

Notes: 1) L = loam or loamy; S = sand or sandy; C = clay: sand modifiers: f = fine; co = coarse
2) GR = gravel; CO= cobble; ST = stone
3) Reaction to dilute acid: eo = none, esl = slight

Table A-2: Sloping to Steep Lithic Soils

Pedon	Horizon	Depth (in)	USDA Texture Class[1]	Salvage Depth	Grade	Sand (%)	Clay (%)	Coarse Fragments (%)[2]				Soil Color	pH	Reaction[3]
								GR	CO	ST	Total			
ESS-A1	A	0-4"	LcoS	~14"	20%	80	10	45	10	5	60	10 YR 2/2	6.5	eo
	Bw	4-14"	LcoS			80	10	50	20	10	80	10 YR 4/4	7	eo
	Cr	14"+												
ESS-A2	A	0-5"	SL	~16"	15%	65	12	20	5	0	25	7.5 YR 2.5/2	6.5	eo
	Bw	5-16"	coSL			75	12	50	30	0	80	7.5 YR 4/6	6	eo
	Cr	16-36"												
ESS-A3	A	0-6"	SL	~16"	15%	60	14	10	10	0	20	10 YR 2/2	6.5	eo
	Bt	6-16"	CL			30	30	45	20	0	65	10 YR 5/4	7	eo
	Cr	16"+	-											
ESS-A4	A	0-4"	L	~22"	20%	45	24	25	10	0	35	7.5 YR 3/3	5.5	eo
	Bt1	4-12"	SCL			60	24	60	10	0	70	7.5 YR 5/6	6.5	eo
	Bt2	12-22"	SCL			55	28	60	15	0	75	7.5 YR 4/6	6	eo
	Cr	22-32"	-											
ESS-I2	A	0-8"	coSL	~24"	15%	65	13	15	10	0	25	7.5 YR 3/3	6.5	eo
	BC	8-14"	coSL			75	13	60	15	0	75	7.5 YR 4/4	7	eo
	Cr	14"+												
ESS-I4	A	0-3"	coSL	~18"	-	75	11	45	0	0	45	10 YR 3/2	5.5	eo
	AC	4-18"	coSL			75	11	50	0	0	50	10 YR 3/3	6.5	eo
	Cr	18-33"												
ESS-A6	A	0-5"	SL	~33"	20%	65	15	45	5	0	50	10 YR 3/4	7	eo
	Bw	5-15"	coSL			75	10	50	10	5	65	10 YR 4/6	7	eo
	BC	15-33"	SL			70	19	40	15	5	60	10 YR 3/3	6.5	eo
	Cr	33"+	-											
ESS-I3	A	0-2"	CL	~35"	2%	45	32	15	0	0	15	7.5 YR 4/6	7	eo
	Bt1	2-12"	CL			45	38	35	0	0	35	7.5 YR 4/6	7	eo
	Bt2	12-20"	coSL			75	15	45	0	0	45	7.5 YR 4/4	7	eo
	Bk	20-35"	coSL			80	10	60	0	0	60	7.5 YR 4/4	7	esl

Notes:
1) L = loam or loamy; S = sand or sandy; C = clay: sand modifiers: f = fine; co = coarse
2) GR = gravel; CO= cobble; ST = stone
3) Reaction to dilute acid: eo = none, esl = slight

Table A-3: Very Steep Lithic Soils

Pedon	Horizon	Depth (in)	USDA Texture Class[1]	Salvage Depth	Grade	Sand (%)	Clay (%)	Coarse Fragments (%)[2]				Soil Color	pH	Reaction[3]
								GR	CO	ST	Total			
ESS-I5	A	0-6"	SL	-	35%	65	13	50	15	0	65	7.5 YR 2.5/3	7	-
	Bw	6-12"	SCL			70	21	60	10	0	70	7.5 YR 5/4	5.5	-
	Cr1	12-21"	-											
	Cr2	21"+	-											
ESS-A5	A	0-6"	coSL	-	40%	75	16	35	0	0	35	7.5 YR 3/4	6.5	eo
	BC	6-22"	coSL			75	16	65	2	0	67	7.5 YR 4/6	6.5	eo
	Cr	22-45"	-										7	

Notes:
1) L = loam or loamy; S = sand or sandy; C = clay: sand modifiers: f = fine; co = coarse
2) GR = gravel; CO= cobble; ST = stone
3) Reaction to dilute acid: eo = none, esl = slight

APPENDIX B

Laboratory Data

ANALYTICAL SUMMARY REPORT

October 11, 2021

Golder Associates Inc
5200 Pasadena NE Ste C
Albuquerque, NM 87113-2208

Work Order: B21090439 Quote ID: B5118

Project Name: Emma Soils, 21476949.200.201

Energy Laboratories Inc Billings MT received the following 10 samples for Golder Associates Inc on 9/7/2021 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
B21090439-001	ESS-M2 [0-11]inches	07/28/21 0:00	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand
B21090439-002	ESS-M1 [0-34]inches	07/28/21 0:00	09/07/21	Solid	Metals, CACL2 Extractable Metals, NH4OAC Extractable Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Very Fine Sand

ANALYTICAL SUMMARY REPORT

B21090439-003	ESS-I4 [0-11]inches	07/27/21 0:00	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand
B21090439-004	ESS-I3 [0-11]inches	07/28/21 0:00	09/07/21	Solid	Same As Above
B21090439-005	ESS-E2 [0-40]inches	07/28/21 0:00	09/07/21	Solid	Metals, CACL2 Extractable Metals, NH4OAC Extractable Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Very Fine Sand
B21090439-006	ESS-A5 [0-11]inches	07/28/21 0:00	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand

ANALYTICAL SUMMARY REPORT

B21090439-007	ESS-I5 [0-6]inches	07/27/21 0:00	09/07/21	Solid	Metals, CACL2 Extractable Metals, NH4OAC Extractable Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Very Fine Sand
B21090439-008	ESS-A2 [0-11]inches	07/27/21 0:00	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand
B21090439-009	ESS-A3 [0-16]inches	07/27/21 0:00	09/07/21	Solid	Metals, CACL2 Extractable Metals, NH4OAC Extractable Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Very Fine Sand

ANALYTICAL SUMMARY REPORT

B21090439-010	ESS-A4 [0-11]inches	07/27/21 0:00	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand

The analyses presented in this report were performed by Energy Laboratories, Inc., 1120 S 27th St., Billings, MT 59101, unless otherwise noted. Any exceptions or problems with the analyses are noted in the report package. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:

CLIENT: Golder Associates Inc
Project: Emma Soils, 21476949.200.201
Work Order: B21090439

Report Date: 09/17/21

CASE NARRATIVE

Revised Date: 10/8/2021

Revised Sample(s):

ESS-M2
ESS-I4
ESS-I3
ESS-A5
ESS-A2
ESS-A4

On 9/21/2021 a request was received from Doug Romig at Golder Associates to revise this workorder by adding the following tests to the samples mentioned above:

Acid-Base Account (with sulfur forms) - Modified Sobek et al. (1978)

AB-DTPA extractable metals - As Cd Cu Fe Pb Mn Mo Ni and Zn - ASA 1982, MNethod 3-5.2 EPA Method 6010/6020

The report has been revised and replaces the previously issued report dated 9/17/2021 in its entirety.

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/11/21
Report Date: 09/17/21
Date Received: 09/07/21

Client: Golder Associates Inc
Project: Emma Soils, 21476949.200.201
Workorder: B21090439

		Analysis	Coarse Frags	Very Fine Sand	Sand	Silt	Clay	Texture	pH, sat_ paste	COND	Saturation	Neut Potential	Acid Potential	Acid/Base Potential	S, Total
		Units	%	wt%	%	%	%		s_u_	mmhos/cm	%	t/kt	t/kt	t/kt	%
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090439-001	ESS-M2	0-11	11	1	57	36	7	SL	6.3	0.5	22.1	5	0	5	0.01
B21090439-002	ESS-M1	0-34	22	0	30	46	24	L	6.1	0.4	37.2				
B21090439-003	ESS-I4	0-11	48	6	70	21	9	SL	5.4	0.6	27.3	11	0	11	0.02
B21090439-004	ESS-I3	0-11	8	8	50	21	29	SCL	6.8	0.6	52.0	11	0	10	0.02
B21090439-005	ESS-E2	0-40	14	7	69	23	8	SL	6.1	0.9	27.1				
B21090439-006	ESS-A5	0-11	50	5	56	24	20	SCL	5.4	0.8	39.4	5	0	5	0.02
B21090439-007	ESS-I5	0-6	40	7	50	39	11	L	6.3	0.9	30.0				
B21090439-008	ESS-A2	0-11	55	5	56	29	15	SL	5.5	0.6	26.1	3	1	2	0.04
B21090439-009	ESS-A3	0-16	56	5	44	25	31	CL	6.5	0.8	45.8				
B21090439-010	ESS-A4	0-11	41	4	56	21	23	SCL	5.4	0.3	31.1	4	1	3	0.05

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/11/21
Report Date: 09/17/21
Date Received: 09/07/21

Client: Golder Associates Inc
Project: Emma Soils, 21476949.200.201
Workorder: B21090439

		Analysis	S, H2O Extr	S, HCL Extr	S, HNO3 Extr	S, Residual	Organic Matter	Organic Carbon	Phos, Olsen	Nitrate as N	B-CACL2	Se-CACL2	K-NH4OAC	As-ABDTPA	Cd-ABDTPA
		Units	%	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090439-001	ESS-M2	0-11	< 0.01	< 0.01	0.01	< 0.01	1.4	0.8	5	6	< 0.1	< 0.1	97	0.07	< 0.1
B21090439-002	ESS-M1	0-34					1.8	1.0	28	3	< 0.1	< 0.1	226		
B21090439-003	ESS-I4	0-11	< 0.01	< 0.01	< 0.01	< 0.01	2.0	1.2	5	6	< 0.1	< 0.1	109	0.06	0.2
B21090439-004	ESS-I3	0-11	< 0.01	< 0.01	0.01	< 0.01	0.9	0.5	5	< 1	< 0.1	< 0.1	199	0.12	< 0.1
B21090439-005	ESS-E2	0-40					1.3	0.8	10	15	0.1	< 0.1	223		
B21090439-006	ESS-A5	0-11	< 0.01	< 0.01	< 0.01	< 0.01	1.8	1.1	12	5	< 0.1	< 0.1	233	0.05	0.1
B21090439-007	ESS-I5	0-6					2.8	1.6	5	15	0.1	< 0.1	210		
B21090439-008	ESS-A2	0-11	< 0.01	< 0.01	< 0.01	0.02	1.6	1.0	4	7	< 0.1	< 0.1	110	0.14	< 0.1
B21090439-009	ESS-A3	0-16					3.0	1.8	9	6	0.2	< 0.1	335		
B21090439-010	ESS-A4	0-11	0.01	< 0.01	< 0.01	0.03	1.3	0.7	7	2	< 0.1	< 0.1	122	0.12	0.2

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/11/21
Report Date: 09/17/21
Date Received: 09/07/21

Client: Golder Associates Inc
Project: Emma Soils, 21476949.200.201
Workorder: B21090439

		Analysis	Cu-ABDTPA	Fe-ABDTPA	Pb-ABDTPA	Mn-ABDTPA	Mo-ABDTPA	Ni-ABDTPA	Zn-ABDTPA
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090439-001	ESS-M2	0-11	51.4	14	1.9	2.4	< 0.1	< 0.1	1.5
B21090439-002	ESS-M1	0-34							
B21090439-003	ESS-I4	0-11	53.6	29	4.8	6.9	< 0.1	0.3	14.6
B21090439-004	ESS-I3	0-11	12.4	17	3.2	3.0	0.1	0.3	2.5
B21090439-005	ESS-E2	0-40							
B21090439-006	ESS-A5	0-11	59.6	20	1.5	5.9	< 0.1	0.3	6.8
B21090439-007	ESS-I5	0-6							
B21090439-008	ESS-A2	0-11	13.4	18	3.2	10.9	< 0.1	0.3	3.0
B21090439-009	ESS-A3	0-16							
B21090439-010	ESS-A4	0-11	112	35	3.0	5.2	0.3	0.2	7.1

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3									Batch: 159269
Lab ID: B21090439-001A DUP	Sample Duplicate				Run: MISC-SOIL_210915A			09/15/21 09:24	
Conductivity, sat. paste	0.510	mmhos/cm	0.10				0.0	30	
Lab ID: LCS-2109150924	Laboratory Control Sample				Run: MISC-SOIL_210915A			09/15/21 09:24	
Conductivity, sat. paste	4.28	mmhos/cm	0.10	104	70	130			
Lab ID: B21090439-001A DUP	Sample Duplicate				Run: MISC-SOIL_210915A			09/15/21 09:24	
pH, sat. paste	6.20	s.u.	0.10				1.6	10	
Lab ID: LCS-2109150924	Laboratory Control Sample				Run: MISC-SOIL_210915A			09/15/21 09:24	
pH, sat. paste	7.20	s.u.	0.10	96	90	110			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA15-5								Batch: R367202	
Lab ID: B21090439-001A DUP	Sample Duplicate				Run: MISC-SOIL_210917A			09/17/21 13:58	
Sand	58.0	%	1.0				1.7	30	
Silt	34.0	%	1.0				5.7	30	
Clay	8.00	%	1.0				13	30	
Lab ID: LCS-2109171358	Laboratory Control Sample				Run: MISC-SOIL_210917A			09/17/21 13:58	
Sand	37.0	%	1.0	103	70	130			
Silt	39.0	%	1.0	93	70	130			
Clay	24.0	%	1.0	109	70	130			
Lab ID: B21090439-001A DUP	Sample Duplicate				Run: MISC-SOIL_210917A			09/17/21 13:58	
Very Fine Sand	1	wt%	1				0.0	50	
Lab ID: LCS-2109171358	Laboratory Control Sample				Run: MISC-SOIL_210917A			09/17/21 13:58	
Very Fine Sand	6	wt%	1	86	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5									Batch: OM_9-17-2021_09-12-30AMA
Lab ID: LCS	Laboratory Control Sample				Run: FIA205-B_210917A				09/17/21 09:14
Phosphorus, Olsen	15	mg/kg	1.0	121	70	130			
Lab ID: B21090439-001ADUP	Sample Duplicate				Run: FIA205-B_210917A				09/17/21 09:24
Phosphorus, Olsen	5.6	mg/kg	1.0				10	30	
Lab ID: B21090439-001AMS	Sample Matrix Spike				Run: FIA205-B_210917A				09/17/21 09:25
Phosphorus, Olsen	16	mg/kg	1.0	103	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3									Batch: R367129
Lab ID: LCS	Laboratory Control Sample				Run: MISC-SOIL_210916A				09/16/21 10:25
Organic Matter	3.33	%	0.17	85	70	130			
Lab ID: B21090439-001ADUP	Sample Duplicate				Run: MISC-SOIL_210916A				09/16/21 10:25
Organic Matter	1.38	%	0.17				1.5	30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc

Work Order: B21090439

Report Date: 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA33-8						Batch: OM_9-17-2021_01-59-36PM			
Lab ID: LCS	Laboratory Control Sample				Run: FIA205-B_210917A			09/17/21 14:00	
Nitrate as N, KCL Extract	4.30	mg/kg	1.0	91	70	130			
Lab ID: B21090439-001ADUP	Sample Duplicate				Run: FIA205-B_210917A			09/17/21 14:03	
Nitrate as N, KCL Extract	5.80	mg/kg	1.0				0.9	30	
Lab ID: B21090439-001AMS	Sample Matrix Spike				Run: FIA205-B_210917A			09/17/21 14:04	
Nitrate as N, KCL Extract	10.9	mg/kg	1.0	97	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc

Work Order: B21090439

Report Date: 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: Sobek Modified								Batch: R368273	
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211007A			10/06/21 20:36	
Neutralization Potential	6.7	t/kt	0.10				7.4	50	
Acid Potential	0.83	t/kt	1.0					50	
Acid/Base Potential	5.9	t/kt					6.6	50	
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211007A			10/06/21 20:36	
Sulfur, Total	0.0362	%	0.010				2.7	50	
Sulfur, Hot Water Extractable	0.00970	%	0.010					50	
Sulfur, HCl Extractable	ND	%	0.010					50	
Sulfur, HNO3 Extractable	0.0172	%	0.010				6.7	50	
Sulfur, Residual	0.0128	%	0.010				9.8	50	
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A			10/07/21 11:33	
Neutralization Potential	98	t/kt	0.10	91	50	150			
Acid Potential	7.2	t/kt	1.0	119	50	150			
Acid/Base Potential	91	t/kt		87	50	150			
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A			10/07/21 11:33	
Sulfur, Total	0.254	%	0.010	121	50	150			
Sulfur, Hot Water Extractable	0.0255	%	0.010	85	50	150			
Sulfur, HCl Extractable	ND	%	0.010		50	150			
Sulfur, HNO3 Extractable	0.204	%	0.010	127	50	150			
Sulfur, Residual	0.0264	%	0.010	106	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Batch: 160048
Lab ID: LCS-160048	Laboratory Control Sample				Run: ICP203-B_211006A				10/06/21 15:34
Cadmium	0.0873	mg/kg	0.10	125	70	130			
Copper	4.23	mg/kg	0.10	76	70	130			
Iron	77.2	mg/kg	1.0	101	70	130			
Lead	4.12	mg/kg	0.10	76	70	130			
Manganese	16.1	mg/kg	0.10	86	70	130			
Molybdenum	0.445	mg/kg	0.10	81	70	130			
Nickel	1.76	mg/kg	0.10	113	70	130			
Zinc	4.96	mg/kg	0.10	110	70	130			
Method: SW6010B									Batch: 160048
Lab ID: B21092238-004ADUP	Sample Duplicate				Run: ICP203-B_211007A				10/07/21 14:28
Cadmium	0.143	mg/kg	0.10				4.4	30	
Copper	2.98	mg/kg	0.10				2.9	30	
Iron	19.9	mg/kg	1.0				4.0	30	
Lead	0.875	mg/kg	0.10				2.4	30	
Manganese	7.37	mg/kg	0.10				3.5	30	
Molybdenum	0.223	mg/kg	0.10				0.1	30	
Nickel	0.0812	mg/kg	0.10					30	
Zinc	18.6	mg/kg	0.10				7.0	30	
Lab ID: B21092238-006AMS2	Sample Matrix Spike				Run: ICP203-B_211007A				10/07/21 14:41
Cadmium	5.03	mg/kg	0.10	99	50	150			
Copper	13.4	mg/kg	0.10	111	50	150			
Iron	67.6	mg/kg	1.0	108	50	150			
Lead	32.7	mg/kg	0.10	99	50	150			
Manganese	64.3	mg/kg	0.10	108	50	150			
Molybdenum	13.1	mg/kg	0.10	102	50	150			
Nickel	10.2	mg/kg	0.10	102	50	150			
Zinc	14.6	mg/kg	0.10	105	50	150			
Method: SW6010B									Batch: 159252
Lab ID: LCS-159252	Laboratory Control Sample				Run: ICP204-B_210915A				09/15/21 10:32
Potassium	313	mg/kg	1.4	103	70	130			
Lab ID: B21090439-001A DUP	Sample Duplicate				Run: ICP204-B_210915A				09/15/21 10:41
Potassium	90.1	mg/kg	1.4				7.3	30	
Lab ID: B21090439-002AMS2	Sample Matrix Spike				Run: ICP204-B_210915A				09/15/21 10:50
Potassium	5820	mg/kg	1.4	112	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6010B**								Batch: 159295	
Lab ID:	**LCS-159295**	Laboratory Control Sample				Run: ICP204-B_210916A			09/16/21 14:47	
Boron		0.410	mg/kg	0.10	117	70	130			
Lab ID:	**B21090439-001A DUP**	Sample Duplicate				Run: ICP204-B_210916A			09/16/21 14:56	
Boron		0.0561	mg/kg	0.10					30	
Lab ID:	**B21090439-002AMS2**	Sample Matrix Spike				Run: ICP204-B_210916A			09/16/21 15:04	
Boron		9.80	mg/kg	0.10	97	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6020**									Batch: 159295
Lab ID:	**LCS-159295**	Laboratory Control Sample				Run: ICPMS206-B_210916A				09/17/21 00:17
Selenium		0.0604	mg/kg	0.10		70	130			
Lab ID:	**B21090439-001A DUP**	Sample Duplicate				Run: ICPMS206-B_210916A				09/17/21 00:34
Selenium		0.00311	mg/kg	0.10					30	
Lab ID:	**B21090439-003AMS**	Sample Matrix Spike				Run: ICPMS206-B_210916A				09/17/21 00:51
Selenium		0.529	mg/kg	0.10	106	70	130			
Method:	**SW6020**									Batch: 160048
Lab ID:	**LCS-160048**	Laboratory Control Sample				Run: ICPMS206-B_211007B				10/08/21 04:39
Arsenic		0.206	mg/kg	0.020	114	70	130			
Lab ID:	**B21090423-002AMS**	Sample Matrix Spike				Run: ICPMS206-B_211007B				10/08/21 04:56
Arsenic		2.62	mg/kg	0.020	105	70	130			
Lab ID:	**B21090423-002ADUP**	Sample Duplicate				Run: ICPMS206-B_211007B				10/08/21 05:01
Arsenic		0.0570	mg/kg	0.020					30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/11/21

Client: Golder Associates Inc **Work Order:** B21090439 **Report Date:** 09/17/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**USDA27a**								Batch: R367063	
Lab ID:	**B21090439-001A DUP**	Sample Duplicate				Run: MISC-SOIL_210915A			09/15/21 09:24	
Saturation		22.6	%	0.10				2.2	30	
Lab ID:	**LCS-2109150924**	Laboratory Control Sample				Run: MISC-SOIL_210915A			09/15/21 09:24	
Saturation		34.8	%	0.10	92	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

Work Order Receipt Checklist

Golder Associates Inc B21090439

Login completed by:	Tabitha Edwards	Date Received:	9/7/2021
Reviewed by:	BL2000\gmccartney	Received by:	tjg
Reviewed Date:	9/10/2021	Carrier name:	Return-FedEx Ground

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	22.4°C No Ice		
Containers requiring zero headspace have no headspace or bubble that is <6mm (1/4").	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Radiochemical precision results represent a 2-sigma Total Measurement Uncertainty.

Contact and Corrective Action Comments:

None

ENERGY

Trust our People. Trust our Data.

Chain of Custody & Analytical Request Record

www.energylab.com

Account Information (Billing information)

Company/Name	Golder Associates Inc
Contact	Doug Romig
Phone	(505) 821-3043
Mailing Address	5200 Pasadena Ave NE Suite C
City State Zip	Albuquerque, NM 87113-2208
Email	Doug_Romig@golder.com
Receive Invoice	☐ Hard Copy ■ Email
Receive Report	☐ Hard Copy ■ Email
Purchase Order	
Quote	NA
Bottle Order	

Report Information (if different than Account Information)

Company/Name	
Contact	
Phone	
Mailing Address	
City State Zip	
Email	
Receive Report	☐ Hard Copy ■ Email
Special Report/Formats	☐ LEVEL IV ☐ NELAC ☐ EDD/EDT (contact laboratory) ☐ Other

Comments

Please retain samples for potential additional testing

Project Information

Project Name PWSID Permit etc	Emma Soils 21476949 200 201
Sampler Name	Doug Romig
Sampler Phone	(505) 821-3043
Sample Origin State	NM
EPA/State Compliance	☐ Yes ■ No

URANIUM MINING CLIENTS MUST indicate sample type

☐ NOT Source or Byproduct Material
☐ Source/Processed Ore (Ground or Refined) **CALL BEFORE SENDING
☐ 11e (2) Byproduct Material (Can ONLY be Submitted to ELI Casper Location)

Matrix Codes

A Air
W Water
S Soils Solids
V Vegetation
B Bioassay
O Other
DW Drinking Water

Analysis Requested

All turnaround times are standard unless marked as RUSH

Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling – See Instructions Page

	Sample Identification (Name Location Interval etc)	Collection Date	Collection Time	Number of Containers	Matrix (See Codes Above)	See Attached	RUSH TAT	ELI LAB ID (Laboratory Use Only)
1	ESS-M2 0-11"	7/28/21		1	S	●		B21090439
2	ESS-M1 0-34"	7/28/21		1	S	●		
3	ESS-I4 0-33"	7/27/21		1	S	●		
4	ESS-I3 0-20"	7/28/21		1	S	●		
5	ESS-E2 0-40"	7/28/21		1	S	●		
6	ESS-A5 0-28"	7/28/21		1	S	●		
7	ESS-I5 0-6"	7/27/21		1	S	●		
8	ESS-A2 0-16"	7/27/21		1	S	●		
9	ESS-A3 0-16"	7/27/21		1	S	●		
10	ESS-A4 0-22"	7/27/21		1	S	●		

Custody Record MUST be signed

Relinquished by (print): Doug Romig	Date/Time: 9/3/21 : 3:00	Signature: [signature]	Received by (print):	Date/Time:	Signature:
Relinquished by (print):	Date/Time:	Signature:	Received by Laboratory (print): Tyler Caskey	Date/Time: 9/7/21 09:05	Signature: [signature]

LABORATORY USE ONLY

Shipped By	Cooler ID(s)	Custody Seals	Intact	Receipt Temp	Temp Blank	On Ice	Payment Type	Amount	Receipt Number (cash/check only)
		Y N C B	Y N	°C	Y N	Y N	CC Cash Check	$	

In certain circumstances samples submitted to Energy Laboratories Inc may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

COC 10/18 v 3

GOLDER

September 3, 2021

Project No 21476949

Ms. Shari Endy
Energy Laboratories Inc
1120 South 27th Street
Billings, MT 59101

RE: LABORATORY TESTING FOR EMMA SOILS

Dear Ms Endy,

This letter accompanies one cooler with 10 soil samples for the Emma soil survey at the Tyrone Mine Please analyze the samples for the following parameters

Analysis/Parameter	Source-Method
Saturated Paste pH	USDA Handbook 60, Method 2 and 21a
Electrical Conductivity, saturated paste	USDA Handbook 60, Method 3a and 4b
Particle Size Analysis including very fine sand	Gee and Bauder (1986)
Rock Fragment (>2mm)	Dry sieve (No 10)/gravimetric
Saturation percentage	USDA Handbook 60, Method 27a
Hot water extractable Boron	ASA 1982, Method 10-3
Hot water extractable Selenium	ASA Mono #9, Part 2, Method 75-4 1
Organic Matter (Carbon)	ASA 1982, Method 29-3 5 2
N as Nitrate	ASA 1982, Method 33-8 1
Phosphorous (Olsen)	ASA 1982, Method 24-5 4
Potassium	ASA 1982, Method 13-3 5

Please retain the samples until we have an opportunity to review the initial lab data as we may select specific samples for additional analyses Please call (505) 821-3034 or email (dromig@golder com) if you have any questions

Sincerely,
Golder Associates Inc.

Doug Romig, CPSS
Senior Consultant

Golder Associates Inc.
5200 Pasadena Avenue N E Suite C Albuquerque New Mexico USA 87113
T +1 505 821-3043 F +1 505 821-5273
https //golderassociates sharepoint com/sites/149301/Project Files/5 Technical Work/Soil Survey/Lab Data/Energy Ltr Emma docx

ANALYTICAL SUMMARY REPORT

October 13, 2021

Freeport McMoRan Tyrone Inc
PO Box 571
Tyrone, NM 88065-0571

Work Order: B21090423 Quote ID: B5118

Project Name: Emma Rds. Soil Testing-GR010RE

Energy Laboratories Inc Billings MT received the following 4 samples for Freeport McMoRan Tyrone Inc on 9/7/2021 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
B21090423-001	210902_S1_OakGrove_Gila	09/02/21 15:18	09/07/21	Solid	Total Sulfur
B21090423-002	210902_S2_OakGrove_Gila	09/02/21 15:27	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Total Sulfur Very Fine Sand
B21090423-003	210902_S3_7A_WBedrock	09/02/21 15:41	09/07/21	Solid	Total Sulfur

ANALYTICAL SUMMARY REPORT

B21090423-004	210902_S4_7A_WBedrock	09/02/21 15:55	09/07/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Coarse Fragments Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Total Sulfur Very Fine Sand

The analyses presented in this report were performed by Energy Laboratories, Inc., 1120 S 27th St., Billings, MT 59101, unless otherwise noted. Any exceptions or problems with the analyses are noted in the report package. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:

CLIENT: Freeport McMoRan Tyrone Inc
Project: Emma Rds. Soil Testing-GR010RE
Work Order: B21090423

Revised Date: 10/13/21
Report Date: 09/10/21

CASE NARRATIVE

Revised Date: 10/13/2021

Revised Sample(s): 210902_S2_OakGrove_Gila (B21090423-002) and 210902_S4_7A_WBedrock (B21090423-004)

On 9/21/2021 a request was received from Doug Romig to revise this workorder by adding the following parameters:

Saturated paste pH
Electrical Conductivity, Saturated paste
Particle size analysis including very fine sand
rock fragment (>2mm)
Saturation percentage
Hot water extractable Boron
Hot water extractable Selenium
Organic Matter (Carbon)
Nitrate as N
Phosphorus (Olsen)
Potassium
Acid Base Account (with sulfur forms)
AB-DTPA extractable metals - As Cd Cu Fe Pb Mn Mo Ni and Zn

The report has been revised and replaces the previously issued report dated 9/10/2021 in its entirety.

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/13/21
Report Date: 09/10/21
Date Received: 09/07/21

Client: Freeport McMoRan Tyrone Inc
Project: Emma Rds. Soil Testing-GR010RE
Workorder: B21090423

	Analysis	Coarse Frags	Very Fine Sand	Sand	Silt	Clay	Texture	pH, sat_ paste	COND	Saturation	Neut Potential	Acid Potential	Acid/Base Potential	S, Total
	Units	%	wt%	%	%	%		s_u_	mmhos/cm	%	t/kt	t/kt	t/kt	%
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090423-001	210902_S1_OakGrove_Gila													
B21090423-002	210902_S2_OakGrove_Gila	14	2	68	20	12	SL	6.1	1.8	27.5	7	0	6	0.04
B21090423-003	210902_S3_7A_WBedrock													
B21090423-004	210902_S4_7A_WBedrock	30	2	66	21	13	SL	4.7	0.4	27.4	5	0	5	0.01

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/13/21
Report Date: 09/10/21
Date Received: 09/07/21

Client: Freeport McMoRan Tyrone Inc
Project: Emma Rds. Soil Testing-GR010RE
Workorder: B21090423

	Analysis	S, H2O Extr	S, HCL Extr	S, HNO3 Extr	S, Residual	Sulfur, Total	Organic Matter	Organic Carbon	Phos, Olsen	Nitrate as N	B-CACL2	Se-CACL2	K-NH4OAC	As-ABDTPA
	Units	%	%	%	%	wt%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090423-001	210902_S1_OakGrove_Gila					0.10								
B21090423-002	210902_S2_OakGrove_Gila	< 0.01	< 0.01	0.02	0.01	0.03	1.9	1.1	26	19	0.2	< 0.1	281	0.04
B21090423-003	210902_S3_7A_WBedrock					0.16								
B21090423-004	210902_S4_7A_WBedrock	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.4	0.2	11	1	< 0.1	< 0.1	161	< 0.02

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Revised Date: 10/13/21
Report Date: 09/10/21
Date Received: 09/07/21

Client: Freeport McMoRan Tyrone Inc
Project: Emma Rds. Soil Testing-GR010RE
Workorder: B21090423

	Analysis	Cd-ABDTPA	Cu-ABDTPA	Fe-ABDTPA	Pb-ABDTPA	Mn-ABDTPA	Mo-ABDTPA	Ni-ABDTPA	Zn-ABDTPA
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21090423-001	210902_S1_OakGrove_Gila								
B21090423-002	210902_S2_OakGrove_Gila	0.5	34.2	20	1.0	32.2	< 0.1	0.4	23.7
B21090423-003	210902_S3_7A_WBedrock								
B21090423-004	210902_S4_7A_WBedrock	0.2	161	21	0.1	30.2	< 0.1	0.2	21.2

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3									Batch: 160046
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211006A				10/06/21 10:43
Conductivity, sat. paste	1.74	mmhos/cm	0.10				0.6	30	
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211006A				10/06/21 10:43
pH, sat. paste	6.10	s.u.	0.10				0.0	10	
Lab ID: LCS-2110061043	Laboratory Control Sample				Run: MISC-SOIL_211006A				10/06/21 10:43
pH, sat. paste	7.30	s.u.	0.10	97	90	110			
Lab ID: LCS-R368180	Laboratory Control Sample				Run: MISC-SOIL_211006A				10/06/21 10:31
Conductivity, sat. paste	3.70	mmhos/cm	0.10	90	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**ASA15-5**								Batch: R368545	
Lab ID:	**B21090423-002A DUP**	Sample Duplicate				Run: MISC-SOIL_211013A			10/13/21 09:45	
Sand		69.0	%	1.0				1.5	30	
Silt		20.0	%	1.0				0.0	30	
Clay		11.0	%	1.0				8.7	30	
Lab ID:	**LCS-2110130945**	Laboratory Control Sample				Run: MISC-SOIL_211013A			10/13/21 09:45	
Sand		39.0	%	1.0	108	70	130			
Silt		39.0	%	1.0	93	70	130			
Clay		22.0	%	1.0	100	70	130			
Lab ID:	**B21090423-002A DUP**	Sample Duplicate				Run: MISC-SOIL_211013A			10/13/21 09:45	
Very Fine Sand		2	wt%	1				29	50	
Lab ID:	**LCS-2110130945**	Laboratory Control Sample				Run: MISC-SOIL_211013A			10/13/21 09:45	
Very Fine Sand		7	wt%	1	88	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5						Batch: OM_10-8-2021_02-20-55PMA			
Lab ID: LCS	Laboratory Control Sample				Run: FIA205-B_211008A			10/08/21 14:22	
Phosphorus, Olsen	13	mg/kg	1.0	102	70	130			
Lab ID: B21090423-002ADUP	Sample Duplicate				Run: FIA205-B_211008A			10/08/21 14:30	
Phosphorus, Olsen	26	mg/kg	1.0				1.2	30	
Lab ID: B21090423-002AMS	Sample Matrix Spike				Run: FIA205-B_211008A			10/08/21 14:32	
Phosphorus, Olsen	39	mg/kg	1.0	124	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3									Batch: R368335
Lab ID: LCS	Laboratory Control Sample				Run: MISC-SOIL_211008A				10/08/21 10:41
Organic Carbon	1.88	%	0.10	85	70	130			
Organic Matter	3.23	%	0.17	83	70	130			
Lab ID: B21090423-002ADUP	Sample Duplicate				Run: MISC-SOIL_211008A				10/08/21 10:41
Organic Carbon	1.04	%	0.10				3.9	30	
Organic Matter	1.79	%	0.17				3.9	30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA33-8								Batch: OM_10-1-2021_03-33-58PM	
Lab ID: LCS	Laboratory Control Sample				Run: FIA205-B_211001A			10/01/21 15:35	
Nitrate as N, KCL Extract	4.64	mg/kg	1.0	99	70	130			
Lab ID: B21091607-001ADUP	Sample Duplicate				Run: FIA205-B_211001A			10/01/21 15:40	
Nitrate as N, KCL Extract	ND	mg/kg-dry	38					30	
Lab ID: B21091607-001AMS	Sample Matrix Spike				Run: FIA205-B_211001A			10/01/21 15:41	
Nitrate as N, KCL Extract	411	mg/kg-dry	40	103	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E3.2.6								Batch: R366904	
Lab ID: B21090423-001A DUP	Sample Duplicate				Run: MISC-SOIL_210910B			09/10/21 12:49	
Sulfur, Total	0.100	wt%	0.010				1	30	
Lab ID: LCS-R366904	Laboratory Control Sample				Run: MISC-SOIL_210910B			09/10/21 12:25	
Sulfur, Total	0.230	wt%	0.010	110	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: Sobek Modified								Batch: R368273	
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211007A			10/06/21 20:36	
Neutralization Potential	6.7	t/kt	0.10				7.4	50	
Acid Potential	0.83	t/kt	1.0					50	
Acid/Base Potential	5.9	t/kt					6.6	50	
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: B21090423-002A DUP	Sample Duplicate				Run: MISC-SOIL_211007A			10/06/21 20:36	
Sulfur, Total	0.0362	%	0.010				2.7	50	
Sulfur, Hot Water Extractable	0.00970	%	0.010					50	
Sulfur, HCl Extractable	ND	%	0.010					50	
Sulfur, HNO3 Extractable	0.0172	%	0.010				6.7	50	
Sulfur, Residual	0.0128	%	0.010				9.8	50	
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A			10/07/21 11:33	
Neutralization Potential	98	t/kt	0.10	91	50	150			
Acid Potential	7.2	t/kt	1.0	119	50	150			
Acid/Base Potential	91	t/kt		87	50	150			
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A			10/07/21 11:33	
Sulfur, Total	0.254	%	0.010	121	50	150			
Sulfur, Hot Water Extractable	0.0255	%	0.010	85	50	150			
Sulfur, HCl Extractable	ND	%	0.010		50	150			
Sulfur, HNO3 Extractable	0.204	%	0.010	127	50	150			
Sulfur, Residual	0.0264	%	0.010	106	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6010B**									Batch: 159993
Lab ID:	**LCS-159993**	Laboratory Control Sample				Run: ICP203-B_211005A				10/05/21 12:29
Potassium		234	mg/kg	1.4	77	70	130			
Lab ID:	**B21092238-009ADUP**	Sample Duplicate				Run: ICP203-B_211005A				10/05/21 13:47
Potassium		53.3	mg/kg	1.4				7.7	30	
Lab ID:	**B21092238-010AMS2**	Sample Matrix Spike				Run: ICP203-B_211005A				10/05/21 14:05
Potassium		5230	mg/kg	1.5	102	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Method: **SW6010B** Batch: 160047

Lab ID: **LCS-160047** Laboratory Control Sample Run: ICP203-B_211006A 10/06/21 13:51

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Boron	0.424	mg/kg	0.10	121	70	130			

Lab ID: **B21090423-002ADUP** Sample Duplicate Run: ICP203-B_211006A 10/06/21 14:08

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Boron	0.164	mg/kg	0.10				6.3	30	

Lab ID: **B21090423-004AMS2** Sample Matrix Spike Run: ICP203-B_211006A 10/06/21 14:17

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Boron	9.43	mg/kg	0.10	94	70	130			

Method: **SW6010B** Batch: 160048

Lab ID: **LCS-160048** Laboratory Control Sample Run: ICP203-B_211006A 10/06/21 15:34

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Cadmium	0.0873	mg/kg	0.10	125	70	130			
Copper	4.23	mg/kg	0.10	76	70	130			
Iron	77.2	mg/kg	1.0	101	70	130			
Lead	4.12	mg/kg	0.10	76	70	130			
Manganese	16.1	mg/kg	0.10	86	70	130			
Molybdenum	0.445	mg/kg	0.10	81	70	130			
Nickel	1.76	mg/kg	0.10	113	70	130			
Zinc	4.96	mg/kg	0.10	110	70	130			

Lab ID: **B21090423-002ADUP** Sample Duplicate Run: ICP203-B_211006A 10/06/21 18:06

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Cadmium	0.543	mg/kg	0.10				9.8	30	
Copper	36.1	mg/kg	0.10				5.5	30	
Iron	21.2	mg/kg	1.0				1.9	30	
Lead	1.23	mg/kg	0.10				16	30	
Manganese	37.0	mg/kg	0.10				13	30	
Molybdenum	ND	mg/kg	0.10					30	
Nickel	0.383	mg/kg	0.10				5.5	30	
Zinc	26.1	mg/kg	0.10				9.6	30	

Lab ID: **B21090423-004AMS2** Sample Matrix Spike Run: ICP203-B_211006A 10/06/21 18:14

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Cadmium	4.93	mg/kg	0.10	94	50	150			
Copper	167	mg/kg	0.10		50	150			A
Iron	69.4	mg/kg	1.0	97	50	150			
Lead	10.1	mg/kg	0.10	99	50	150			
Manganese	80.1	mg/kg	0.10	99	50	150			
Molybdenum	9.45	mg/kg	0.10	94	50	150			
Nickel	10.1	mg/kg	0.10	99	50	150			
Zinc	30.6	mg/kg	0.10	94	50	150			

Qualifiers:

RL - Analyte Reporting Limit

A - Analyte level was greater than four times the spike level - in accordance with the method, percent recovery is not calculated

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc **Work Order:** B21090423 **Report Date:** 09/10/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6020**								Batch: 160047	
Lab ID:	**LCS-160047**	Laboratory Control Sample				Run: ICPMS206-B_211007B			10/08/21 01:49	
Selenium		0.0570	mg/kg	0.10		70	130			
Lab ID:	**B21090423-002ADUP**	Sample Duplicate				Run: ICPMS206-B_211007B			10/08/21 02:12	
Selenium		0.00556	mg/kg	0.10					30	
Lab ID:	**B21092238-009AMS**	Sample Matrix Spike				Run: ICPMS206-B_211007B			10/08/21 03:48	
Selenium		0.639	mg/kg	0.10	128	70	130			
Method:	**SW6020**								Batch: 160048	
Lab ID:	**LCS-160048**	Laboratory Control Sample				Run: ICPMS206-B_211007B			10/08/21 04:39	
Arsenic		0.206	mg/kg	0.020	114	70	130			
Lab ID:	**B21090423-002AMS**	Sample Matrix Spike				Run: ICPMS206-B_211007B			10/08/21 04:56	
Arsenic		2.62	mg/kg	0.020	105	70	130			
Lab ID:	**B21090423-002ADUP**	Sample Duplicate				Run: ICPMS206-B_211007B			10/08/21 05:01	
Arsenic		0.0570	mg/kg	0.020					30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Revised Date: 10/13/21

Client: Freeport McMoRan Tyrone Inc

Work Order: B21090423

Report Date: 09/10/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**USDA27a**									Batch: R368180
Lab ID:	**B21090423-002A DUP**	Sample Duplicate				Run: MISC-SOIL_211006A				10/06/21 10:43
Saturation		28.4	%	0.10				3.2	30	
Lab ID:	**LCS-2110061043**	Laboratory Control Sample				Run: MISC-SOIL_211006A				10/06/21 10:43
Saturation		41.7	%	0.10	110	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

Work Order Receipt Checklist

Freeport McMoRan Tyrone Inc B21090423

Login completed by:	Taylor K. Burris	Date Received:	9/7/2021
Reviewed by:	BL2000\darcy	Received by:	dac
Reviewed Date:	9/9/2021	Carrier name:	UPS

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	19.6°C No Ice		
Containers requiring zero headspace have no headspace or bubble that is <6mm (1/4").	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Radiochemical precision results represent a 2-sigma Total Measurement Uncertainty.

Contact and Corrective Action Comments:

Cancelled all analysis requested on the Chain of Custody and added Total Sulfur analysis to all samples per email from Doug Romig with Golder Associates Inc on 9/7/21.

ENERGY

Chain of Custody and Analytical Request Record

PLEASE PRINT (Provide as much information as possible.)

Company Name: Freeport-McMoRan Tyrone Inc.	Project Name, PWS, Permit, Etc. Emma Rds. Soil Testing - GR010RE	Sample Origin State: NM	EPA/State Compliance: Yes ☐ No ☐
Report Mail Address (Required): PO Drawer 571 Tyrone, NM 88065	Contact Name: Mandy J Lilla Phone/Fax: (575) 912 - 5388	Cell: (575) 313 - 7142	Sampler: (Please Print) See Comments
☐ No Hard Copy Email: mlilla@fmi.com	Invoice Contact & Phone: mlilla@fmi.com, (575) 912 - 5388	Purchase Order: ZN000007TX	Quote/Bottle Order: B5118 - NoVeryFineSands

Invoice Address (Required): Hwy 90 S Tyrone Mine Rd. PO Drawer 571 Tyrone, NM 88065

☒ No Hard Copy Email: Freeport@bscs.basware.com

Special Report/Formats:
- ☐ DW
- ☐ POTW/WWTP
- ☐ State: ______
- ☐ Other: ______
- ☐ EDD/EDT (Electronic Data) Format: ______
- ☐ LEVEL IV
- ☐ NELAC

Number of Containers; Sample Type: A W S V B O DW; Air Water Soils/Solids Vegetation Bioassay Other DW - Drinking Water

ANALYSIS REQUESTED

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: Send report by email and mail. Send invoice by email only to: Freeport@bscs.basware.com and mlilla@fmi com

Shipped by:

Cooler ID(s):

Receipt Temp ______ °C

On Ice: Y N

Custody Seal On Bottle Y N; On Cooler Y N

Intact Y N

Signature Match Y N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	See Attachment	SEE ATTACHED	Standard Turnaround (TAT)	RUSH	Comments	LABORATORY USE ONLY
1	210902_S1_OakGrove_Gila	9/2/2021	3:18pm	Soil		✓	✓	✓	Mandy Lilla	B21090423
2	210902_S2_OakGrove_Gila	9/2/2021	3:27pm	Soil		✓	✓	✓	Mandy Lilla	
3	210902_S3_7A_WBedrock	9/2/2021	3:41pm	W. Bedrock		✓	✓	✓	Mandy Lilla	
4	210902_S4_7A_WBedrock	9/2/2021	3:55pm	W. Bedrock		✓	✓	✓	Mandy Lilla	
5										
6										
7										
8										
9										
10										

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Mandy J Lilla	9/2/2021	Mandy J Lilla			
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Sample Disposal: Return to Client: ______	Lab Disposal: ______		Received by Laboratory: Dylan Chinich	9/7/21 09:30	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Test
Metals, CACL2 Extractable
Acid/Base Potential
Coarse Fragments
Conductivity, Saturated Paste Extract
Nitrate as N, KCL Extract
Organic Carbon/Matter Walkley-Black
pH, Saturated Paste
Phosphorus-Olsen
CaCl2 Hot Water Soil Extraction ASA25-9
Saturated Paste Extraction ASA
Particle Size Analysis / Texture
Saturation Percentage
Sulfur Forms
Very Fine Sand

ANALYTICAL SUMMARY REPORT

October 13, 2021

Golder Associates Inc
5200 Pasadena NE Ste C
Albuquerque, NM 87113-2208

Work Order: B21092238 Quote ID: B5118

Project Name: Emma Project

Energy Laboratories Inc Billings MT received the following 11 samples for Golder Associates Inc on 9/23/2021 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
B21092238-001	11:2018-13 100-110		09/23/21	Solid	ABDPTA extractable metals Metals, CACL2 Extractable Metals, NH4OAC Extractable Acid/Base Potential Conductivity, Saturated Paste Extract Nitrate as N, KCL Extract Organic Carbon/Matter Walkley-Black pH, Saturated Paste Phosphorus-Olsen ABDTPA extraction for metals ASA3-5.2 CaCl2 Hot Water Soil Extraction ASA25-9 Ammonium Acetate Extraction ASA13-3 Saturated Paste Extraction ASA Particle Size Analysis / Texture Saturation Percentage Sulfur Forms Very Fine Sand
B21092238-002	3:2018-07 20-30		09/23/21	Solid	Same As Above
B21092238-003	3:2018-10 20-30		09/23/21	Solid	Same As Above
B21092238-004	2019-07 10-20		09/23/21	Solid	Same As Above
B21092238-005	2019-14 40-50		09/23/21	Solid	Same As Above
B21092238-006	2019-07 30-40		09/23/21	Solid	Same As Above
B21092238-007	2019-06 40-50		09/23/21	Solid	Same As Above
B21092238-008	2019-06 70-80		09/23/21	Solid	Same As Above
B21092238-009	2019-02 20-30		09/23/21	Solid	Same As Above
B21092238-010	2019-06 130-140		09/23/21	Solid	Same As Above
B21092238-011	2019-02 130-140		09/23/21	Solid	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 1120 S 27th St., Billings, MT 59101, unless otherwise noted. Any exceptions or problems with the analyses are noted in the report package. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

ANALYTICAL SUMMARY REPORT

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Golder Associates Inc
Project: Emma Project
Workorder: B21092238

Report Date: 10/13/21
Date Received: 09/23/21

	Analysis	Very Fine Sand	Sand	Silt	Clay	Texture	pH, sat_ paste	COND	Saturation	Neut Potential	Acid Potential	Acid/Base Potential	S, Total	S, H2O Extr
	Units	wt%	%	%	%		s_u_	mmhos/cm	%	t/kt	t/kt	t/kt	%	%
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21092238-001	11:2018-13 100-110	7	8	81	11	Si	7.6	1.0	36.9	13	0	12	0.02	< 0.01
B21092238-002	3:2018-07 20-30	8	10	74	16	SiL	7.5	1.1	40.1	8	0	8	0.02	< 0.01
B21092238-003	3:2018-10 20-30	5	6	79	15	SiL	6.0	2.4	39.3	8	3	5	0.11	0.01
B21092238-004	2019-07 10-20	8	72	22	6	SL	7.7	1.1	25.9	16	0	15	0.01	< 0.01
B21092238-005	2019-14 40-50	1	62	34	4	SL	7.3	1.8	25.9	16	0	16	0.02	< 0.01
B21092238-006	2019-07 30-40	6	60	26	14	SL	7.7	0.6	35.9	13	0	13	0.01	< 0.01
B21092238-007	2019-06 40-50	5	60	33	7	SL	7.1	0.7	28.1	10	0	10	0.02	< 0.01
B21092238-008	2019-06 70-80	6	68	28	4	SL	7.2	0.9	20.2	9	0	9	0.02	< 0.01
B21092238-009	2019-02 20-30	4	69	27	4	SL	7.5	0.8	19.6	9	0	8	0.02	< 0.01
B21092238-010	2019-06 130-140	1	64	32	4	SL	7.6	0.7	21.7	14	0	14	0.02	< 0.01
B21092238-011	2019-02 130-140	8	68	25	7	SL	7.6	0.9	26.4	5	0	4	0.02	< 0.01

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Golder Associates Inc
Project: Emma Project
Workorder: B21092238

Report Date: 10/13/21
Date Received: 09/23/21

	Analysis	S, HCL Extr	S, HNO3 Extr	S, Residual	Organic Matter	Organic Carbon	Phos, Olsen	Nitrate as N	B-CACL2	Se-CACL2	K-NH4OAC	As-ABDTPA	Cd-ABDTPA	Cu-ABDTPA
	Units	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21092238-001	11:2018-13 100-110	< 0.01	< 0.01	< 0.01	0.2	0.1	6	1	< 0.1	< 0.1	354	0.03	< 0.1	46.8
B21092238-002	3:2018-07 20-30	< 0.01	< 0.01	< 0.01	0.4	0.2	5	< 1	0.1	< 0.1	344	0.03	< 0.1	66.7
B21092238-003	3:2018-10 20-30	< 0.01	0.07	0.03	0.2	0.1	4	< 1	0.1	< 0.1	512	< 0.02	< 0.1	78.4
B21092238-004	2019-07 10-20	< 0.01	< 0.01	< 0.01	0.3	0.2	4	< 1	< 0.1	< 0.1	73	< 0.02	0.1	2.9
B21092238-005	2019-14 40-50	< 0.01	< 0.01	0.02	0.5	0.3	5	< 1	< 0.1	< 0.1	115	< 0.02	< 0.1	11.6
B21092238-006	2019-07 30-40	< 0.01	< 0.01	< 0.01	< 0.2	< 0.1	4	< 1	< 0.1	< 0.1	221	< 0.02	0.1	2.3
B21092238-007	2019-06 40-50	< 0.01	< 0.01	0.01	0.3	0.2	5	< 1	< 0.1	< 0.1	107	< 0.02	< 0.1	29.2
B21092238-008	2019-06 70-80	< 0.01	< 0.01	< 0.01	0.2	0.1	5	< 1	< 0.1	< 0.1	86	< 0.02	< 0.1	8.1
B21092238-009	2019-02 20-30	< 0.01	< 0.01	< 0.01	0.4	0.2	5	< 1	< 0.1	< 0.1	58	0.05	< 0.1	14.0
B21092238-010	2019-06 130-140	< 0.01	< 0.01	< 0.01	0.2	0.1	5	< 1	< 0.1	< 0.1	132	< 0.02	< 0.1	6.0
B21092238-011	2019-02 130-140	< 0.01	< 0.01	0.01	0.2	0.1	4	< 1	< 0.1	< 0.1	134	0.04	< 0.1	3.0

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Golder Associates Inc
Project: Emma Project
Workorder: B21092238

Report Date: 10/13/21
Date Received: 09/23/21

	Analysis	Fe-ABDTPA	Pb-ABDTPA	Mn-ABDTPA	Mo-ABDTPA	Ni-ABDTPA	Zn-ABDTPA
	Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID	**Client Sample ID**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
B21092238-001	11:2018-13 100-110	54	0.5	7.9	0.6	0.2	22.8
B21092238-002	3:2018-07 20-30	44	8.2	17.3	0.8	0.2	23.4
B21092238-003	3:2018-10 20-30	53	0.9	1.4	0.7	0.1	6.8
B21092238-004	2019-07 10-20	19	0.9	7.1	0.2	< 0.1	17.4
B21092238-005	2019-14 40-50	20	0.3	4.5	0.5	< 0.1	1.8
B21092238-006	2019-07 30-40	14	22.8	10.2	2.8	< 0.1	4.1
B21092238-007	2019-06 40-50	24	0.7	25.9	0.5	< 0.1	6.1
B21092238-008	2019-06 70-80	21	0.8	11.4	0.2	< 0.1	2.4
B21092238-009	2019-02 20-30	17	1.9	6.3	0.2	< 0.1	6.9
B21092238-010	2019-06 130-140	21	2.1	10.1	0.2	< 0.1	1.5
B21092238-011	2019-02 130-140	21	5.6	5.1	0.2	0.1	2.6

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3								Batch: 160046	
Lab ID: B21092238-004A DUP	Sample Duplicate				Run: MISC-SOIL_211006A			10/06/21 10:43	
Conductivity, sat. paste	1.21	mmhos/cm	0.10				6.0	30	
Lab ID: B21092238-004A DUP	Sample Duplicate				Run: MISC-SOIL_211006A			10/06/21 10:43	
pH, sat. paste	7.70	s.u.	0.10				0.0	10	
Lab ID: LCS-2110061043	Laboratory Control Sample				Run: MISC-SOIL_211006A			10/06/21 10:43	
pH, sat. paste	7.30	s.u.	0.10	97	90	110			
Lab ID: LCS-R368180	Laboratory Control Sample				Run: MISC-SOIL_211006A			10/06/21 10:31	
Conductivity, sat. paste	3.70	mmhos/cm	0.10	90	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**ASA15-5**									Batch: R368545
Lab ID:	**B21092238-007A DUP**	Sample Duplicate				Run: MISC-SOIL_211013A				10/13/21 09:45
Sand		60.0	%	1.0				0.0	30	
Silt		33.0	%	1.0				0.0	30	
Clay		7.00	%	1.0				0.0	30	
Lab ID:	**LCS-2110130945**	Laboratory Control Sample				Run: MISC-SOIL_211013A				10/13/21 09:45
Sand		39.0	%	1.0	108	70	130			
Silt		39.0	%	1.0	93	70	130			
Clay		22.0	%	1.0	100	70	130			
Lab ID:	**B21092238-007A DUP**	Sample Duplicate				Run: MISC-SOIL_211013A				10/13/21 09:45
Very Fine Sand		5	wt%	1				0.0	50	
Lab ID:	**LCS-2110130945**	Laboratory Control Sample				Run: MISC-SOIL_211013A				10/13/21 09:45
Very Fine Sand		7	wt%	1	88	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5						Batch: OM_10-8-2021_02-20-55PMA			
Lab ID: LCS	Laboratory Control Sample				Run: FIA205-B_211008A			10/08/21 14:22	
Phosphorus, Olsen	13	mg/kg	1.0	102	70	130			
Lab ID: B21092238-004ADUP	Sample Duplicate				Run: FIA205-B_211008A			10/08/21 14:55	
Phosphorus, Olsen	4.0	mg/kg	1.0				10	30	
Lab ID: B21092238-004AMS	Sample Matrix Spike				Run: FIA205-B_211008A			10/08/21 14:57	
Phosphorus, Olsen	15	mg/kg	1.0	105	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3									Batch: R368335
Lab ID: LCS	Laboratory Control Sample				Run: MISC-SOIL_211008A				10/08/21 10:41
Organic Carbon	1.88	%	0.10	85	70	130			
Organic Matter	3.23	%	0.17	83	70	130			
Lab ID: B21092238-007ADUP	Sample Duplicate				Run: MISC-SOIL_211008A				10/08/21 10:41
Organic Carbon	0.179	%	0.10				3.8	30	
Organic Matter	0.308	%	0.17				3.8	30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**ASA33-8**						Batch: OM_10-1-2021_03-33-58PM			
Lab ID:	**LCS**	Laboratory Control Sample				Run: FIA205-B_211001A			10/01/21 15:35	
Nitrate as N, KCL Extract		4.64	mg/kg	1.0	99	70	130			
Lab ID:	**B21092238-010ADUP**	Sample Duplicate				Run: FIA205-B_211001A			10/01/21 16:05	
Nitrate as N, KCL Extract		ND	mg/kg	1.0					30	
Lab ID:	**B21092238-010AMS**	Sample Matrix Spike				Run: FIA205-B_211001A			10/01/21 16:05	
Nitrate as N, KCL Extract		5.67	mg/kg	1.0	108	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: Sobek Modified									Batch: R368273
Lab ID: B21092238-011A DUP	Sample Duplicate				Run: MISC-SOIL_211007A				10/06/21 17:12
Neutralization Potential	4.6	t/kt	0.10				0.0	50	
Acid Potential	0.62	t/kt	1.0					50	
Acid/Base Potential	4.0	t/kt					0.0	50	
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: B21092238-011A DUP	Sample Duplicate				Run: MISC-SOIL_211007A				10/06/21 17:12
Sulfur, Total	0.0200	%	0.010				0.0	50	
Sulfur, Hot Water Extractable	ND	%	0.010					50	
Sulfur, HCl Extractable	ND	%	0.010					50	
Sulfur, HNO3 Extractable	0.0100	%	0.010					50	
Sulfur, Residual	0.0100	%	0.010				15	50	
Lab ID: B21092238-001A DUP	Sample Duplicate				Run: MISC-SOIL_211007A				10/07/21 10:53
Neutralization Potential	13	t/kt	0.10				3.9	50	
Acid Potential	0.47	t/kt	1.0					50	
Acid/Base Potential	13	t/kt					4.3	50	
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: B21092238-001A DUP	Sample Duplicate				Run: MISC-SOIL_211007A				10/07/21 10:53
Sulfur, Total	0.0152	%	0.010				1.6	50	
Sulfur, Hot Water Extractable	ND	%	0.010					50	
Sulfur, HCl Extractable	ND	%	0.010					50	
Sulfur, HNO3 Extractable	0.00712	%	0.010					50	
Sulfur, Residual	0.00788	%	0.010					50	
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A				10/07/21 11:33
Neutralization Potential	98	t/kt	0.10	91	50	150			
Acid Potential	7.2	t/kt	1.0	119	50	150			
Acid/Base Potential	91	t/kt		87	50	150			
The acid-base potential was calculated from the non-sulfate sulfur %									
Lab ID: LCS-SOLO14072110071	Laboratory Control Sample				Run: MISC-SOIL_211007A				10/07/21 11:33
Sulfur, Total	0.254	%	0.010	121	50	150			
Sulfur, Hot Water Extractable	0.0255	%	0.010	85	50	150			
Sulfur, HCl Extractable	ND	%	0.010		50	150			
Sulfur, HNO3 Extractable	0.204	%	0.010	127	50	150			
Sulfur, Residual	0.0264	%	0.010	106	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6010B**								Batch: 159993	
Lab ID:	**LCS-159993**	Laboratory Control Sample				Run: ICP203-B_211005A			10/05/21 12:29	
Potassium		234	mg/kg	1.4	77	70	130			
Lab ID:	**B21092238-009ADUP**	Sample Duplicate				Run: ICP203-B_211005A			10/05/21 13:47	
Potassium		53.3	mg/kg	1.4				7.7	30	
Lab ID:	**B21092238-010AMS2**	Sample Matrix Spike				Run: ICP203-B_211005A			10/05/21 14:05	
Potassium		5230	mg/kg	1.5	102	70	130			
Method:	**SW6010B**								Batch: 160047	
Lab ID:	**LCS-160047**	Laboratory Control Sample				Run: ICP203-B_211006A			10/06/21 13:51	
Boron		0.424	mg/kg	0.10	121	70	130			
Lab ID:	**B21092238-009ADUP**	Sample Duplicate				Run: ICP203-B_211006A			10/06/21 15:13	
Boron		0.0584	mg/kg	0.10					30	
Lab ID:	**B21092238-010AMS2**	Sample Matrix Spike				Run: ICP203-B_211006A			10/06/21 15:21	
Boron		9.89	mg/kg	0.10	99	70	130			
Method:	**SW6010B**								Batch: 160048	
Lab ID:	**LCS-160048**	Laboratory Control Sample				Run: ICP203-B_211006A			10/06/21 15:34	
Cadmium		0.0873	mg/kg	0.10	125	70	130			
Copper		4.23	mg/kg	0.10	76	70	130			
Iron		77.2	mg/kg	1.0	101	70	130			
Lead		4.12	mg/kg	0.10	76	70	130			
Manganese		16.1	mg/kg	0.10	86	70	130			
Molybdenum		0.445	mg/kg	0.10	81	70	130			
Nickel		1.76	mg/kg	0.10	113	70	130			
Zinc		4.96	mg/kg	0.10	110	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B								Batch: 160048	
Lab ID: B21092238-004ADUP	Sample Duplicate				Run: ICP203-B_211007A			10/07/21 14:28	
Cadmium	0.143	mg/kg	0.10				4.4	30	
Copper	2.98	mg/kg	0.10				2.9	30	
Iron	19.9	mg/kg	1.0				4.0	30	
Lead	0.875	mg/kg	0.10				2.4	30	
Manganese	7.37	mg/kg	0.10				3.5	30	
Molybdenum	0.223	mg/kg	0.10				0.1	30	
Nickel	0.0812	mg/kg	0.10					30	
Zinc	18.6	mg/kg	0.10				7.0	30	
Lab ID: B21092238-006AMS2	Sample Matrix Spike				Run: ICP203-B_211007A			10/07/21 14:41	
Cadmium	5.03	mg/kg	0.10	99	50	150			
Copper	13.4	mg/kg	0.10	111	50	150			
Iron	67.6	mg/kg	1.0	108	50	150			
Lead	32.7	mg/kg	0.10	99	50	150			
Manganese	64.3	mg/kg	0.10	108	50	150			
Molybdenum	13.1	mg/kg	0.10	102	50	150			
Nickel	10.2	mg/kg	0.10	102	50	150			
Zinc	14.6	mg/kg	0.10	105	50	150			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte		Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6020**								Batch: 160047	
Lab ID:	**MB-160047**	Method Blank				Run: ICPMS206-B_211007B			10/08/21 01:43	
Selenium		ND	mg/kg	0.0007						
Lab ID:	**B21092238-009AMS**	Sample Matrix Spike				Run: ICPMS206-B_211007B			10/08/21 03:48	
Selenium		0.639	mg/kg	0.10	128	70	130			
Lab ID:	**B21092238-009ADUP**	Sample Duplicate				Run: ICPMS206-B_211007B			10/08/21 03:53	
Selenium		ND	mg/kg	0.10					30	
Method:	**SW6020**								Batch: 160048	
Lab ID:	**LCS-160048**	Laboratory Control Sample				Run: ICPMS206-B_211007B			10/08/21 04:39	
Arsenic		0.206	mg/kg	0.020	114	70	130			
Lab ID:	**B21092238-004AMS**	Sample Matrix Spike				Run: ICPMS206-B_211007B			10/08/21 06:32	
Arsenic		2.67	mg/kg	0.020	106	70	130			
Lab ID:	**B21092238-004ADUP**	Sample Duplicate				Run: ICPMS206-B_211007B			10/08/21 06:43	
Arsenic		0.0147	mg/kg	0.020					30	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

QA/QC Summary Report

Prepared by Billings, MT Branch

Client: Golder Associates Inc **Work Order:** B21092238 **Report Date:** 10/13/21

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA27a									Batch: R368180
Lab ID: B21092238-004A DUP	Sample Duplicate				Run: MISC-SOIL_211006A				10/06/21 10:43
Saturation	26.2	%	0.10				1.2	30	
Lab ID: LCS-2110061043	Laboratory Control Sample				Run: MISC-SOIL_211006A				10/06/21 10:43
Saturation	41.7	%	0.10	110	70	130			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

Work Order Receipt Checklist

Golder Associates Inc B21092238

Login completed by:	Richard L. Shular	Date Received:	9/23/2021
Reviewed by:	BL2000\gmccartney	Received by:	srg
Reviewed Date:	9/29/2021	Carrier name:	UPS

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	21.8°C No Ice		
Containers requiring zero headspace have no headspace or bubble that is <6mm (1/4").	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Radiochemical precision results represent a 2-sigma Total Measurement Uncertainty.

Contact and Corrective Action Comments:

None

CHAIN OF CUSTODY RECORD

Page of

COC Number

Project Name: EMMA Project	Send Results To: Name: Tyrone operations Department: Environmental Services Department Address: PO Box 571 Tyrone, NM 88065
Project Location: Tyrone operations	
Purchase Order Number	

Sample Identifier	Sample Date	Sample Time	Sample Method	Matrix	Sampler	Number of Containers	Analysis Required	Remarks
11, 2018-13 100-110				Soil		1	B21092236-001	
3 2018-07 20-30				Soil		1	-002	
3, 2018-10 20-30				Soil		1	-003	
2019-07 10-20				Soil		1	-004	
2019-14 40-50				Soil		1	-005	
2019-07 30-40				Soil		1	-006	
2019-06 40-50				Soil		1	-007	
2019-06 70-80				Soil		1	-008	
2019-02 20-30				Soil		1	-009	
2019-06 130-140				Soil		1	-010	
2019-02 130-140				Soil		1	-011	

Signatures	Date	Time	Shipping Details
Relinquished by			Method of Shipment
Received by:			Airbill Number
Relinquished by			Lab Address Name: Energy Laboratories Inc Address: 1120 South 27th Street Billings, MT 59101 Phone Fax
Received for Laboratory by [signature]	9/3/21	9:30	

GOLDER

September 21, 2021

Project No. 21476949

Ms. Shari Endy
Energy Laboratories Inc.
1120 South 27th Street
Billings, MT 59101

RE: LABORATORY TESTING FOR EMMA DRILL CORE SAMPLES

Dear Ms. Endy,

This letter accompanies 14 drill core samples for the Emma Project at the Tyrone Mine. Please analyze the samples for the following parameters.

Analysis/Parameter	Source-Method
Saturated Paste pH	USDA Handbook 60; Method 2 and 21a
Electrical Conductivity, saturated paste	USDA Handbook 60; Method 3a and 4b
Particle Size Analysis including very fine sand	Gee and Bauder (1986)
Saturation percentage	USDA Handbook 60, Method 27a
Hot water extractable Boron	ASA 1982, Method 10-3
Hot water extractable Selenium	ASA 1982, Method 75-4.1
Organic Matter (Carbon)	ASA 1982, Method 29-3.5.2
N as Nitrate	ASA 1982, Method 33-8.1
Phosphorous (Olsen)	ASA 1982, Method 24-5.4
Potassium	ASA 1982, Method 13-3.5
Acid-Base Account (with sulfur forms)	Modified Sobek et al (1978)
AB-DTPA extractable metals (As, Cd, Cu, Fe, Pb, Mn, Mo, Ni and Zn)	ASA 1982, Method 3-5.2 EPA Method 6010/6020

If these samples are too rocky, please crush to increase the available fines for testing. If you have any questions, please call (505) 821-3034 or email (dromig@golder.com).

Sincerely,
Golder Associates Inc.

Doug Romig, CPSS
Senior Consultant

GOLDER
MEMBER OF WSP

golder.com

APPENDIX E

Emma Project Stockpile Stability Evaluation

REPORT

Emma Expansion

Stockpile Stability Evaluation

Submitted to:

Mandy Lilla

Freeport-McMoRan Tyrone Inc.
PO Box 571
Tyrone, New Mexico 88065

Submitted by:

Golder Associates USA Inc.

2000 SW 1st Avenue, Suite 220, Portland, Oregon, USA 97201

+1 503 607-1820

21476949-007-R-Rev0

November 12, 2021

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates USA Inc. (Golder), a Member of WSP, prepared this technical memorandum for Freeport-McMoRan Tyrone Inc. (Tyrone) to evaluate the stability of the reclaimed configurations of the waste stockpiles in support of the 2021 Closure/Closeout Plan (CCP) for the Emma Mine expansion, a modification to Discharge Permit (DP) -1341, and a revision application for a New Unit to an Existing Mine to Mining Act Permit GR010RE in accordance with the Copper Rule (20.6.7 NMAC) criteria. The Copper Rule states that:

> *At closure, tailing impoundment(s) not regulated by the office of the state engineer, leach stockpile(s) or waste rock stockpile(s) shall be constructed to promote the long-term stability of the structure. Closure of all critical structures at a copper mine facility shall be designed for a long-term static factor of safety of 1.5 or greater and non-critical structures shall be designed for a long-term static factor of safety of 1.3 or greater. The units being closed shall also be designed for a factor of safety of 1.1 or greater under pseudo-static analysis. A stability analysis shall be conducted for the unit and shall include evaluation for static and seismic induced liquefaction.*
>
> *"Critical Structure" means earthen or rock structures or embankments (such as the outslope of a rock stockpile), that are likely to cause an exceedance of applicable groundwater standards or undue risk to property in the event of a significant unexpected slope movement.*

This report addresses only the new planned stockpiles consisting of the 6HW Waste stockpile located immediately south of the 6D and 7B Leach stockpiles, and the EMW Waste stockpile peripheral to the planned Emma Pit. The stability of the stockpiles was evaluated for their reclaimed configurations if mining ceased at the end of year (EOY) 2026, representing the highest cost year for the 5-year mine plan.

2.0 APPROACH

The stability analyses apply methods consistent with the methods applied during previous assessments of the stability of the Tyrone and Little Rock stockpiles that was recently summarized in Appendix F of the 2013 Tyrone Mine CCP Update (Golder 2020). The final reclaimed geometries of the stockpiles were developed by Golder as part of the Emma Closure/Closeout Plan. The geologic conditions were taken from the available mapping information which is based on the geologic map of the Wind Mountain quadrangle (Hedlund 1978) and mapping by Tyrone geologists. Information on the groundwater levels is available from DP-396 semiannual groundwater monitoring reports that are prepared by Daniel B. Stephens & Associates Inc. (DBS&A) and the recent Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project (DBS&A 2021c). The geotechnical engineering parameters for the geologic units are generally consistent with parameters that have been developed previously and summarized in the stockpile stability report contained within the 2013 Tyrone Mine CCP Update (Golder 2020) where similar geologic units are present.

Previous assessments of the stability of the Tyrone stockpiles that addressed Condition 78 of DP-1341, included an evaluation of the changes in the stockpile strength parameters and long-term stability resulting from the natural weathering processes. Assessment of the long-term impacts of chemical weathering were addressed by the Supplemental Materials Characterization study prepared by EnviroGroup Limited (2005). Golder evaluation of the impacts of weathering on the long-term strengths of the stockpiles is discussed in detail in the stockpile stability report contained within the 2013 Tyrone Mine CCP Update (Golder 2020). Golder has concluded that the soil matrix fraction of material weathered for long periods of time remains similar in character to the matrix fraction of the less weathered material but may become higher in proportion due to the physical breakdown of the rock fragments. Therefore, the laboratory derived shear strengths of samples that are scalped of the larger size rock fragments are considered to reflect the fully weathered long-term strengths of the stockpiles.

3.0 SITE CONDITIONS

3.1 Stockpile Descriptions

The following stockpiles which are designated on Figure 1 comprise the Emma stockpile system addressed in this report.

- 6HW Waste
- EMW Waste

Figure 1 illustrates the existing topography with the EOY 2026 reclamation plan designs overlain on the surface geology map. Surface geology is interpreted from Emma Exploration Prospect Surface Geology Draft Report (DBS&A 2021b).

The stockpile crest elevations of the 6HW Waste stockpile is approximately 6,540 feet (ft) and the stockpile is generally 310 feet from crest to toe. The EMW Waste stockpile has a crest elevation of 6,320 ft and the maximum overall slope height is 280 on the north side of the stockpile. The stockpile will partially backfill the Upper North area of the Emma Pit. The stockpiles will be constructed by end dumping the materials in 30 to 50-foot lifts from the bottom up with small setbacks between lifts to result in approximately 1.8 horizontal to 1 vertical (1.8H:1V) to 2.0H:1V overall slopes. The stockpiles will be regraded upon closure, as shown on Figure 1, to achieve the approximately 3.5H:1V overall slopes with intermittent bench channels to promote revegetation, establish surface water conveyances, and provide long-term erosional stability.

3.2 Climate

The Emma area is in a semi-arid region with elevations ranging from about 5,800 to 6,300 feet above mean sea level (amsl). The climate is warm and dry with mean annual precipitation of about 16 inches and a mean annual temperature near 50° F (Golder 2007). Precipitation falls mainly as rain, but snow may occur from November to March. Most precipitation falls during monsoon period from July through October in the form of short intense thunderstorms. About 60% of the precipitation falls during the monsoon. Annual evaporation greatly exceeds annual precipitation.

3.3 Geology

The bedrock geology below the 6HW Waste stockpile shown on Figure 2 was prepared by Golder (2007) from the geologic map of the Wind Mountain quadrangle supplemented with mapping by Tyrone geologists. The surface geology and descriptions shown on Figure 1 and described here was developed and provided to Golder by DBS&A (2021c). Descriptions of the geologic units in this section are likewise credited to DBS&A.

The geologic setting of the Emma area is similar to that at the Tyrone and Little Rock Mines. The mineralization is in and around the Quartz Monzonite of Tyrone (Tqm) stock, a 53- to 57-million-year-old Paleocene quartz monzonite porphyry emplaced into the Precambrian Burro Mountain Granite (p€g) as a small stock and as east-west trending dikes (Tqmd). Precambrian aplite (p€apl) bodies occur within the p€g. A Tertiary Granodiorite unit (Tgd) and Quartz Monzonite is present west of the Emma Pit area (Tgd/Tqm). Miocene-Pliocene-Pleistocene fan, sheet flood deposits, and older fan deposits (Qfo/Qtg), which includes the Gila Conglomerate (also referred to locally as the Mangas Conglomerate) are in depositional contact with the crystalline basement rocks and are exposed east of the pit area. Holocene alluvium (Qal) and alluvial fan deposits (Qf) are present along Oak Grove Wash. The Qa and Qf units are considered equivalent in terms of their engineering properties.

Large scale structural features in the Emma area are dominated by the high angle east-west striking Tqmd dikes. There are two major faults near Emma: (1) the Sprouse-Copeland Fault to the north and (2) an unnamed fault to the south (Figure 1). As established in DBS&A hydrogeology report, the Sprouse-Copeland Fault is a southwest-northeast striking fault with an approximately 80-degree dip to the southeast. It is a Laramide age fault that exhibits hundreds of feet of displacement. Along the north side of the proposed Emma Pit, it crosscuts Precambrian Granite (DBS&A 2021c).

Along the southeast side of the Tyrone Mine near the reclaimed 1C Waste stockpile, the Sprouse-Copeland Fault appears to be an impediment to groundwater flow based on differences in groundwater elevations at monitor wells located on opposite sides of the fault. The predominant groundwater flow direction in this area is parallel to the fault rather than across it.

The second major fault near Emma is unnamed. The unnamed fault is located to the south of the proposed area of the open pit. It is a west-east striking fault of unknown age that crosscuts Precambrian Granite and dips 75 degrees to the north (Hedlund 1978).

3.4 Hydrogeologic Conditions

Groundwater levels applied in the stability models are based on groundwater monitoring data reported in the DP-396 semiannual monitoring reports provided by DBS&A and the recent Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project (DBS&A 2021c). Groundwater contours were provided based on water levels measured during the first and second quarter (Q1 and Q2) 2021 monitoring cycle. Water table surfaces are developed for the perched water table present in the alluvium and the deeper regional bedrock aquifer.

4.0 DEVELOPMENT OF MODEL PARAMETERS

4.1 Summary of Material Parameters Applied in the Stability Analyses

Table 1 summarizes the unit weights and the Mohr-Coulomb (M-C) strength parameters (i.e., friction angle [ϕ] and cohesion [c]) applied in the stability analyses. The values are consistent with the values applied in the Golder stockpile stability report for the Tyrone 2013 CCP update (Golder 2020) and the basis for the selection of the parameters are provided in that report. All of the lithologic units that are present at Emma have had material parameters developed and applied in the previous stockpile stability reports. The waste rock strengths applied represent the long-term decrepitated strengths.

The Tertiary Granodiorite unit (Tgd) was included with the Quartz is assigned a strength comparable to the Burro Mountain Granite (p€g) based on the similarity in the intact rock strength and the fracture characteristics.

Table 1: Summary of Material Parameters

Material	Strength Model	Moist Unit Weight (pcf)	Saturated Unit Weight (pcf)	ϕ (°)	c (psi)
Waste Rock	M-C	125	138	30.9	11.5
Leached Ore	M-C	125	138	35.5	2

Material	Strength Model	Moist Unit Weight (pcf)	Saturated Unit Weight (pcf)	ϕ (°)	c (psi)
Alluvium (Qal/Qf)	M-C	125	138	29.0	0
Liquefied Alluvium (Qal)	M-C	125	138	8.0	0
Gila Conglomerate (QTg/Qfo)	M-C	125	138	35	6.94
Granodiorite (Tgd)	M-C	160	160	35	340
Quartz Monzonite (Tqm) or Quartz Monzonite with Granodiorite (Tgd/Tqm)	M-C	160	160	43	669
Burro Mountain Granite (p€g)	M-C	160	160	35	340

4.2 Hydrogeologic Conditions

4.2.1 Stockpile Moisture Conditions

Information regarding moisture conditions in the stockpiles at Tyrone is available in the Golder (2020) report. The data and conclusions indicate that the stockpiles are drained, that moisture content correlates with the grain size of the materials, with sands and gravels having low moisture content and zones with higher clay content having higher retained moisture. Overall, the stockpiles are assumed to be unsaturated in all areas above the water table. Drained conditions are also assumed for the Emma stockpiles.

4.2.2 Perched Alluvial and Regional Bedrock Groundwater Conditions

The regional groundwater table is 150 to 300 feet below the existing ground surface in the Emma open pit area (DBS&A 2021a). Groundwater levels applied in the stability models are based on the groundwater levels provided in the DP-396 semiannual monitoring reports provided by DBS&A (2021a). The regional water table is in the basement below the stockpiles, generally 200 to 500 feet below the native ground surface and is intercepted by the Emma open pit. Contoured perched water level data is also available for the alluvium in the Oak Grove wash in the area of the planned EMW stockpile obtained from individual well measurements.

Seasonal fluctuations in the perched groundwater of Oak Grove Wash alluviums are expected, but currently unquantified. Therefore, these analyses consider both the condition in which the perched water table is as-measured from the exploratory drillholes, and the worst-expected case scenario in which the water table rises to the top of the Alluvium.

4.3 Seismic Coefficient

A pseudo-static analysis requires selection of the pseudo-static coefficient, which is estimated as a fraction of the peak ground acceleration (PGA) that the structure is expected to experience for a specified annual exceedance probability (AEP). Based on the previous criteria applied for the stockpile stability assessments at Tyrone, an earthquake ground motion with a 2% probability of exceedance in 50 years (i.e., a 2,475-year return period) is applied for the stockpile stability assessment for closure conditions.

The seismic parameters applied for the Emma stockpiles are the same that were applied to the Tyrone and Little Rock stockpiles as described in the 2013 Tyrone CCP Update report (Golder 2020). The PGA at a site is influenced by the type of soils overlying the bedrock. An amplification factor of 1.3, reflecting a soil Site Class C (appropriate for placement of the 6HW on top of previous stockpiled material), was applied to the bedrock PGA of 0.1088 resulting in a site PGA of 0.141.

A pseudo-static coefficient equal to two-thirds of the amplified peak ground acceleration (i.e., 0.094) was applied for the pseudo-static analyses of these facilities. We have conservatively retained the same pseudo-static coefficient for the EMW stockpile underlain by bedrock units. Therefore, those results are conservative.

5.0 STABILITY ANALYSIS METHOD

Golder analyzed the stability through two-dimensional, limit-equilibrium, method of slices analysis using the software program, Slide version 2018 (RocScience 2018). This program provides for various failure surface types, including circular and non-circular (block), and various failure surface search methods. Golder applied Morgenstern-Price’s Method of Slices which satisfies conditions of static horizontal and vertical equilibrium, as well as moment equilibrium.

Analyses considered both circular and block type failure surfaces. Circular failure surface searches were generally used to identify the most critical failure surface (i.e., lowest factor of safety) for failures through the stockpile materials. The circular surfaces also evaluate failures through the stockpile foundation. Block type failures are typically used to identify critical failure surfaces that develop along preferential zones of weakness, such as thin layers of weak alluvium or through liner systems.

The stability of the reclaimed configurations of the stockpiles are analyzed for static and pseudo-static loading conditions. The stability analyses cross section output for each analyzed failure mode is included in Appendix A. The geotechnical units are indicated by colors with the color legend at the front on Figure 1 in Appendix A. The cross sections show the limits of the circular failure searches and the factor of safety for the lowest surface reported. The regional water table applied in the stability analyses is shown on the stability cross sections as blue lines.

Two-dimensional cross-sectional models were prepared based on pre-mining topography (digitized from early topographic maps), recent aerial surveys, and the EOY 2026 reclamation plan designs prepared by Golder. The geologic units present below the stockpiles is interpreted from the geological site map (Figure 1).

5.1 Selection of Critical Cross Sections

One section was selected for the evaluation of the stability of 6HW Waste stockpile in its EOY 2026 closure configuration, and two were selected for EMW waste stockpile. Selection of the most-critical sections was based on the planned closure facility design slope gradient, slope height, subsurface geology, and hydrogeologic conditions. The critical cross section models for each stockpile are described in more detail in Section 6.0. The planned closure geometry, surficial geology and locations of the critical cross sections are shown in Figure 1. The cross-section models are shown on Figure 2.

5.2 Loading Conditions

The stability of the reclaimed stockpile configurations was evaluated considering static and pseudo-static loading conditions targeting factors of safety as defined by the Copper Rule. For the seismic case, Golder evaluated pseudo-static earthquake loading applying a pseudo-static coefficient of 0.094 as discussed in Section 4.3. A factor-of-safety of 1.5 for critical structures and 1.3 for non-critical structures is considered suitable under the Copper Rule for static loading and minimum target factors of safety for pseudo-static loading are 1.1 or greater.

5.3 Evaluation of Liquefaction Potential

Consideration of the potential for liquefaction is a requirement of 20.6.7 NMAC. Liquefaction potential exists where saturated Holocene alluvium is present. The west toe area of the EMW stockpile will extend into Oak Grove wash where the mapped geology shows Holocene alluvium is present. Where standard penetration test (SPT) or other data to assess the liquefaction potential is not available, the alluvium is conservatively assumed to be potentially liquefiable. Post-liquefaction stability was conservatively analyzed assuming the alluvium below the water table has a liquefied shear strength.

The liquefied shear strength is based on previous work by Golder (2020) as approximately equivalent to an internal friction angle of 5° to 11°. For the analysis of the stability with liquefied alluvium, the zones of alluvium below the modelled groundwater table were assigned an internal friction angle (ϕ) of 8° representative of an undrained, post-liquefaction shear strength.

Due to the coarse grainsize distribution and free draining character, waste rock is considered to be non-liquefiable.

6.0 STABILITY ANALYSIS RESULTS

The results of the stability analyses provided in this section were based on the parameters and methods described in the preceding sections. All the calculated factors of safety were found to be above the minimum required factor of safety criterion, and the stockpiles are predicted to maintain long-term stability for the planned closure geometries. Table 2 summarizes the minimum factors of safety obtained for each stockpile for static and pseudo-static loading conditions.

The following sections describe the individual stability models prepared for each stockpile, the analyses completed and resulting factors of safety. The stability cross section models are shown in the Appendix A. The minimum factors of safety are provided for each of the failure surface search methods analyzed (e.g., block, circular). Outputs from all stability analysis models are provided in Appendix A.

Unless otherwise noted the reclaimed slope geometry consists of overall 3.5H:1V overall slopes consisting of 3H:1V interbench slopes and benches spaced every 200 feet of slope length.

Table 2: Stability Analysis Results Summary

Stockpile	Critical Failure Mode	Minimum Static FOS	Minimum Pseudo-static FOS	Liquefied FOS
6HW Waste	Global failure, circular type	2.86	2.11	No liquefiable soils present
EMW Waste	Local toe, circular type	3.05	2.22	1.87

6.1 6HW Waste Stockpile

The 6HW Waste stockpile is located directly west of the Gettysburg Pit and will be placed over the 6C and 7AE Leach stockpiles. The southern slope has a crest elevation of 6540 feet and a maximum stockpile height of 310 feet. At closure, the slopes will be regraded to overall 3.5H:1V. The stockpiles are underlain by Tertiary quartz monzonite (Tqm). The San Salvador fault and a parallel unnamed fault pass east-west beneath the footprint of the stockpiles. The faults do not have orientations that are adverse to stability and are not modeled in the stability analysis.

One critical stability section was selected to run north-south (Section 6HW) perpendicular to slope contours at the maximum slope height. The location of the critical cross-section is shown on Figure 1. The most critical failure surface is an overall circular failure from crest to toe of the slope along Section 6HW with a minimum static factor of safety of 2.82 (Figure 2 in Appendix A) and the minimum pseudo-static factor of safety is 2.08 (Figure 3 in Appendix A). No potentially liquefiable soils are present below the stockpile. The 6HW Waste stockpile stability results are provided in Table 3.

Table 3: 6HW Waste Stability Results

						Factor of Safety	
Section Name	Failure Type	Crest El.	Toe El.	Slope Height (ft)	Critical Failure Type	Static	Seismic (k = 0.94g)
6HW	Circular	6540	6230	310	Global	2.86	2.11
	Block				Global	2.93	2.15

6.2 EMW Waste Stockpile

The EMW Waste stockpile is located to the northeast of the proposed Emma Pit. The reclaimed stockpile slopes are overall 3.5H:1V with maximum slope heights of 300 ft. The EMW Waste stockpile toe will extend a short distance over an area with mapped Quaternary alluvium (or fan deposit depending on the geologic mapping source). The liquefaction potential was assessed under two conditions, the expected case applying the measured perched groundwater levels from semiannual monitoring reports provided by DBS&A (2021a) and the worst-case scenario in which the water table rises to the top of the alluvium. The measured perched water table lies in alluvium at the toe of EMW-2 at an elevation of 5,960 feet, approximately 13 ft below the existing ground surface.

Two critical stability sections were selected to run perpendicular to the slope of the stockpile. The location of the critical cross-sections (EMW-1 and -2) are shown on Figure 1. The most critical failure surface was found to be a global circular failure along the northern slope. The minimum static factor of safety is 3.17 (Figure 6 in Appendix A) and the minimum pseudo-static factor of safety is 2.31 (Figure 7 in Appendix A). The EMW Waste stockpile stability results are provided in Table 4.

Table 4: EMW Waste Stability Results

					Factor of Safety			
Section Name	Failure Type	Crest El. (ft)	Toe El. (ft)	Slope Height (ft)	Static	Seismic (k = 0.94g)	Liquefied Alluvium	Liquefied Alluvium with Worst-Case Perched Water
EMW-1	Circular	6320	6045	275	3.47	2.41	NA	NA
	Block				3.27	2.55		
EMW-2	Circular	6320	6020	300	3.10	2.27	3.10	1.87
	Block				3.05	2.22	3.05	2.88

7.0 CONCLUSIONS

Stability evaluations incorporating the design parameters outlined in this report indicate long-term factors of safety for the reclaimed stockpile configurations of at least 2.82 under static conditions and 2.08 under seismic loading. The stockpiles are not predicted to undergo long-term reductions in shear strength and reductions in the factor of safety due to weathering. These safety factors meet the minimum factor of safety criteria and indicate the stockpiles will be stable post-closure to support the Closure/Closeout Plan designs and meet state stability criteria.

The potential for earthquake induced instability was evaluated using pseudo-static analyses. The pseudo-static coefficient applied considered the peak ground acceleration associated with a design basis earthquake with a 2,500-year return period and applied an amplification factor appropriate for the sites underlain by leach stockpile. The factors of safety applying the pseudo-static loads met the typical minimum factors of safety. All were above 1.5.

The stability analyses also considered the potential for liquefaction and determined the potential for liquefaction exists in the Quaternary alluvium deposits. The alluvium below the observed water table were conservatively analyzed as liquefied and determined to meet acceptable limits of stability.

The stockpiles are expected to be unsaturated. Golder expects moisture contents in the stockpile will decrease further after closure as a result of revegetation of the reclaimed stockpiles and implementation of surface water management controls. The development of elevated groundwater levels in the stockpiles that could impact the stockpile’s long-term stability is not expected.

8.0 REFERENCES

Daniel B. Stephens & Associates, Inc. (DBS&A). 2021a. Figure 9 Tyrone Mine Regional Groundwater Level Elevations and Flow Direction. Report. Prepared for Freeport McMoRan Tyrone, Inc. September 14, 2021.

DBS&A. 2021b. Emma Exploration Prospect Surface Geology. DRAFT Report. Prepared for Freeport McMoRan Tyrone, Inc. May 6, 2021.

DBS&A. 2021c. Hydrogeologic Report for Proposed Open Pit at Emma Exploration Project. Prepared for Freeport-McMoRan Tyrone Inc., Tyrone, New Mexico. September 15.

EnviroGroup Limited. 2005. Supplemental Materials Characterization of the Leached Ore Stockpiles and Waste Rock Stockpiles Final Report for DP-1341, Condition 80 Tyrone Mine, prepared for Phelps Dodge Tyrone, Inc., dated December 29, 2005, Project No. PD-0447.

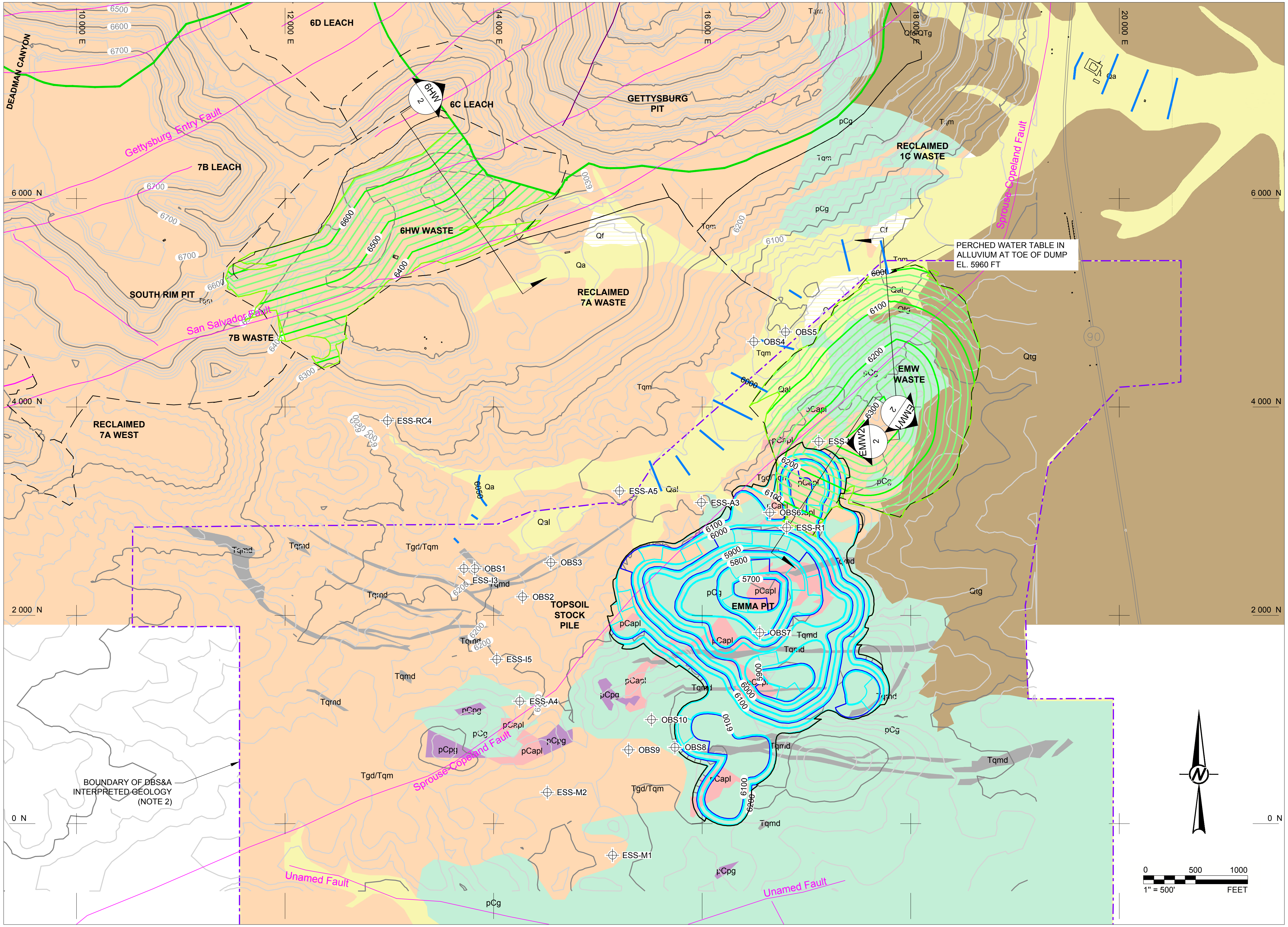
Golder. 2007. Tyrone Mine Closure/Closeout Plan Update, prepared for NMED and MMD, submitted by Phelps Dodge Tyrone Inc., Project No. 073-80012, dated October 11, 2007.

Golder. 2020. Updated Closure/Closeout Plan for Little Rock Mine. Report. Prepared by Golder for Freeport-McMoRan Tyrone, Inc. Dated June 11, 2020.

Hedlund, D.C. 1978. Geologic Map of the Wind Mountain Quadrangle, Grant Co., New Mexico, USGS, MF-1031, scale 1:24,000.

Rocscience. 2018. SLIDE2, SLIDE-2D Limit Equilibrium Slope Stability Analysis version 2018, Rocscience Inc., Toronto.

Figures



LEGEND

- YEAR 5 EXISTING TOPOGRAPHY (20 FT CONTOUR INTERVAL)
- PIT CONTOURS (20 FT INTERVALS)
- CLOSURE STOCKPILES (20 FT CONTOUR INTERVALS)
- PROPOSED FUTURE RECLAMATION AREA
- INTERPRETED GEOLOGY BOUNDARY (NOTE 2)
- CONDITIONAL WAIVER AREA ASSOCIATED WITH EOY 2026 MINE PLAN TOPOGRAPHY
- KNOWN FAULT (NOTE 5)
- PERCHED WATER TABLE IN ALLUVIUM WATER CONTOURS (10 FT INTERVALS)
- OBS-1 / ESS-1 — PERCHED ZONE WELL (BY OTHERS)
- Qal — QUATERNARY ALLUVIAL DEPOSITS
- Qf — QUATERNARY ALLUVIAL FAN DEPOSITS
- QTg — QUATERNARY-TERTIARY GILA CONGLOMERATE
- Tgd/Tqm — TERTIARY GRANODIORITE AND QUARTZ MONZONITE
- Tqm — TERTIARY QUARTZ MONZONITE
- Tqmd — TERTIARY QUARTZ MONZONITE PORPHYRY DIKE
- pCg — PRECAMBRIAN GRANITE
- pCapl — PRECAMBRIAN APLITE
- pCpg — PRECAMBRIAN PEGMATITE

SOURCE

1. EXISTING REGIONAL GEOLOGY FROM TYRONE CLOSURE/CLOSEOUT PLAN FIGURE 2-15 (GOLDER, 2014). MAP WAS DEVELOPED FROM RECENT UNPLUBLISHED DATA FROM PD KOLESSAR, J., 1982, THE TYRONE COPPER DEPOSIT. IN TITLEY, HEDLUND, 1978, GEOLOGIC MAP OF THE WIND MOUNTAIN QUADRANGLE, GRANT CO., NM, USGS MISC.
2. LOCAL GEOLOGY OF EMMA PIT AREA INTERPRETED BY DBS&A IN AN ELCTRONIC FILE TITLED 'EMMA Exploration Prospoect Surface Geology.pdf'
3. EXISTING TOPOGRAPHY AND WASTE ROCK DUMP CLOSURE CONTOURS PROVIDED BY FREEPORT MCMORAN ON AUGUST 8, 2021 IN AN ELECTRONIC FILES TITLED 'EMMA_FINAL_YR_CONTOURS_REV2.DXF'.
4. INDIVIDUAL FACILITY LABEL LOCATIONS ARE APPROXIMATE.
5. EXISTING FAULT TRACES PROVIDED BY FMI TYRONE IN APRIL 2020 IN A ELECTRONIC FILE TITLED 'FAULTS.dwg'. UPDATED BASED ON INFORMATION PROVIDED BY TYRONE GEOLOGY DEPARTMENT.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	11-12-2021	CCP 2021 EMMA STOCKPILE STABILITY - FINAL REPORT				
C	11-5-2021	CCP 2021 EMMA STOCKPILE STABILITY - DRAFT REPORT	KDP	KDP	TW	TS
B	10-12-2021	CCP 2021 EMMA STOCKPILE STABILITY - DRAFT REPORT	KDP	KDP	TW	TS

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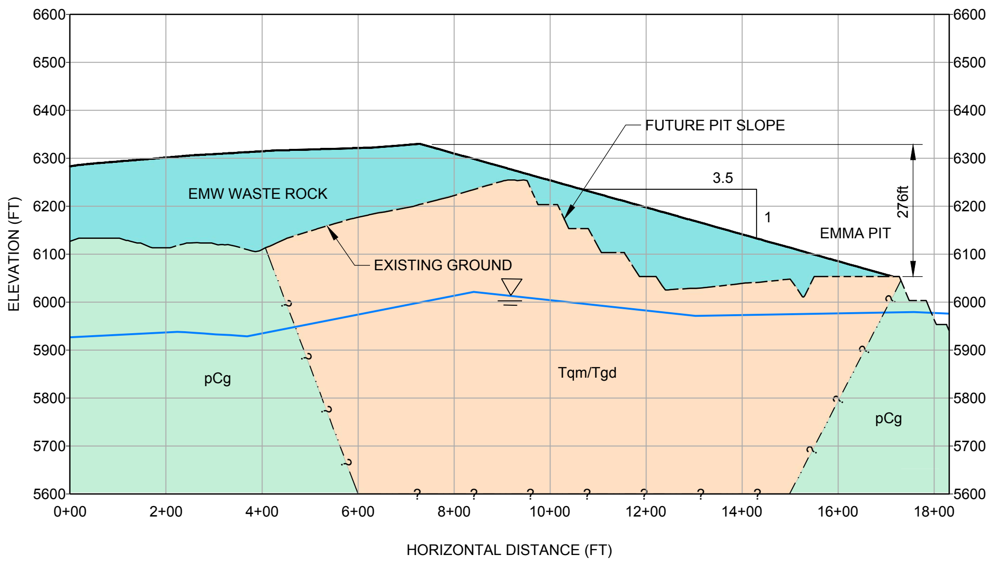
PROJECT
EMMA CLOSURE/CLOSEOUT PLAN
EMMA MINE STOCKPILE STABILITY

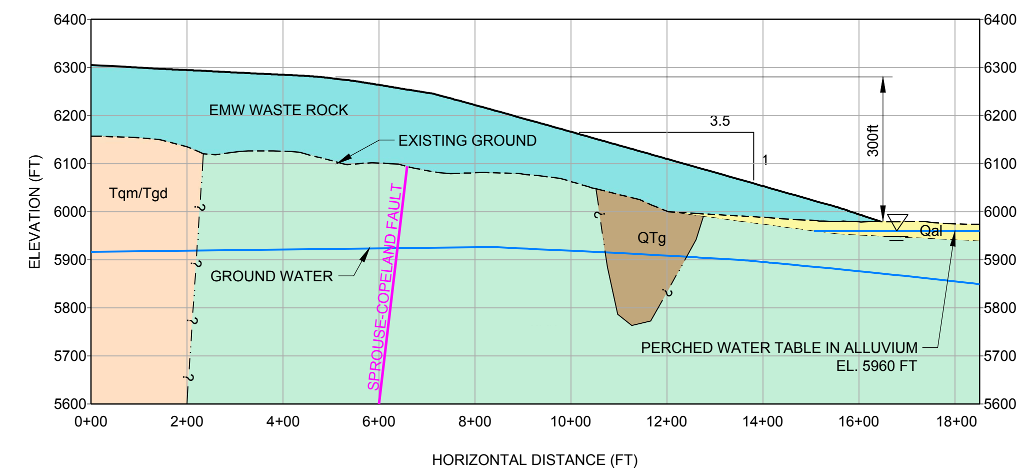
TITLE
EMMA STOCKPILE CRITICAL STABILITY PLAN

PROJECT NO. 21476949 | REV. 0 | 1 of 2 | FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE 1" = 200' EMW1 / 1 GEOLOGIC CROSS SECTION-EMW WASTE



SCALE 1" = 200' EMW2 / 1 GEOLOGIC CROSS SECTION-EMW WASTE

SOURCE

1. EXISTING REGIONAL GEOLOGY FROM TYRONE CLOSURE/CLOSEOUT PLAN FIGURE 2-15 (GOLDER, 2014). MAP WAS DEVELOPED FROM RECENT UNPLUBLISHED DATA FROM PD KOLESSAR, J., 1982, THE TYRONE COPPER DEPOSIT. IN TITLEY, HEDLUND, 1978, GEOLOGIC MAP OF THE WIND MOUNTAIN QUADRANGLE, GRANT CO., NM, USGS MISC.
2. LOCAL GEOLOGY OF EMMA PIT AREA INTERPRETED BY DBS&A IN AN ELCTRONIC FILE TITLED 'EMMA Exploration Prospoect Surface Geology.pdf'
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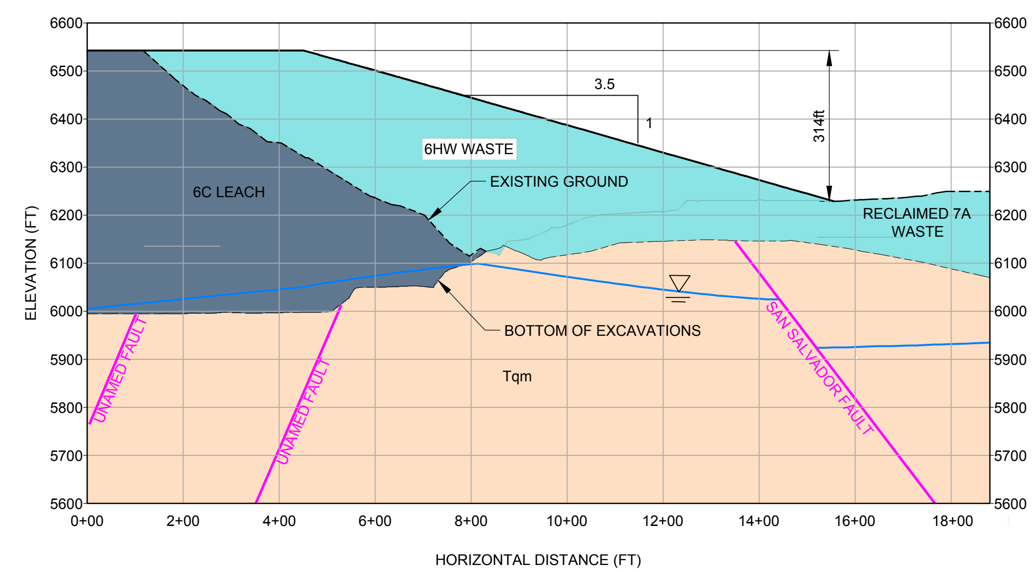
4. INDIVIDUAL FACILITY LABEL LOCATIONS ARE APPROXIMATE.
5. EXISTING FAULT TRACES PROVIDED BY FMI TYRONE IN APRIL 2020 IN A ELECTRONIC FILE TITLED 'FAULTS.dwg'. UPDATED BASED ON INFORMATION PROVIDED BY TYRONE GEOLOGY DEPARTMENT.

LEGEND

— — —	EXISTING GROUND
(magenta line)	KNOWN FAULT (NOTE 5)
(blue line)	GROUNDWATER AND PERCHED WATER TABLE IN ALLUVIUM WATER (10 FT INTERVALS)
Qal	QUATERNARY ALLUVIAL DEPOSITS
Qf	QUATERNARY ALLUVIAL FAN DEPOSITS
QTg	QUATERNARY-TERTIARY GILA CONGLOMERATE
Tqm/Tgd	TERTIARY GRANODIORITE AND QUARTZ MONZONITE
Tqm	TERTIARY QUARTZ MONZONITE
Tqmd	TERTIARY QUARTZ MONZONITE PORPHYRY DIKE
pCg	PRECAMBRIAN GRANITE
pCapl	PRECAMBRIAN APLITE
pCpg	PRECAMBRIAN PEGMATITE
	WASTE ROCK
	LEACHED ORE



SCALE 1" = 200' 6HW / 1 GEOLOGIC CROSS SECTION-6HW WASTE

0 200 400
1" = 200' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	11-12-2021	CCP 2021 EMMA STOCKPILE STABILITY - FINAL REPORT				
C	11-5-2021	CCP 2021 EMMA STOCKPILE STABILITY - DRAFT REPORT	KDP	KDP	TW	TS
B	10-12-2021	CCP 2021 EMMA STOCKPILE STABILITY - DRAFT REPORT	KDP	KDP	TS	TW

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PROJECT
EMMA CLOSURE/CLOSEOUT PLAN
EMMAN MINE STOCKPILE STABILITY

TITLE
EMMA STOCKPILE CRITICAL STABILITY PROFILES

PROJECT NO. 21476949
REV. 0

APPENDIX A

Stability Results

Material Properties

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qal - Quaternary Alluvial Deposits		125	138	Mohr-Coulomb	0	29	Water Surface
Qa - Alluvium (liquefied)		125	138	Mohr-Coulomb	0	8	Water Surface
QTg - Quaternary Mangas Congolomerate		125	138	Mohr-Coulomb	1000	35	Water Surface
Tgd - Tertiary Granodiorite		160	160	Mohr-Coulomb	48960	35	Water Surface
Tgd/Tqm - Tertiary Quartz Monzonite or Granodiroite		160	160	Mohr-Coulomb	48960	35	Water Surface
Tqm - Tertiary Quartz Monzonite		160	160	Mohr-Coulomb	96336	43	Water Surface
pCg - Precambrian Granite		160	160	Mohr-Coulomb	48960	35	Water Surface
Waste Rock		125	138	Mohr-Coulomb	1656	30.9	Water Surface
Leached Ore		125	138	Mohr-Coulomb	288	35.5	Water Surface

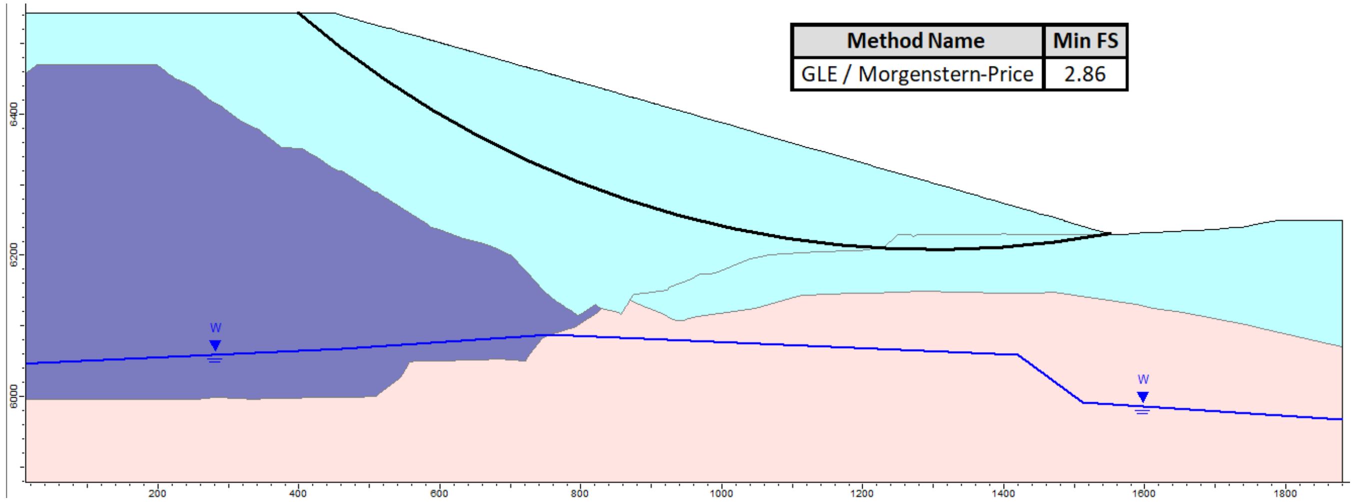
Stability Model Results

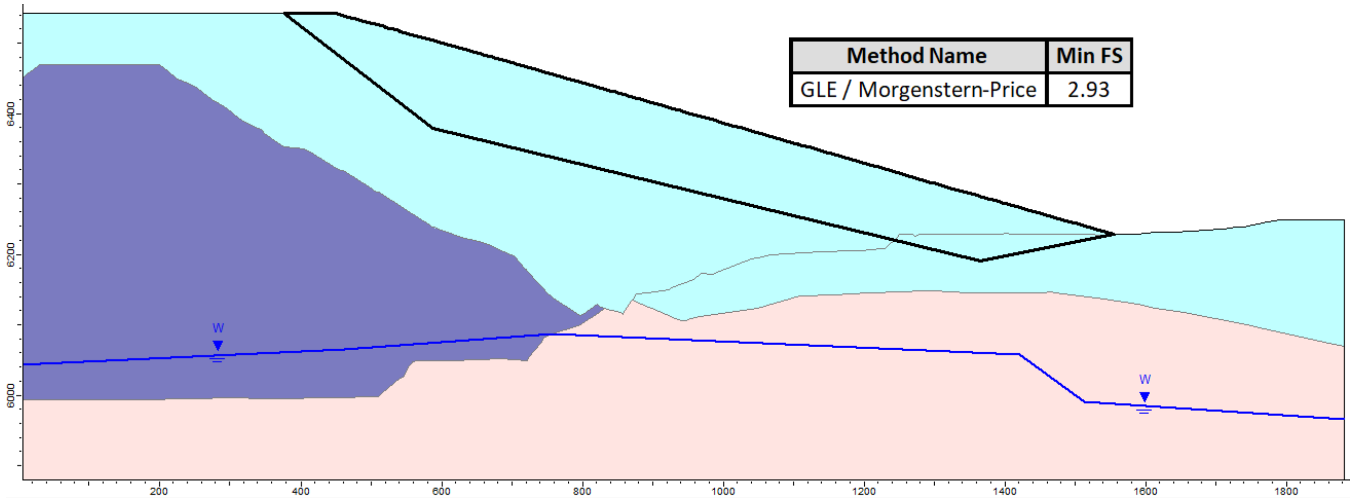
					Factor of Safety			
Emma Stockpile Waste Dump (Year 5)	Failure Type	Crest El. (ft)	Toe El. (ft)	Slope Height (ft)	Static	Seismic (k = 0.94g)	Liquefied Alluvium	Liquefied Alluvium with worst-case water table
6HW	Circular	6540	6230	310	2.86	2.11	-	-
	Block				2.93	2.15	-	-
EM1	Circular	6320	6045	275	3.47	2.41	-	-
	Block				3.27	2.55	-	-
EM2	Circular	6305	6055	250	3.10	2.27	3.10	1.87
	Block				3.05	2.22	3.05	2.88

GOLDER

SLIDEINTERPRET 8.014

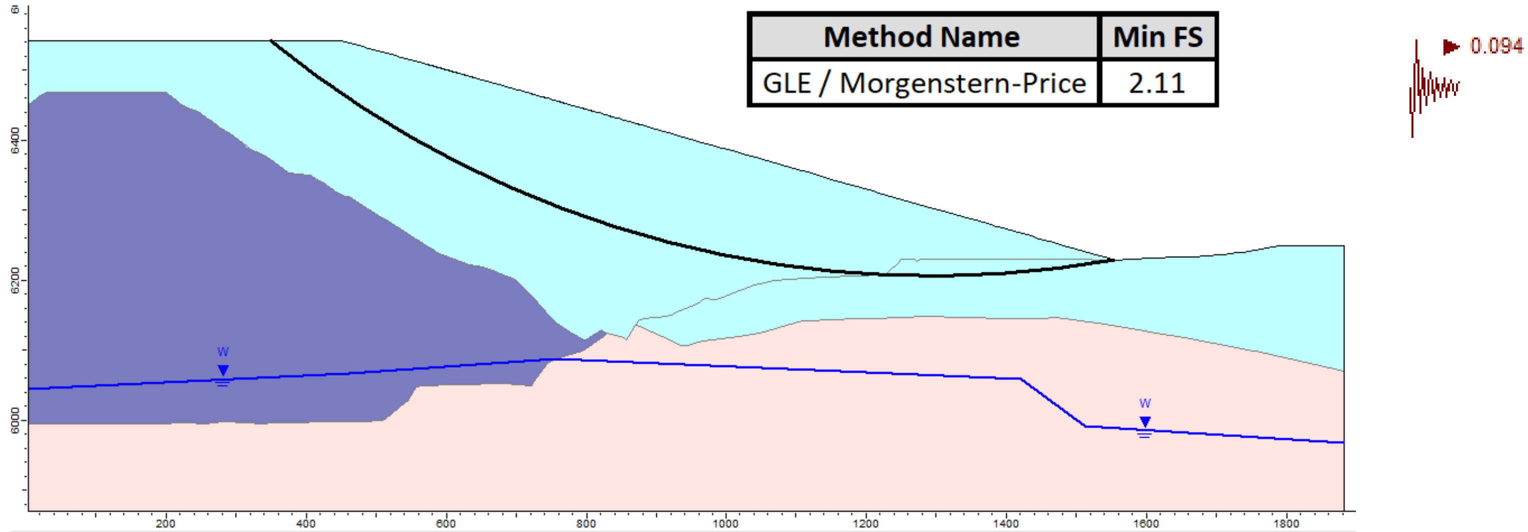
Project	FMI – Tyrone: Emma Stockpiles
Analysis Description	MATERIAL PROPERTIES AND RESULTS
Figure	1
Company	FMI - Tyrone
Date	11-8-2021
File Name	

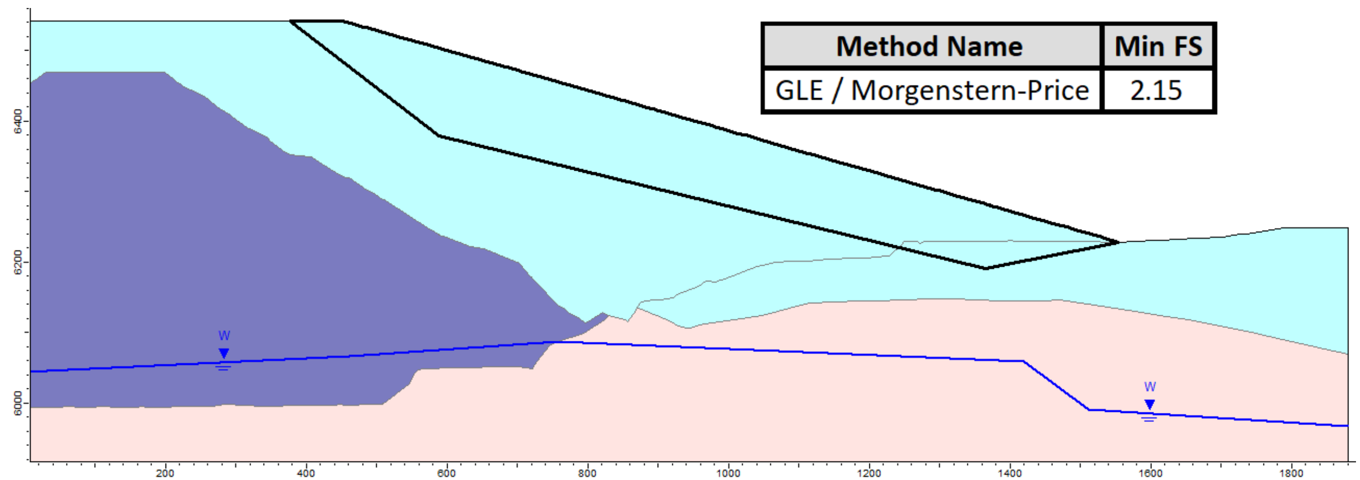




SECTION: *6HW*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, STATIC*

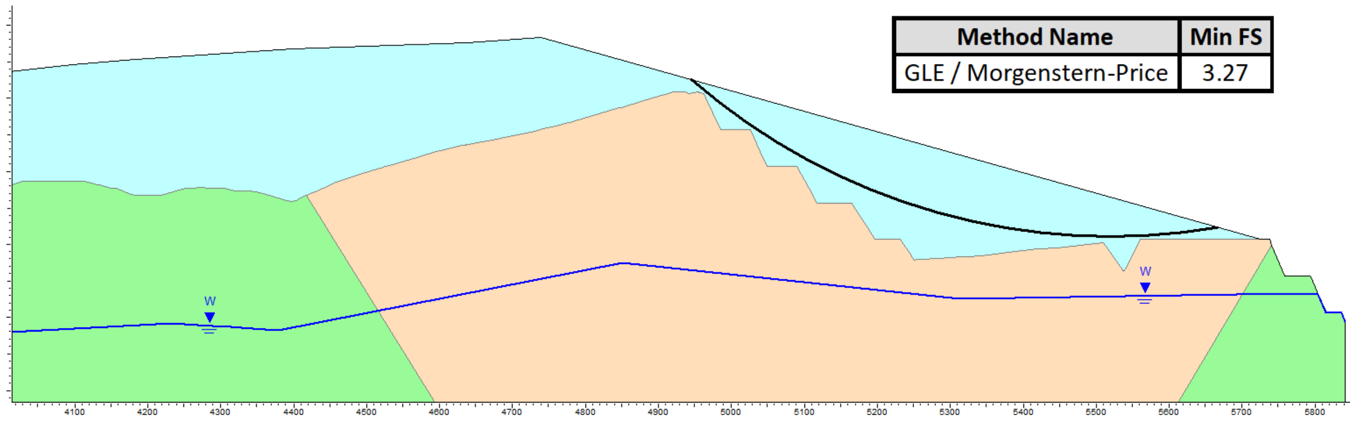
GOLDER	*Project* FMI – Tyrone: Emma Stockpiles		
	Analysis Description SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)		
	Figure 2		*Company* FMI - Tyrone
SLIDEINTERPRET 8.014	*Date* 11-8-2021		*File Name*

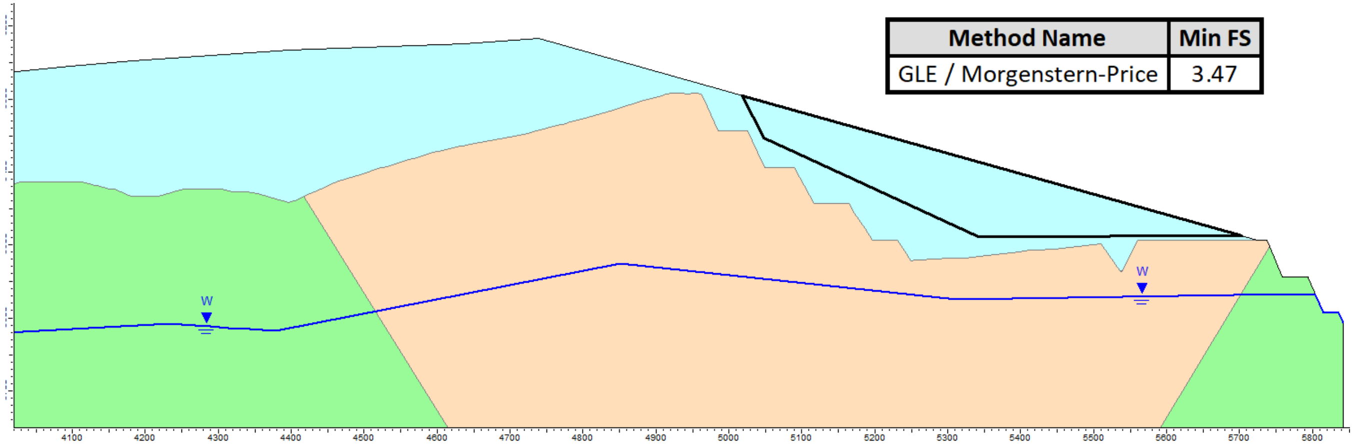




SECTION: *6HW*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, SEISMIC*

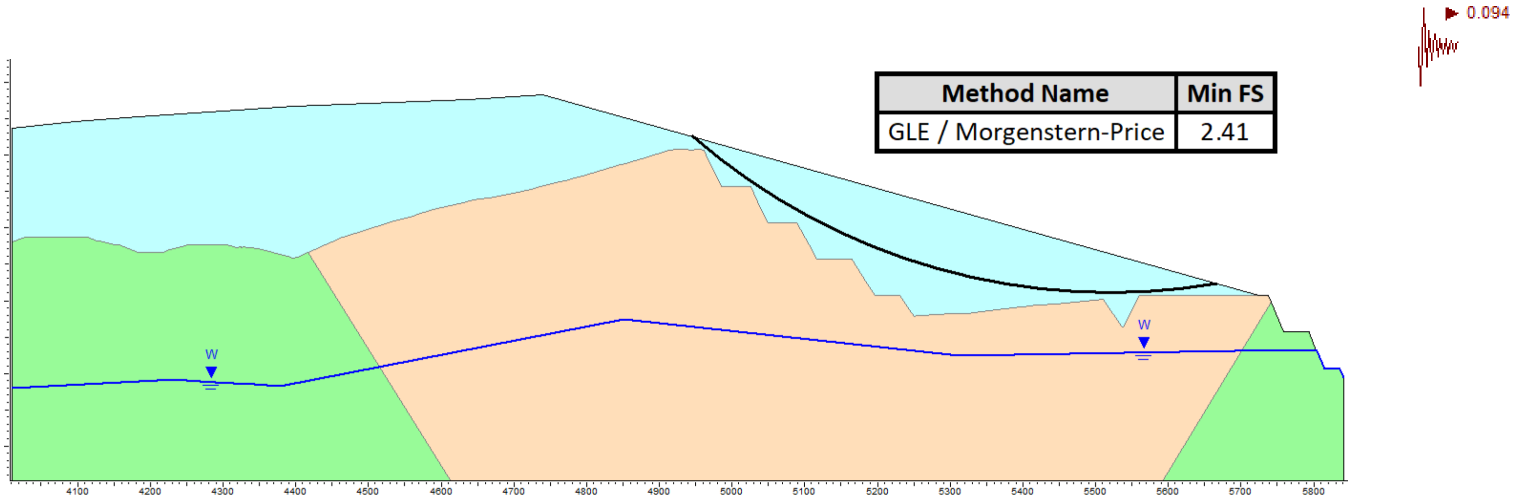
GOLDER	*Project* FMI – Tyrone: Emma Stockpiles	
	Analysis Description SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)	
	Figure 3	*Company* FMI - Tyrone
SLIDEINTERPRET 8.014	*Date* 11-8-2021	*File Name*



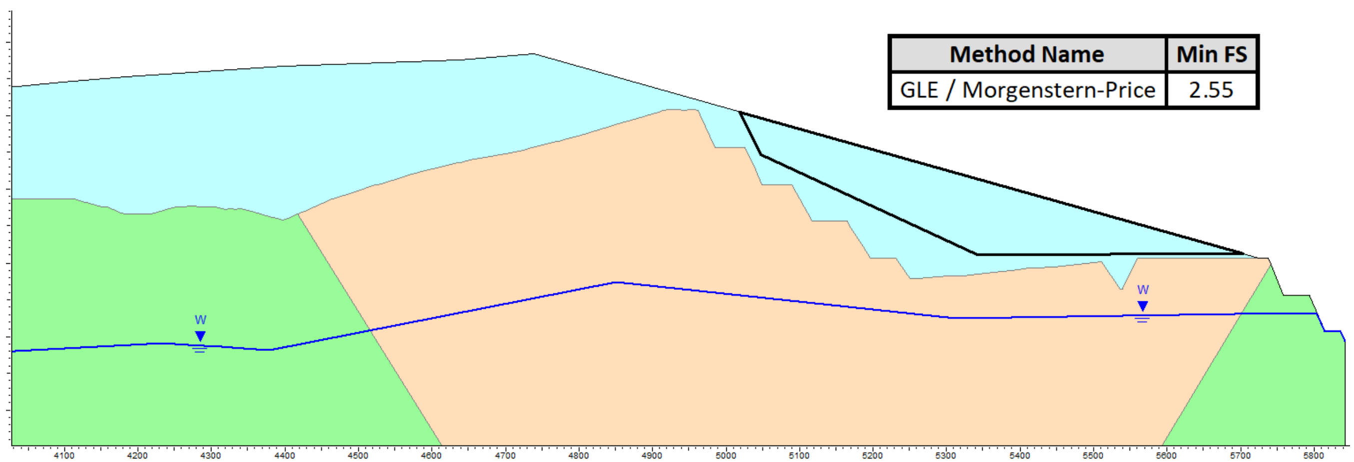


SECTION: *EM1*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, STATIC*

GOLDER			
	Project: FMI – Tyrone: Emma Stockpiles		
	Analysis Description: SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)		
	Figure: 4		Company: FMI - Tyrone
SLIDEINTERPRET 8.014	Date: 11-8-2021		File Name:



Method Name	Min FS
GLE / Morgenstern-Price	2.41



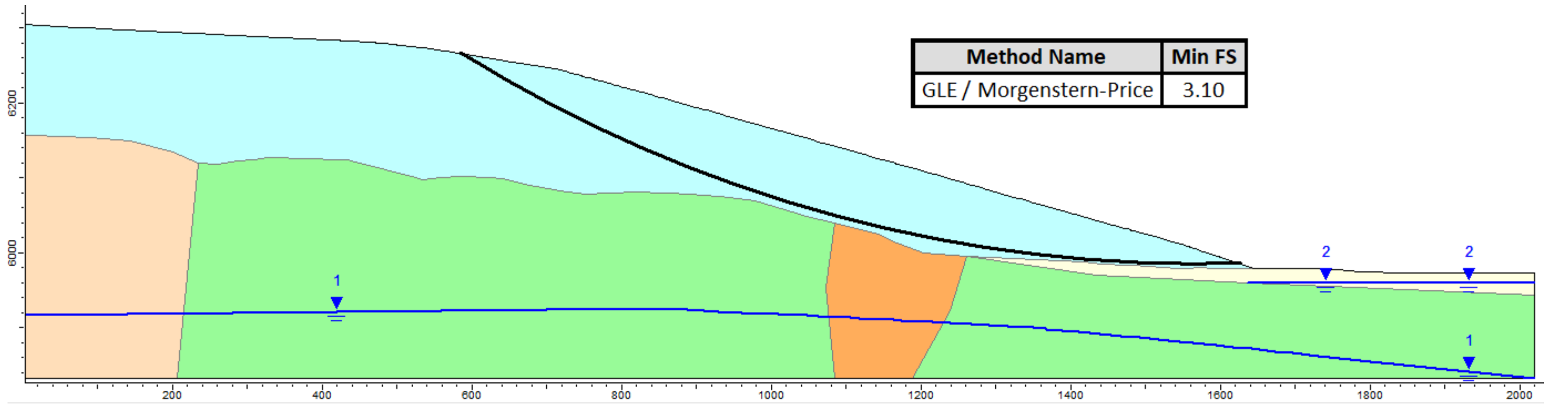
Method Name	Min FS
GLE / Morgenstern-Price	2.55

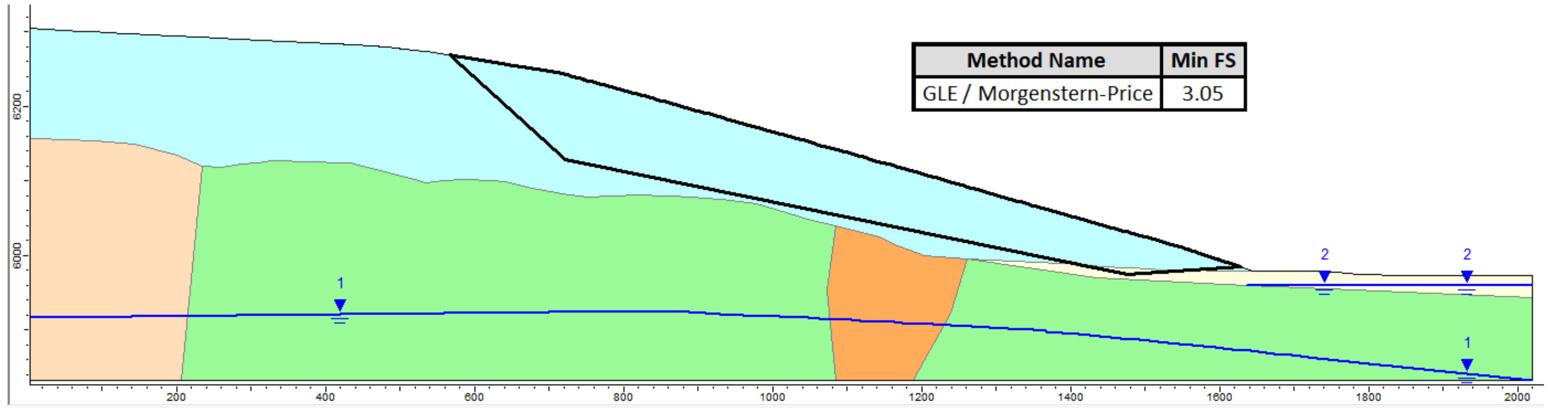
SECTION: *EM1*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, SEISMIC*

GOLDER

Project	FMI – Tyrone: Emma Stockpiles		
Analysis Description	SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)		
Figure	5	*Company*	FMI - Tyrone
Date	11-8-2021	*File Name*	

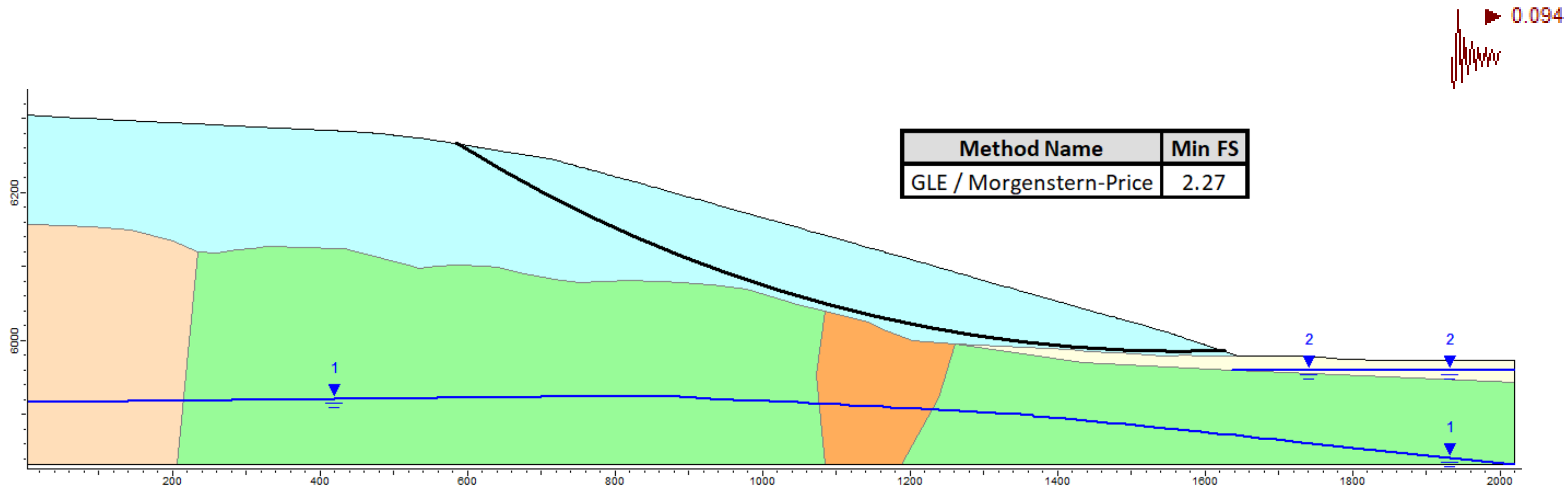
SLIDEINTERPRET 8.014



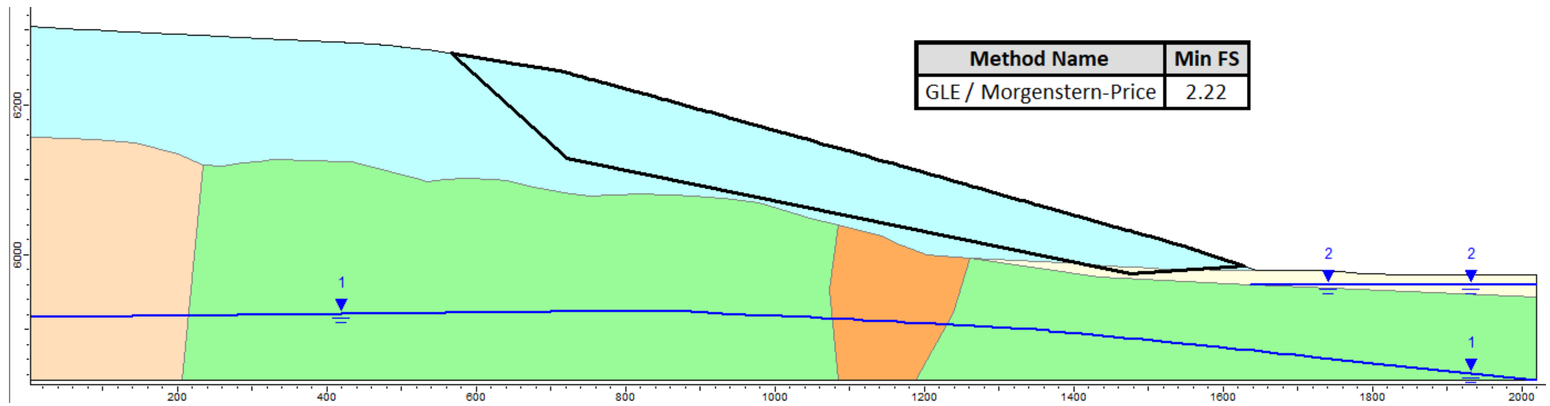


SECTION: *EM2*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, STATIC*

GOLDER	Project: FMI – Tyrone: Emma Stockpiles		
	Analysis Description: SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)		
	Figure: 6		Company: FMI - Tyrone
SLIDEINTERPRET 8.014	Date: 11-8-2021		File Name



Method Name	Min FS
GLE / Morgenstern-Price	2.27



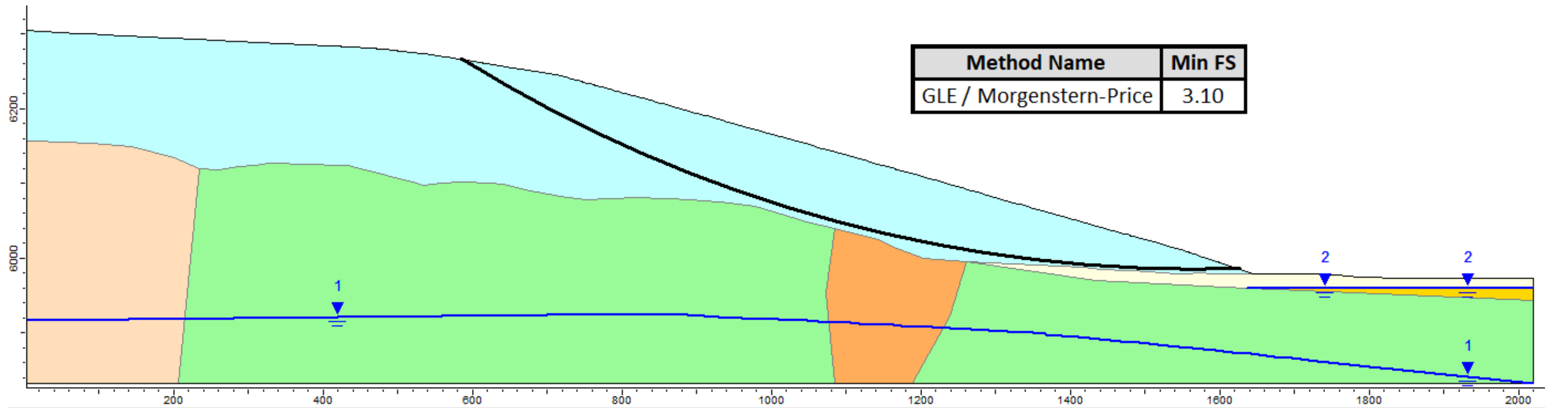
Method Name	Min FS
GLE / Morgenstern-Price	2.22

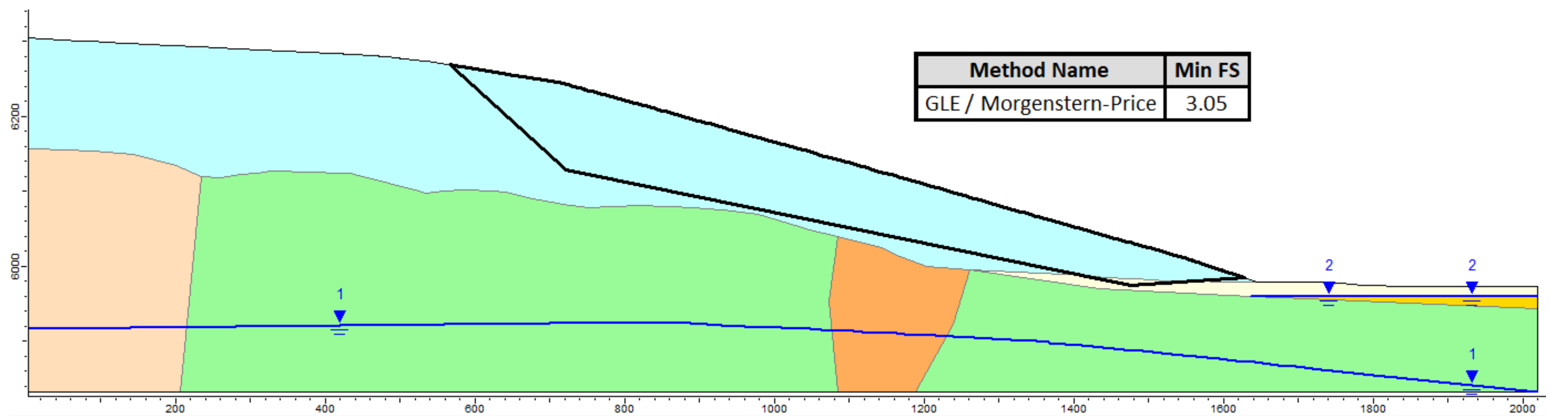
SECTION: *EM2*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, SEISMIC*

GOLDER

Project FMI – Tyrone: Emma Stockpiles			
Analysis Description SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)			
Figure 7		*Company* FMI - Tyrone	
Date 11-8-2021		*File Name*	

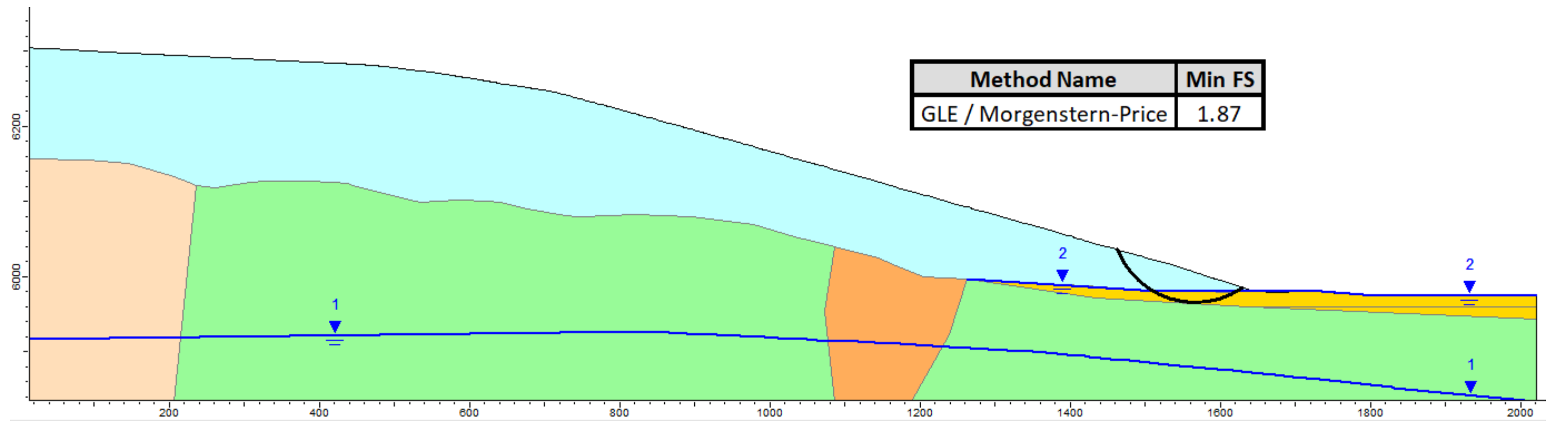
SLIDEINTERPRET 8.014

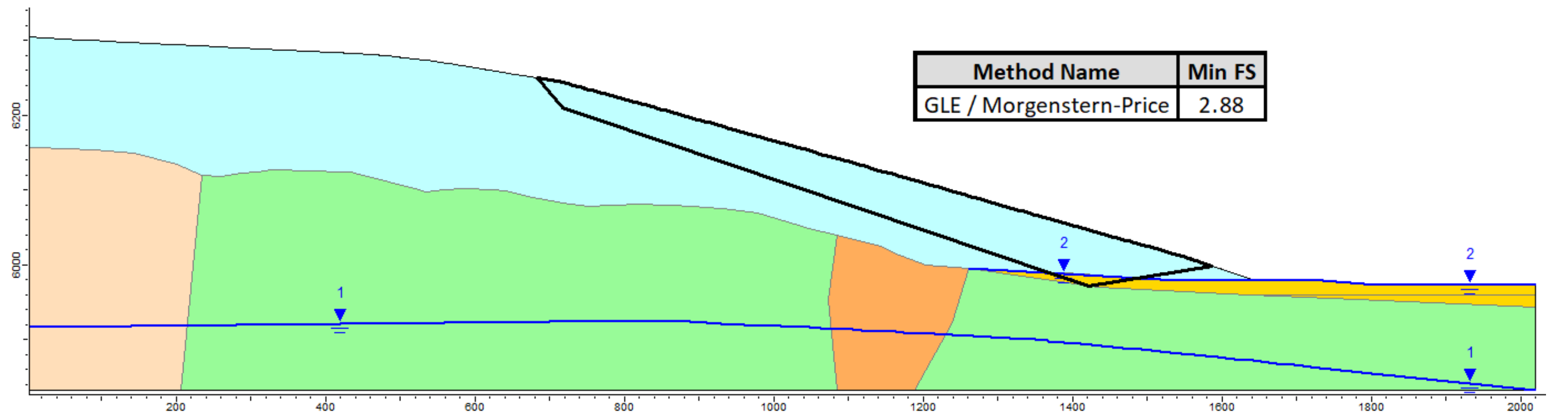




SECTION: *EM2*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *MODELLED WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, LIQUEFIED ALLUVIUM*

GOLDER	*Project* FMI – Tyrone: Emma Stockpiles	
	Analysis Description SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)	
	Figure 8	*Company* FMI - Tyrone
SLIDEINTERPRET 8.014	*Date* 11-8-2021	*File Name*





SECTION: *EM2*
MINE YEAR: *EOY 5*
WATER CONDITIONS: *WORST-CASE SEASONAL WATER TABLE*
FAILURE /CONDITONS: *CIRCULAR AND BLOCK-TYPE, LIQUEFIED ALLUVIUM*

GOLDER	Project: FMI – Tyrone: Emma Stockpiles	
	Analysis Description: SLIDE 2D LIMIT EQUILIBRIUM – (GLE/Morgenstern-Price)	
	Figure: 9	Company: FMI - Tyrone
SLIDEINTERPRET 8.014	Date: 11-8-2021	File Name:

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