Earthwork Cost Estimate Summary Report

Tyrone Mine Closure/Closeout Plan

Prepared for

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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 and accompanying appendices describe the base assumptions and approach used to determine the FA earthwork reclamation cost estimate (RCE) for Freeport-McMoRan Tyrone Inc. (Tyrone). Operations and maintenance (O&M) costs are also included in this RCE.

Telesto Solutions Inc. (Telesto) presents this earthwork RCE for Tyrone as part of an update to the Tyrone Mine Closure Closeout Plan (CCP) previously provided in 2013 (Golder Associates, 2013) and updated per Agency comments in 2015 (Golder Associates, 2015). This current earthwork RCE work is updated from the 2013 earthwork RCE (Telesto Solutions, Inc., 2013) and was completed in coordination with Golder, who provided overall project management and technical review, and MWH America Inc. (MWH), now part of Stantec, who prepared the reclamation designs and the earthwork quantity take-offs.

This current submittal incorporates 2019 unit costs and labor rates, along with 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).

1.1 Reclamation Overview

This earthwork RCE update is based on the configuration of facilities as described in the end-of-year (EOY) 2014 mine plan, and assumes design for reclamation would take place

during the first two years (2015-2016) with reclamation starting the following year (2017). A recent evaluation of the 2014 and 2022 mining sequence determined that 2014 is still the highest liability year based on total acreages and proportions (and relative reclamation cost) of sloped, flat, and regraded sloped areas to be reclaimed (Figure 1). The 2022 mine plan evaluation included the following facilities: Gettysburg Waste Stockpile (permitted and no FA required), Valencia In-Pit Stockpile (permitted and no FA required), and Mill Site Stockpile (currently not permitted). These facilities are not included in the earthwork RCE update because the 2022 mine plan analysis included these areas and it was shown that Year 2014 used as the basis of this estimate will yield a higher cost than Year 2022 and other years when all or portions of these stockpiles exist.

A summary of the mine facilities, including waiver and reclamation status, is provided in Table 1. This earthwork RCE includes facilities not reclaimed as of EOY 2014, along with some additional O&M costs for previously reclaimed borrow areas. A description of completed reclamation projects and projects where reclamation was projected to be complete by EOY 2014 can be found in CCP Section 3.0.

1.2 Report Layout

This earthwork RCE report consists of the following sections:

- **Section 1.0** provides an introduction and overview of the RCE prepared for Chino.
- **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.

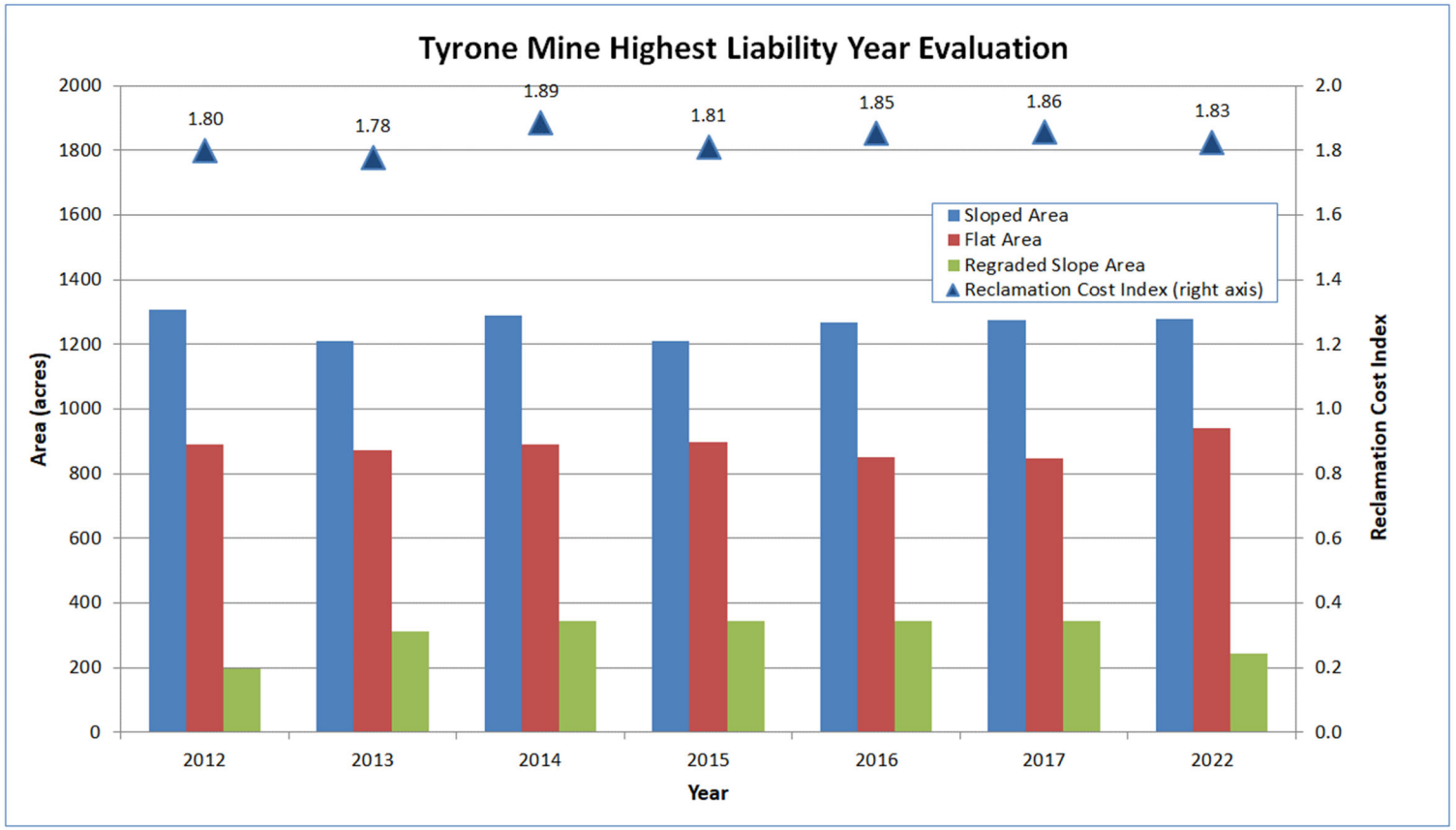
The following appendices provide supporting information, calculations, and results of the RCE:

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

Table 1 Reclamation Overview

Feature	Waiver	Notes
Tailings		
Tailing Thickeners, Precipitation Plant	-	Reclaim (no demolition) by hauling cover, grading, and revegetating
Tailing Dam 1 Reclaim Water Pumphouse	-	Reclaim with demolition, hauling cover, grading, and revegetating
Tailing Launder Line	-	Majority was demolished in 2005. Reclaim by remaining fills and culverts, regrading, cover placement, and demolishing steel trestle
Tailing Series 1 (1, 1A, 1X)	-	Reclamation complete; maintenance only
Tailing 2	-	Reclamation complete; maintenance only
Tailing 3x	-	Reclamation complete; maintenance only
Tailing 3	-	Reclamation complete; maintenance only
Burro Mountain	-	Reclamation complete; maintenance only
Stockpiles		
1A and 1B	Reclamation waiver for outslopes within OPSDA	1A pullback and 1B buttressing
2A and 2B	Reclamation waiver for 2B outslopes within OPSDA	2A interior slope to be reclaimed; 2-ft cover will be imported from 9AX Stockpile along with 1 ft of Gila from Lube Shop Area
3A and 3B	Reclamation waiver for 3B outslopes within OPSDA	Pullback with truck/shovel; dozer grading

5A	-	-
4C	-	-
2C, 4A, 7B, 4B	Reclamation waiver for 2C, 4A outslopes within OPSDA	7B interior slope within OPSDA will be reclaimed
6B and 6C	Reclamation waiver for outslopes within OPSDA	-
9A, 9AX	-	Imported cover not required for 9A; 9AX to be covered with 1-ft of cover and used as reclamation cover borrow area for 2A (2 ft of cover)
Copper Mountain Stockpile	Reclamation waiver for outslopes within OPSDA	-
8C	-	Used for long-term sludge disposal area. Reclamation included in this estimate.
Lube Shop Area	-	Used as reclamation cover borrow area. Removal of borrow material will result in an expansion of the existing open pit that will be incorporated into a future waiver area annual review.
1C	-	Reclamation complete; maintenance only
7A	-	Reclamation complete; maintenance only
Stockpile 1	-	Reclamation complete; maintenance only
Mill area south of Mangas Wash	-	Reclamation complete; maintenance only
Copper Mountain Reclamation Area	-	Reclamation complete; maintenance only
Pits		
South Rim Pit	-	Backfilled prior to EOY 2014; Becomes part of 2C, 4A, 7B, 4B stockpile
Copper Mountain Pit	Pit reclamation waiver	Requires public safety measures (fencing & signage)
San Salvador Pit	-	To be partially backfilled prior to EOY 2014; cost to complete backfilling & reclamation included in estimate
Savanna Pit	Pit reclamation waiver	To be partially backfilled as part of mine plan by EOY 2014; costs included for reclamation of the backfilled interior flat area (Savanna In-pit Stockpile)
Main/Valencia In-Pit Stockpile	Pit reclamation waiver	Requires public safety measures (fencing & signage); Valencia In-Pit Stockpile not reclaimed as it is within OPSDA and MMD pit waiver
Gettysburg Waste Stockpile	Pit reclamation waiver	Requires public safety measures (fencing & signage); Gettysburg Waste Stockpile not reclaimed as it is within OPSDA and MMD pit waiver



Notes: (1) The Reclamation Cost Index accounts for the relative cost to reclaim sloped, flat, and regraded slope areas along with the acreage of each type of area that exists each year. The relative costs to relaim each type of area are represented by the following relative cost indexes: sloped (1.0), flat (0.4), and regraded slope (0.7).
(2) The Mill Site Stockpile (exists only in 2022) is to be removed at closure.
(3) 2022 includes the full-build out of the Valencia In-Pit Stockpile, Gettysburg Waste Stockpile, and Mill Site Stockpile.

Figure 1 Highest Liability Year Evaluation

2.0 DATA AND ASSUMPTIONS

The reclamation design used as the basis for the earthwork RCE is presented in CCP Appendix A which is part of the overall Tyrone CCP update submittal. 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 B. The sub-appendices in Appendix B are organized as follows:

- **Appendix B.1** tabulates the 2019 labor rates from the New Mexico Department of Labor (NMDOL).
- **Appendix B.2** contains copies of the EquipmentWatch (Penton Media, 2019) sheets from which equipment unit rates were obtained.
- **Appendix B.3** provides the curve fits used in the production sheets for dozers and haul trucks.
- **Appendix B.4** provides copies of the pertinent information from RSMeans (R.S. Means, 2019) and pages from several editions of the Caterpillar Performance Handbook (CPH).
- **Appendix B.5** provides direct quotes used in the cost estimates.
- **Appendix B.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 hydraulic shovels with dozer assist, water truck, and motor grader perform cover loading and distribution. The economic optimum number of trucks per 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 Gila borrow areas and the 9AX Stockpile which is an expansion of the 9A Stockpile footprint. Although the 9A Stockpile is considered a borrow source, it was not used for reclamation in this cost estimate. Tailing repositories borrow areas are reclaimed in addition to the following: 1) the 5A Stockpile and 9AX Stockpile borrow areas will be reclaimed as part of the stockpile reclamation, and 2) removal of Gila borrow material from the Lube Shop area will result in an expansion to the existing open pit that will be incorporated into a future waiver area annual review.
- **Truck and Shovel Operations**: All truck and shovel operations (pullback and backfill 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 are developed based on the NMDOL Type H (Heavy Engineering) labor rates effective January 1, 2019 (NMDOL, 2019). These rates include the base, fringe benefit, and apprenticeship contribution rates (Table 3).
- **Equipment Rates:** Table 3 summarizes the rates for earth-moving equipment, commonly available to a contractor, which are used in the estimate. The equipment unit operating costs are taken from EquipmentWatch (Penton Media, 2019) Custom Cost Evaluator. The equipment costs for the heavy construction equipment to be utilized to complete the CCP earthwork can be found in Appendix B.2.
- **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:** Scarifying the final surface takes place at the same time as revegetation.
- **Equipment Production Factors:** Table 2 summarizes equipment production factors from the CPH Editions 29, 35, 41, 44, 47, and 48 (Caterpillar, Inc., 1998; Caterpillar, Inc., 2004; Caterpillar, Inc., 2011; Caterpillar, Inc., 2014; Caterpillar, Inc., 2017; Caterpillar, Inc., 2018), and EquipmentWatch (Penton Media, 2019). Productivity curves are also developed from the Caterpillar references as described in Appendix B.3.

- **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 B.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 E 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 E).
- **Reclamation Timeframe**: This earthwork cost estimate assumes that reclamation occurs relatively evenly (in terms of dollars spent) over a 12-year period. Revegetation monitoring, operations, and maintenance 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 or 2118).

2.3 Direct Quotes

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

- **Articulated Concrete Blocks (ACBs):** The ACB unit cost is based on a quote for materials and installation obtained in September 2018 from the Armortec Area Manager (West) for Contech Engineered Solutions, the

manufacturer and distributor of ACBs currently used at Freeport-McMoRan mines in New Mexico.

- **Revegetation Materials:** Costs for seed and hay mulch used for reclamation are taken from a quote provided by Rocky Mountain Reclamation in April 2018.
- **Well Abandonment:** The well abandonment unit costs are based on a quote from Layne Christensen Company obtained in July 2018 (Appendix B.5).
- **Well Replacement:** Well replacement cost are from Wilcox Professional Services with an estimated cost for a 5.5-inch bore (Appendix B.5).

2.4 Changes from Previously Submitted CCP Update

The specific sources for input data and assumptions used to prepare the RCE are identified in the spreadsheet notes, some of which have been updated from the previously submitted CCP. These changes include the following:

- The 9AX Stockpile was permitted and approved for construction at Tyrone after the previous CCP submittal (Golder Associates, 2013) and (Golder Associates, 2015) and is included at full buildout in the cost estimate and engineering drawings.
- The following facilities were permitted and approved for construction at Tyrone after the previous CCP submittal (Golder Associates, 2013) and (Golder Associates, 2015). These facilities are not included in the earthwork RCE update because the 2022 mine plan analysis included these areas and it was shown that Year 2014 used as the basis of this estimate will yield a higher cost than Year 2022 and other years when all or portions of these stockpiles exist:
  - Gettysburg Waste Stockpile
  - Valencia In-Pit Stockpile
- The following facility is scheduled for construction in 2019. This facility is not included in the earthwork RCE update because the 2022 mine plan analysis included this area and the stockpile will be removed at closure.
  - Mill Site Stockpile
- The following facilities were originally assumed to be reclaimed by EOY 2014, but were not reclaimed and therefore are added to this earthwork RCE update:
  - Tailing Thickeners

    - Precipitation Plant
    - Tailing Dam 1 Reclaim Water Pumphouse (located near the Tailing Launder Line)
    - Tailing Launder Line
- Cover is placed on 2A Stockpile at a 2-ft thickness (from 9AX Stockpile) plus 1-ft thickness (Gila).
- Cover thickness is 1 ft on the new 9AX Stockpile.
- Bench channel sizes are revised to match bench channels designed for other Freeport New Mexico operations (e.g., Chino Mine). The bench channel design is also used where flow is conveyed in low-gradient channels between downdrains and downgradient areas. Bench channels are conservatively designed for erosion protection with riprap over filter.
- ACBs are used for downdrains instead of riprap, based on specifications for use at other Freeport New Mexico operations including the Chino Mine.
- An additional volume of 20% is included for demolition of those buildings containing large equipment.
- Wastes requiring special handling is included in building demolition.
- Updated quantities for channels and downdrains are used (Appendix C).
- Updated revegetation unit cost is used, based on R.S. Means (R.S. Means, 2019) and EquipmentWatch (Penton Media, 2019).
- O&M costs are added for previously reclaimed areas based on the proposed actions presented in the borrow site investigation completed on Tyrone borrow areas.
- Updated labor rates reflect 2019 values.
- Updated EquipmentWatch equipment costs reflect 2019 values.
- Updated fuel cost is used based on discussions with the FA Work Group in the fall of 2018 as agreed in January 2019 (see Appendix B.6); historical local quotes are correlated with public data to estimate the fuel cost.
- Equipment production factors are revised to be consistent with CPH Editions 29, 35, 41, 44, 47, and 48 (Caterpillar, Inc., 1998; Caterpillar, Inc., 2004; Caterpillar, Inc., 2011; Caterpillar, Inc., 2014; Caterpillar, Inc., 2017; Caterpillar, Inc., 2018), and EquipmentWatch (Penton Media, 2019).
- Indirect costs are 30% of capital costs and 17.5% of O&M costs per the 2019 agreement between NMED, MMD, and GRIP on indirect costs (see Appendix E).

Table 2 Earthwork Equipment Production Factors

Parameter	Value	Comment/Reference
Swell Factor[(1)]	0% for native rock 15% for Tailing Launder Line 8% for cover load & haul sites	Regraded material has no swell factor. Highly compacted material will swell with excavation and regrading. 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 – Tops	1.0	(CPH 48: 19-55) 1 to 5% Slope
Grade Factor - Outslopes[(1)]	1.6	(CPH 48: 19-55) 3H:1V Slopes
Material Weight (lb/cy)	3,300 2,900	Stockpiles Tailing, 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 – Tops	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)	2,900	Fine grading cover material and tailing
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

Parameter	Value	Comment/Reference
Elevation	1.0	(CPH 48: 30-7)
Direct Drive Transmission	1.0	-
Ripper (D11T CD Multi-shank [w/MSR-359H])		
Ripping Length (ft)	1,000 large surface areas 100 liners	-
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)		
Struck 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) $\geq$ 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)		
Struck 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) $\geq$ 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)		
Struck 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) $\geq$ 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

Parameter	Value	Comment/Reference
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 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
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

Parameter	Value	Comment/Reference
		revegetation equipment/implements
Work Hour (min/hr)	50	Assigned for consistency with other earthwork operations

CPH = Caterpillar Performance Handbook Editions 29, 35, 41, 44, 47, and 48 (Caterpillar, Inc., 1998; Caterpillar, Inc., 2004; Caterpillar, Inc., 2011; Caterpillar, Inc., 2014; Caterpillar, Inc., 2017; Caterpillar, Inc., 2018)

(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	$69.62	$254.44	Equipment Operator IV	$27.41	$351.47
Cat D9T, SU Blade	Dozer	$33.58	$198.37	Equipment Operator IV	$27.41	$259.36
Cat D6T, SU Blade	Dozer	$16.89	$63.65	Equipment Operator IV	$27.41	$107.96
Cat D6T XL, SU Blade	Dozer	$18.25	$65.52	Equipment Operator IV	$27.41	$111.18
Cat 319D L	Excavator	$12.29	$52.38	Equipment Operator VI	$27.70	$92.37
Cat 992K	Loader	$59.97	$216.23	Equipment Operator VI	$27.70	$303.90
Cat 988H	Loader	$35.57	$128.76	Equipment Operator VI	$27.70	$192.03
Cat 980H	Loader	$25.27	$77.56	Equipment Operator VI	$27.70	$130.53
Cat 966H	Loader	$19.61	$73.11	Equipment Operator VI	$27.70	$120.42
Cat 16M	Motor Grader	$22.23	$93.51	Equipment Operator IV	$27.41	$143.15
Cat 14M	Motor Grader	$19.40	$86.71	Equipment Operator IV	$27.41	$133.52
Finn B260	Mulcher	$9.66	$15.92	Truck Driver III	$24.27	$49.85
Cat D11T CD Multi-shank (w/MSR-359H)	Dozer w/Ripper	$69.62	$259.35	Equipment Operator IV	$27.41	$356.37
Ripper (MSR-189H)	Ripper	--	$6.77	--	--	$6.77
Hitachi EX3600-5	Shovel	$193.56	$507.98	Equipment Operator VI	$27.70	$729.25
Deere 7430	Tractor	$13.99	$38.00	Truck Driver III	$24.27	$76.27
Cat 769D	Truck	$22.79	$108.01	Truck Driver III	$24.27	$155.07
Cat 725	Truck	$14.09	$73.11	Truck Driver III	$24.27	$111.47
Komatsu 730E	Truck	$78.34	$221.79	Truck Driver III	$24.27	$324.40
Off-Hwy Water Truck,6,000-gal.	Water Truck	$26.33	$67.69	Truck Driver III	$24.27	$118.28
1 Deck Screening Plant (5X16, 48X60)	Screening Plant	$11.35	$40.59	Laborer I	$23.09	$75.02
3 Deck Screening Plant (5X16, 42X60)	Screening Plant	$11.35	$41.16	Laborer I	$23.09	$75.60

Table 4 Miscellaneous Unit Costs

Activity	Base Per Unit Cost	Fuel Per Unit Cost	Units	Source	Reference
Fuel	$2.34	-	gal	N/A	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 $2.34/gal
Revegetation	$820.12	$3.85	ac	N/A	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
Bench Grading Stockpile	$1.35	$0.33	ft	N/A	See unit rates calculations
Bench Grading Tailings Pond	$1.35	$0.33	ft	N/A	See unit rates calculations
Downdrain Construction	$374.38	-	ft	N/A	See unit rates calculations
Downdrain Dissipater	$14,556.48	-	ea	N/A	See unit rates calculations
Channel Construction w/ Riprap	$4.13	$0.87	ft	N/A	See unit rates calculations
Channel Construction w/o Riprap	$0.41	$0.10	ft	N/A	See unit rates calculations
Structure Demolition	$0.25	-	cf	Means Line Item 024116.13 0100	Building demolition, large urban projects, mixture of types, excludes foundation demolition, dump fees
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
Storage Tank Demolition (5,000-10,000 gallons)	$1,005.97	-	ea	Means Line Item 130505.75 0530	Selective Demolition - Storage Tanks, steel tank, single wall, above ground, not incl foundations, pumps, piping, 5,000-10,000 gallon
Storage Tank Demolition (15,000-30,000 gallons)	$2,168.93	-	ea	Means Line Item 130505.75-0540	Steel tank, single wall, above ground, 15,000-30,000 gallon, selective demolition, excluding foundation, pumps or piping
Storage Tank Demolition (45,500 gallons)	$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
Power Line Demolition	$0.63	-	ft	Means Line Item 260505.10 0370	Electrical Demolition - Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead powerlines
Power Pole Demolition	$216.24	-	ea	Means Line Item 024113.80 0200	Selective Demolition - wood utility poles 35-45 ft high
Well Plug & Abandon	$10.55	-	ft	N/A	Layne Christensen Co., 7/31/18 Tyrone estimate is $10,000 mob/demob plus $5,704.94 (escalated 2% to $5819.04) for 1500 ft well
Well Replacement	$67.76	-	ft	N/A	Wilcox Professional Services, 8/2011 cost for 5.5-in bore, $173,500 for 3000 ft total ($57.83/ft). Escalated 2% 2011-2019= $67.76/ft
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
Disc Harrow Attachment, for Tractor	$616.33	-	month	Means Line Item 015433.20 1500	Equipment rental cost
Cast-In-Place Concrete	$254.97	-	cy	Means Line Item 033053.40 6200	Structural concrete, in place, gravity retaining wall (3000 psi), includes forms and reinforcement
Cleanup & Disposal of Wastes Requiring Special Handling	$335.20	-	ton	Means Line Item 028120.10 1120/1130	Solid pickup (drums); average of minimum and maximum
Transport of Wastes Requiring Special Handling	$4.78	-	mile	Means Line Item 028120.10 1260/1270	Transportation to disposal site (Truckload = 80 drums or 25 cy or 18 tons); average of minimum and maximum
Erosion Control	$2,923.36	$382.26	day	Modified Means 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)
Road Maintenance	$4,945.96	$1,240.32	month	N/A	Road maintenance for O&M - includes one 14M motor grader and one 6,000-gal water truck
Tailing Cover Maintenance	$1,851.84	$213.22	day	Modified Means Crew B-13A	Tailing cover maintenance for O&M - includes 1 foreman, 2 laborers, 1 loader (4 cy), 1 dump truck (12 ton)
Groundwater Monitoring	$2,282.94	-	day	N/A	Groundwater monitoring for O&M - includes 1 foreman, 1 laborers, rental equipment, misc. field equipment, and aqueous chemistry
Berming	$0.06	-	ft	N/A	Assumed height of 1’ with top width 2’ (2 X berm height); slopes of 1.5H:1V; volume 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 outslope. See unit rates calculations
Fencing	$23.05	-	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	$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
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
Fire Hydrant Demolition	$396.73	-	ea	Means Line Item 024113.33 0900	Utility removal, hydrants, fire, remove only, excludes hauling
Seepage Collection Replacement	$133,355.94	-	ea	N/A	See unit rates calculations
Culvert Removal	$12.69	-	ft	Means Line Item 024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation
Grade Control Wall	$165.59	-	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
Steel Trestle Demolition	$30,689.10	-	ea	N/A	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide; see unit rates calculations
Sludge Removal from Tanks (for Estimation of Sludge Removal from Pipelines)	$306.69	-	ea	Means Line Item 026510.30 0320	Removal of underground storage tanks, petroleum storage tanks, non-leaking, remove sludge, water and remaining product from tank bottom of tank with vacuum truck, 9,000 - 12,000 gallon tank. See unit rates calculations for ranges of pipe sizes
Substation Demo	$12,470.55	-	ea	N/A	See unit rates calculations

Means data are obtained from RS Means online (2019) with location adjustment for Las Cruces.

3.0 CALCULATIONS

This section describes the elements included in estimating the earthwork reclamation costs for the Tyrone Mine, utilizing the data and assumptions discussed in Section 2.0. Key equations and calculations used for the cost estimate calculations are presented in Appendix D, along with the spreadsheet within which the calculations are performed and documented. 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.

Appendix B provides the supporting documentation utilized to develop the earthwork 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 2 summarizes the costing steps used for one piece of equipment in developing the fleet.

The main reclamation activities for this earthwork RCE are discussed in this section for tailing dams, stockpiles, open pits, building demolition, and other miscellaneous costs. Key reclamation activities for facility types are shown in Table 5.

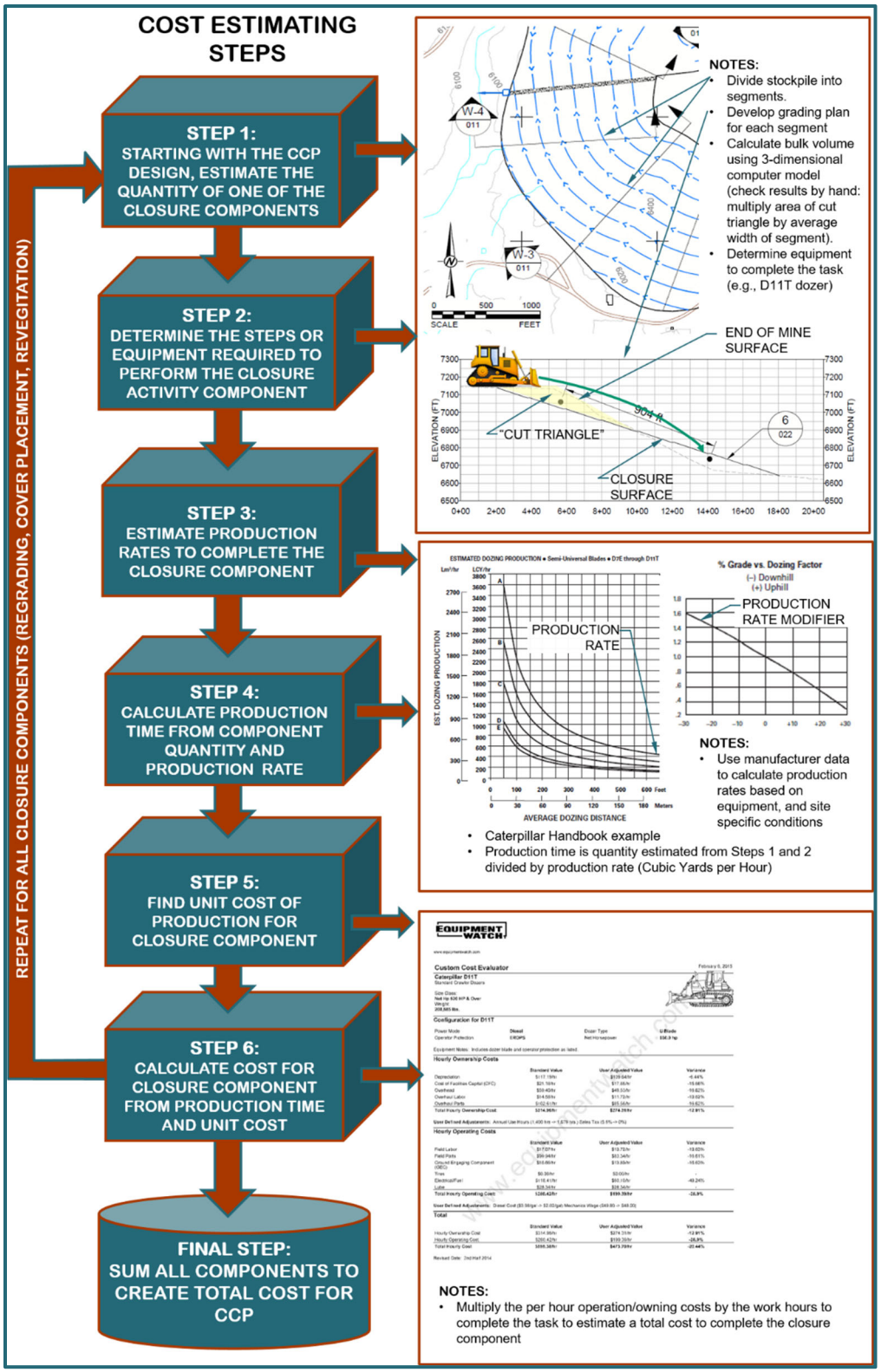


Figure 2 Earthwork Cost Estimating Process

Table 5 Reclamation Activity by Facility Type

Facility Type	Truck Shovel Operation	Regrade 3.5:1	Regrade 1%	Cover Placement [1]	Bench and Outslope Channels	Downdrains	Revegetation	Well Replacement [2]	Seepage Collection	Fencing/Berms	O&M
Impoundments			X	X			X				X
Stockpiles											
Top Surfaces											
Inside Waiver & OPSDA			X	X			X				X
Outside Waiver & OPSDA			X	X			X				X
Outslopes											
Inside Waiver & OPSDA		X [3]		X			X				X
Outside Waiver & OPSDA	X	X		X	X	X	X	X	X		X
Building Demolition			X	X			X				X
Open Pits											
Inside Waiver & OPSDA										X	X
Outside Waiver & OPSDA	X			X							X
Tailing Dams											X
Miscellaneous Areas			X	X			X	X	X		X

[1] Cover placement at 3-ft thickness except for 9A Stockpile (no cover) and 9AX (1 ft cover)
[2] Also includes Plug and Abandon Well activity
[3] For part of 2A/2B Stockpile and Savanna In-Pit Stockpile (see Drawing 3 of CCP Appendix A)

The primary design elements for this 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, 3H:1V interbench slopes, and 1% minimum top surface slope (low-gradient areas). Grading is done in a manner to ensure positive drainage.
- **Channels:** Bench and other channels are constructed with 5-foot base width and 3:1 (inner) and 2.5:1 (outer) side slopes, 5.0% maximum cross-bench slope, and 2.0% longitudinal bench slope; cover material is placed at 3-ft thickness; and filter material and riprap are placed for erosion control.
- **Downdrains:** Downdrains utilize ACBs for erosion protection.
- **Cover**: A cover thickness of 36 inches is used on the tops and outslopes, originating mainly from the Lube Shop Area. The 9AX borrow material

stockpile requires 1 ft of cover. The 2A Stockpile use cover material from 9AX (2 ft) and Gila (1 ft).

- **Truck and Shovel:** Trucks and loaders with dozer assist perform pullback of stockpile material at the 3A/3B stockpile and backfill of San Salvador Pit.
- **Cover Placement:** Trucks and loaders with dozer assist perform all cover loading and distribution. The economic optimum number of trucks per loader is used for each haul route.
- **Revegetation and Scarification:** Scarifying of the final surface is performed at the same time as the revegetation and is included in the revegetation cost.
- **Well Replacement and Abandonment:** Replace 3 monitoring wells (286-2008-04, 286-2008--05, 286-2008--06), and plug and abandon 2-inch, 4-inch, and 6-inch wells covered during reclamation. Plugging exploration holes are also included in the estimate and described in Section 3.5.1.
- **Seepage Collection System Replacement:** Replace collection systems covered by stockpile grading or other activities.
- **Haul Roads:** Place 36 inches of cover and revegetate the haul road crossing the top of the 1C stockpile area. The Lube Shop Area haul road is removed as part of borrow material excavation. All other haul roads are being covered by regrading.
- **Ripping of Liners:** Liners are ripped and buried in place.

3.1 Tailing Dams

Reclamation work has been completed for the 1, 1A, 1X, 2, 3, 3 X, and Burro Mountain tailing dams. However, portions of the 1, 1A, 2, 3, and 3X Dams range in cover thickness from 2 feet to more than 5 feet. It was assumed that tailing cover maintenance for all the dams was initiated following completion seeding of the 1, 1A, 1X and 2 tailing dams in 2009 and continues in each area for 12 years thereafter. Thus, assuming reclamation design will start in 2015, with reclamation commencing in 2017, 7 years of tailing cover maintenance are added to the O&M costs to address cover-specific maintenance on dams for areas that have areas with less than 3 feet of cover.

Tailing cover maintenance is assumed to take place over 7 years at 10 days/year during Years 0 and 1, and 10 days/year during Years 2 to 6. Erosion control, road maintenance, and vegetation maintenance costs are also included for all tailing dams as part of site-wide O&M as discussed in Section 3.6.

Facilities related to tailing operations are included in this cost estimate, as they have not yet been reclaimed. The Tailing Thickeners and Precipitation Plant are not demolished but are reclaimed by hauling cover, grading, and revegetating. The Tailing Dam 1 Reclaim Water Pumphouse (located near the Tailing Launder Line) is to be demolished along with the adjacent substation. The Tailing Launder Line is reclaimed by excavating the fills and culverts, and re-establishing pre-existing channels and regrading remaining fill to surrounding terrain. The steel trestle will also be demolished.

3.2 Stockpiles

The conceptual designs and associated earthwork cost estimate 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.

Stockpile surfaces targeted for reclamation under this plan include all top surfaces and outslopes of leach and waste stockpiles that are located outside the OPSDA and waiver. The 2A interior slope and the 7B interior slope are outside the waiver and are included in this cost estimate in accordance with the requirements of the 2012 conditional waiver from MMD. The top surfaces of leach stockpiles and waste rock piles within the OPSDA and waiver areas will be regraded to a minimum slope of 1%, covered, and seeded. Runoff from unreclaimed slopes (impacted water) within the OPSDA will be diverted by gravity around reclaimed surfaces to the bottom of a pit such that impacted water does not adversely affect any reclaimed areas.

Tyrone has applied for, and has received conditional approval of, a reclamation waiver for the following interior-facing stockpile outslopes, located within the OPSDA:

- 1A 1B Leach
- 2B Waste
- 2C 4A Leach
- 3B Waste
- 6B 6C Leach
- Copper Mountain Stockpile interior outslope
- 4C Leach
- 5A Waste
- Savanna In-Pit Stockpile (Savanna In-Pit Leach Stockpile)

The main activities that will occur in closing the stockpiles inside the OPSDA and waiver areas include:

- Regrading top surfaces and some of the outslopes (part of 2A/2B Stockpile and Savanna In-Pit Stockpile, see Drawing 3 of CCP Appendix A)
- Hauling and grading cover material for the top surfaces and some of the outslopes (part of 2A/2B Stockpile and Savanna In-Pit Stockpile, see Drawing 3 of CCP Appendix A)
- Scarification and revegetation of covered areas

The main activities that will occur in closing stockpiles outside the OPSDA and waiver areas include:

- Regrading top surfaces and outslopes
- Hauling and grading cover material
- Completing surface water channels to route storm water from the stockpile
- Scarification and revegetation of covered areas

The design elements for stockpile reclamation for this cost estimate include:

- Regrading
- Bench Channels
- Downdrains
- Cover
- Truck and Shovel
- Cover Placement
- Revegetation and Scarification
- Well Replacement and Abandonment
- Seepage Collection System Replacement
- Haul Roads

3.3 Open Pits

The Main, West Main, Valencia, Savanna, and Gettysburg pits are contiguous open pits. These pits have been granted a conditional waiver from the requirement of achieving a self-sustaining ecosystem (SSE), and will not be reclaimed other than installation of public safety measures. Where stockpiles have been placed inside a pit, such as at the Savanna Pit, then the estimated cost to reclaim that feature's level area is included in this estimate.

Two new in-pit stockpiles were constructed since the previous update (Telesto Solutions, Inc., 2013) – the Gettysburg Waste Stockpile and Valencia In-Pit Stockpile. These two facilities are not included in the earthwork RCE update because the 2022 mine plan analysis included these areas and it was shown that Year 2014 used as the basis of this estimate will yield a higher cost than Year 2022 and other years when all or portions of these stockpiles exist.

The main activities that will occur in closing the Main, Valencia, Savanna, Gettysburg, and Copper Mountain open pits include installation of fencing; a 6-foot high chain link fence will be installed around the perimeter of the high wall to satisfy public safety requirements. Vehicle gates are assumed at 1-mile intervals and warning signs posted every 500 feet for this estimate.

The San Salvador Pit is projected to be partially backfilled at the end of 2014 and costs for finishing the backfilling, and reclaiming the pit backfill surface, projected to exist at that time, are included in the estimate. Backfilling of the South Rim Pit is projected to be completed prior to 2014. The South Rim Pit will then become part of 2C, 4A, 7B, and 4B stockpile which, is included in the estimate. The Savanna Pit will be partially backfilled by 2014 as part of the mine plan. Costs to reclaim the Savanna In-pit Stockpile are included in the estimate.

The main activities that will occur in closing the Savanna In-pit Stockpile and the San Salvador Pit include:

- Regrading (including Backfill)
- Cover
- Truck and Shovel
- Cover Placement
- Revegetation and Scarification

3.4 Building Demolition

A number of facilities will be used for Industrial PMLU. Those facilities not designated for Industrial PMLU will be demolished, removed, and/or buried or otherwise closed in accordance with an approved plan. Demolition costs to take down buildings and other miscellaneous structures upon closure are included in the calculation spreadsheet (Appendix A). In addition to the data and assumptions presented in Section 2, the following parameters are used for this cost estimate:

- All equipment and above-grade structures are demolished and removed from the area or buried.
- Wastes requiring special handling are removed.
- Salvage value for all structures and equipment is assumed to be zero.

3.5 Other Miscellaneous Costs

This category includes miscellaneous estimated closure costs such as abandonment of exploration holes and wells, utility demolition, replacement of the 3A stockpile seepage collection systems covered by regrading, surface impoundments and small collection systems that will need to be replaced following stockpile regrading, unplanned disturbed areas, and pipeline demolition. A brief discussion also summarizes an evaluation of potential overlap between the Little Rock Mine CCP (earthwork RCE) and this Tyrone Mine earthwork RCE. Appendix B and Table 4 provide the support for the other miscellaneous unit cost estimates.

3.5.1 Exploration Holes and Wells

Costs are included for the abandonment of all monitoring and extraction wells. As of the EOY 2014, the following estimated number of exploration holes and wells are to be plugged and abandoned at closure:

- 124 exploration holes
- 162 wells that will be plugged and covered by grading
- 522 wells not covered by grading, including 94 extraction wells, 282 monitoring wells (3 monitoring wells per extraction well) abandoned at year 99, and 146 wells abandoned at year 20

See Appendix C for a list of the wells to be abandoned. Exploration hole plugging and well abandonment unit cost estimates are based on MMD guidance for abandoning wet drill holes.

Reclamation of the No. 3A Stockpile will cover several existing environmental monitoring and extraction wells located adjacent to the stockpile. Wells needed for continued monitoring of groundwater conditions or extraction and hydraulic containment of impacted groundwater will be placed outside of the reclaimed stockpile footprint. Specifically, extraction wells 286-2008-04 and 286-2008-05, which remove impacted groundwater originating from the Canyon 6 area, will be replaced. Monitoring well 286-2008-06 will also be replaced to allow for continued monitoring of potential perched seepage in Canyon 11 (Appendix C). Replaced wells will be abandoned at year 99.

3.5.2 Utility Demolition

Utilities serving buildings to be demolished are included in the estimate for utility demolition and include:

- Power Poles
- Powerlines
- Telephone Lines
- Light Poles
- Fire Hydrants

Powerlines to be demolished include existing powerlines not used for PMLU and the proposed 4160V powerline to the 1X1 pump station. Buried powerlines are assumed to be de-energized and left in place and are not included in the cost estimate.

3.5.3 No. 3A Stockpile Seepage Collection Systems

Regrading of the No. 3A Stockpile will require construction of new seepage collection facilities in Canyons 5, 6, 7, 8, 10, and 11, and breaching the existing HDPE-lined seepage collection trenches located within the future footprint of the stockpile. These costs have been included in the estimate for the 3A Stockpile.

3.5.4 Surface Impoundments and Small Collection Systems

Cost for surface impoundments and small collection systems covered as part of regrading operations will be buried in-place as part of regrading operations. Facilities to be covered include the following:

- Lube Shop Pond
- 5E Pond 1
- Niagara Stormwater
- No. 1A Stormwater Pond
- No. 2A (Seep 5E Pond Discharge)

The Seep 5E Collection system will be covered during regrading but is needed for PMLU. Therefore, replacement costs are included in the estimate for the Seep 5E Collection System.

Costs are included in the estimate to close surface impoundments used during post closure at year 99. Copper Mountain Pit Sump, Gettysburg Collection Pit, the Main Pit sump, and the Crusher Pond will stay in place after year 99 and are not included in the estimate. Surface impoundments and collection system takeoffs are included in Appendix C. The 2A West and 2A East PLS tanks will be used for process solution elimination and will be demolished six years after the start of closure. The 1A and 1B PLS Tanks are needed for post closure water treatment and will be demolished at year 99. Demolition costs for these tanks are included with building demolition calculations (Appendix A).

The main activities that will occur in closing surface impoundments include:

- Grading
- Ripping of Liners
- Cover
- Revegetation and Scarification

- Seepage Collection System Replacement

3.5.5 Unplanned Disturbed Areas

An additional cost is included 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 financial assurance amendments. Unplanned disturbed areas may include small staging areas, utility corridors, haul roads, pull-offs, stockpile expansions, or other miscellaneous unforeseen changes in the mine plan. The unplanned disturbed area reclamation cost was calculated based on the following reclamation activities:

- Regrading
- Cover
- Cover Placement
- Revegetation and Scarification

3.5.6 Pipelines

Pipelines covered by stockpile regrading will be buried in-place as part of regrading operations. Subsurface pipelines will be drained, capped, and left in place. Subsurface fresh water pipelines require no special measures and will remain in place. Pipeline demolition costs include the following parameters:

- PLS and raffinate pipelines located outside the stockpile regrade footprint will be used for process solution elimination and then demolished 6 years after the start of closure.
- Sewer pipelines are closed 6 years after closure.
- Pipelines used for post-closure water treatment are demolished at year 99.
- Little Rock Mine Pipeline alignment #1 and #2 extending from the Tyrone permit boundary to the lined 1X1 pond are closed 34 years after Little Rock Mine closure.

Pipeline takeoffs are included in Appendix C.

3.5.7 Borrow Area Reclamation

A borrow site investigation was completed on Tyrone borrow areas (371 acres) in 2019 for additional reclamation and O&M requirements. Erosion features were identified and a draft action/maintenance plan was proposed in an email sent on March 22, 2019. Based on the draft plan, for FA purposes Tyrone has included costs for outslope regrading (23.6 acres), revegetation (74.7 acres), and construction of channels (13,501 ft) and berms (3,142 ft). Tyrone has also proposed vegetation O&M on the 169.1 acres of borrow where Tyrone proposed action.

3.5.8 Little Rock Permit Boundary Overlap Area

Reclamation coverage in the 2014 Little Rock Mine CCP (earthwork RCE) was evaluated relative to the reclamation covered in this Tyrone Mine earthwork RCE. While there is a small amount of overlap in the two permit boundaries, there is no overlap or double-counting between the two earthwork RCEs.

3.6 Operations and Maintenance

Operations and maintenance estimated costs related to periodic erosion control, road maintenance, and vegetation maintenance are included in the spreadsheet calculations (Appendix A). Operations and maintenance costs are assumed to diminish with time and are allocated over time periods of years 0 to 6 (tailing cover maintenance), and 0 to 19, 20 to 39, and 40 to 99. O&M for this cost estimate includes the following:

Years 0-6:
Tailing cover maintenance: 10 days/year

Years 0-19:
Erosion Control: 10 days/year
Road Maintenance: Monthly during the monsoon season (4 months/yr)
Groundwater Monitoring: 20 days/year

Years 20-39:
Erosion Control: 8 days/year

Road Maintenance: Monthly during the monsoon season (4 months/yr)
Groundwater Monitoring: 10 days/year

Years 40-99:
Erosion Control: 5 days/year
Road Maintenance: Monthly during the monsoon season (4 months/yr)
Groundwater Monitoring: 5 days/year

Vegetation maintenance of reclaimed areas assumes a 2% failure every year for a total of 12 years, starting the year reclamation is completed. Vegetation maintenance accounts for the number of years that have already passed since reclamation was completed for items that have already been reclaimed; based on that timing, tailing cover maintenance for previously reclaimed areas will continue for 7 years after closure. For example, reclamation of the Burro Mountain tailing dam was completed in 2004 and vegetation maintenance will be completed in 2016. Thus, the last 2 years of vegetation maintenance are included in the estimate for the Burro Mountain tailing dam.

4.0 RESULTS

The total current dollar cost for earthwork reclamation is estimated to be $93,129,000 plus $8,875,000 O&M for a total of $102,004,000. A summary of the cost estimate is provided in Table 6. The costs presented in this RCE are current (2019) dollar costs.

Table 6 Earthwork Cost Estimate Summary

Item	Direct Cost	Indirect Cost	Total Estimated Cost
Facility		**30% of Direct**	
1A and 1B Leach	$3,599,081	$1,079,724	$4,678,805
1C	$109,734	$32,920	$142,654
2A Leach and 2B Waste	$10,134,497	$3,040,349	$13,174,846
3A / 3B	$23,204,860	$6,961,458	$30,166,318
3A Leach (Seep Collection)	$1,733,627	$520,088	$2,253,715
4C Leach	$3,733,295	$1,119,989	$4,853,284
5A Overburden	$5,786,669	$1,736,001	$7,522,670

Item	Direct Cost	Indirect Cost	Total Estimated Cost
6B	$681,333	$204,400	$885,733
6C	$914,011	$274,203	$1,188,214
2C, 4A, 4B, 7B Leach	$4,927,423	$1,478,227	$6,405,650
8C	$245,276	$73,583	$318,859
9A Overburden	$1,275,984	$382,795	$1,658,780
9AX	$484,385	$145,315	$629,700
Stockpile Subtotal	***$56,830,176***	***$17,049,053***	***$73,879,229***
San Salvador Pit	$4,639,545	$1,391,864	$6,031,409
Savanna In-Pit Leach Stockpile	$348,113	$104,434	$452,547
Main, Savanna, Gettysburg & Copper Mountain Pits	$1,343,904	$403,171	$1,747,075
Pits Subtotal	***$6,331,562***	***$1,899,469***	***$8,231,030***
Surface Impoundments	$143,729	$43,119	$186,848
Tailing Dam 1 Reclaim Water Pumphouse	$301,978	$90,593	$392,572
Tailing Launder Line	$220,766	$66,230	$286,996
Tailing Repositories Borrow Areas	$69,500	$20,850	$90,350
Unplanned Disturbance Area	$808,369	$242,511	$1,050,880
Other Disturbed Areas Subtotal	***$1,544,343***	***$463,303***	***$2,007,646***
Demolition	$5,040,149	$1,512,045	$6,552,194
Demolition Subtotal	***$5,040,149***	***$1,512,045***	***$6,552,194***
Monitoring & Exploration Wells	$1,758,065	$527,420	$2,285,485
Seep 5E Collection System	$133,356	$40,007	$173,363
Miscellaneous Subtotal	***$1,891,421***	***$567,426***	***$2,458,848***
Closure Costs Total	**$71,637,651**	**$21,491,295**	**$93,128,947**
O&M		**17.5% of Direct**	
Full Site O&M Costs Total	**$7,553,631**	**$1,321,886**	**$8,875,517**
Total Cost (Closure + O&M)	**$79,191,283**	**$22,813,181**	**$102,004,464**

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APPENDICES

Appendix A

Cost Spreadsheet

Unit Rates

Code	Activity	Base Per Unit Cost	Fuel Per Unit Cost	Units	Source	Reference
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 includes direct and indirect costs at $2.34/gal.
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, crimping, seed, and mulch.
U3	**Bench Grading Stockpile**	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
U4	**Bench Grading Tailings Pond**	$ 1.35	$ 0.33	ft	Bench Grading Unit Cost Sheet	See unit rates calculations
U5	**Downdrain Construction**	$ 374.38	$ -	ft	Downdrain Unit Cost Sheet	See unit rates calculations
U6	**Downdrain Dissipater**	$ 14,556.48	$ -	ea	Downdrain Unit Cost Sheet	See unit rates calculations
U7a	**Channel Construction w/ Riprap**	$ 6.58	$ 1.38	ft	Channul Unit Cost Sheet	See unit rates calculations
U7b	**Channel Construction w/o Riprap**	$ 0.41	$ 0.10	ft	Channul Unit Cost Sheet	See unit rates calculations
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
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
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
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
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
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
U14	**Power Line Demolition**	$ 0.63	$ -	ft	Means Line Item 260505.10 0370	Electrical Demolition - Nonmetallic sheathed cable 3 wire; assume similar enough in cost to overhead powerlines.
U15	**Power Pole Demolition**	$ 216.24	$ -	ea	Means Line Item 024113.80 0200	Selective Demolition - wood utility poles 35-45 ft high
U16	**Pipeline (small HDPE pipe)**	$ 2.29	$ -	ft	Means Line Item 024113.38 1700	Selective demolition water, process water HDPE piping; (6 to 8-inch diameter); excludes excavation
U17	**Pipeline (medium HDPE pipe)**	$ 3.82	$ -	ft	Means Line Item 024113.38 1800	Selective demolition water, process water HDPE piping; (10 to 18-inch diameter); excludes excavation
U18	**Pipeline (large HDPE pipe)**	$ 5.72	$ -	ft	Means Line Item 024113.38 1900	Selective demolition water, process water HDPE piping (20 to 36-inch diameter); excludes excavation
U19	**Well Plug & Abandon**	$ 10.55	$ -	ft	Quote	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
U20	**Well Replacement**	$ 67.76	$ -	ft	Quote	Wilcox Professional Services, 8/2011, est. cost for 5 ½ in bore, $173,500 for 3000 ft total ($57.83/ft). Escalated 2% 2011-2019= $67.76/ft
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.
U22	**Disc harrow attachment, for tractor**	$ 616.33	$ -	month	Means Line Item 015433.20 1500	Equipment rental costs
U23	**Cast-In-Place Concrete**	$ 254.97	$ -	cy	Means Line Item 033053.40 6200	Structural concrete, in place, gravity retaining wall (3000 psi), includes forms and reinforcement
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
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
U26	**Road Maintenance**	$ 4,945.96	$ 1,240.32	month		Road maintenance for O&M - includes one 14M motor grader and one 6,000-gal water truck
U27	**Tailing Cover Maintenance**	$ 2,144.29	$ 269.57	day	Modified Crew B-13A	Tailing cover maitenance for O&M - includes 1 foreman, 2 laborers, 1 loader (4 cy), 1 dump truck (12 ton)
U28	**Berming**	$ 0.06	$ -	ft	See Berm Unit Cost Sheet	Assumed height of 1' with top width 2' (2 X berm height); slopes of 1.5H:1V; volume 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 outslope.
U29	**Fencing**	$ 23.05	$ -	ft	Means Line Item 323113.20 0800	
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
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
U32	**Fire Hydrant Demolition**	$ 396.73	$ -	ea	Means Line Item 024113.33 0900	Utility removal, hydrants, fire, remove only, excludes hauling
U33	**Seepage Collection Replacement**	$ 133,355.94	$ -	ea	Seepage Collection Unit Cost Sheet	See unit rates calculations
U34	**Culvert Removal**	$ 12.69	$ -	ft	Means Line Item 024113.40 0190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation
U35	**Grade Control Wall**	$ 165.59	$ -	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
U36	**Steel Trestle Demolition**	$ 30,689.10	$ -	ea	Trestle Demo Unit Cost Sheet	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide; see unit rates calculations
U37	**Sludge Removal**	$ 306.69	-	ea	Means Line Item 026510.30 0320	Removal of underground storage tanks, petroleum storage tanks, non-leaking, remove sludge, water and remaining product from tank bottom of tank with vacuum truck, 9,000 - 12,000 gallon tank
U38	**Substation Demo**	$ 12,470.55	$ -	ea	Substation Demo Unit Cost	See unit rates calculations

RS Means Location adjustment: New Mexico Las Cruces 85.4%

Not all unit rates are used in this RCE. Other unit rates are kept for alternatives and testing purposes and to maintain spreadsheet integrity
[1] Applied to RSM derived costs only. EquipmentWatch items and items based on local quotes adjusted at base rate
RS Means Online, 2019

Tyrone Mine
Stockpile Spreadsheet Worksheet #1
5/1/2019

General Information

Applicant	Freeport McMoRan Tyrone Inc. Tyrone, New Mexico 88065	
Disturbed Surface Area (acres) *(does not include previously reclaimed areas)*		3,079
Type of Operation	Existing/Surface/Copper	
Current value of earthwork and O&M before escalation and discounting	**$102,004,464**	

Stockpiles, Tailing, Reservoirs, Haul Roads and Disturbed Areas

Demolition

Building Demolition costs are calculated in "1 BuildingDemo", "2 BuildingCover", "3 BuildingVeg", and "4BuildingWaste" and summarized on the last line of this table.

Item	Activity	Quantity	Unit	Unit Cost ($/unit)	Direct Item Cost ($)	Reference	Means Line Item	Description
Powerline 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.
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
Powerline 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.
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
Powerlines 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.
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
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.
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
Fire Hydrants Mainly by SXEW	-	14	ea	$396.73	$5,554	Means	Means Line Item 024113.33 0900	Minor Site Demolition; remove fire hydrants
Little Rock Dewatering Pipeline Alighnment #1 and #2 (Year 34 of Closure)	6"-8" Diameter Plastic	4,940	ft	$1.84	$9,073	-	-	See Pipeline UC
Water Treatment Pipelines (Year 99 of Closure)	assume 20-36-inch diameter	74,500	ft	$4.48	$333,594	-	-	See Pipeline UC
Sewer Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	1,414	ft	$4.48	$6,332	-	-	See Pipeline UC
PLS Pipelines (Year 6 of Closure)	assume 20-36-inch diameter	18,893	ft	$4.48	$84,598	-	-	See Pipeline UC
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
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
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 excavation
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; see unit rates calculations
Substation Removal at Tailing Dam 1 Reclaim Water Pumphouse	Substation Demo	2	ea	$12,470.55	$0	-	-	See Substation Demo UC
Buildings and Associated Facilities	Demolition	See Demo Sheets	-	-	$4,458,460	-	-	-

Total Direct Cost: $5,040,149

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 stsockpile is volume weighted average of Gila Borrow Area (1/3) & 9AX Stockpile (2/3)

ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
3401-M-e-U	Post-Closure O&M-Mining Area-Final Grade	1C Waste Stockpile	-	-	-	-
3402-M-e-U	Post-Closure O&M-Mining Area-Final Grade	1C Waste Stockpile	-	-	-	-
3403-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7A Far West Stockpile	-	-	-	-
3404-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Upper	-	-	-	-
3405-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Wing	-	-	-	-
3406-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Wing	-	-	-	-
3407-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AE Upper	-	-	-	-
3408-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AE Upper	-	-	-	-
3409-M-e-U	Post-Closure O&M-No Man's Land-Final Grade	No Man's Land	-	-	-	-
3410-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailings Series 1 (1, 1A, 1X) Dam	-	-	-	-
3411-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 2 Dam	-	-	-	-
3412-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 3x Dam	-	-	-	-
3413-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 3 Dam	-	-	-	-
3414-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Burro Mountain Tailings Dam	-	-	-	-
3415-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Burro Mountain	-	-	-	-
3416-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Stockpile 1	-	-	-	-
3417-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Mill Initial	-	-	-	-
3418-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Mill (11 redo)	-	-	-	-
3419-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Copper Mountain	-	-	-	-
1003-A-a-Dz2	Grade-Outslopes - Area outside of pullback-Existing Ground	1A and 1B Leach	-	250	-29.0%	Cat D11T CD
1002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	1A and 1B Leach	-	90	-29.0%	Cat D11T CD
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	470	-29.0%	Cat D11T CD
1304-A-a-Dz2	Grade-Outslopes (total area, volume outside of pullback)-Existing Ground	3A / 3B	-	560	-29.0%	Cat D11T CD
1303-A-f-Dz2	Grade-Outslopes - Regrade benches from pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	90	-29.0%	Cat D11T CD
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	540	-29.0%	Cat D11T CD
2302-A-a-Dz2	Grade-Outslopes-Existing Ground	Savanna In-Pit Leach Stockpile	-	160	-29.0%	Cat D11T CD
1402-A-a-Dz2	Grade-Outslopes-Existing Ground	4C Leach	-	430	-29.0%	Cat D11T CD
1802-A-a-Dz2	Grade-Outslopes-Existing Ground	2C, 4A, 4B, 7B Leach	-	420	-29.0%	Cat D11T CD
1602-A-a-Dz2	Grade-Outslopes-Existing Ground	6B	-	180	-29.0%	Cat D11T CD
1702-A-a-Dz2	Grade-Outslopes-Existing Ground	6C	-	325	-29.0%	Cat D11T CD
2002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	9A Overburden	-	90	-29.0%	Cat D11T CD
1001-A-a-Mg1	Grade-Top-Existing Ground	1A and 1B Leach	-	430	1.0%	Cat 16M
1201-A-a-Mg1	Grade-Top-Existing Ground	2A Leach and 2B Waste	-	370	1.0%	Cat 16M
1301-A-a-Mg1	Grade-Top-Existing Ground	3A / 3B	-	560	1.0%	Cat 16M
1501-A-a-Mg1	Grade-Top-Existing Ground	5A Overburden	-	610	1.0%	Cat 16M
2200-A-a-Dz2	Grade-Entire Pit-Existing Ground	San Salvador Pit	-	185	-5.0%	Cat D11T CD
1401-A-a-Mg1	Grade-Top-Existing Ground	4C Leach	-	480	1.0%	Cat 16M
1801-A-a-Mg1	Grade-Top-Existing Ground	2C, 4A, 4B, 7B Leach	-	740	1.0%	Cat 16M
1601-A-a-Mg1	Grade-Top-Existing Ground	6B	-	350	1.0%	Cat 16M
1701-A-a-Mg1	Grade-Top-Existing Ground	6C	-	180	1.0%	Cat 16M
2301-A-a-Mg1	Grade-Top-Existing Ground	Savanna In-Pit Leach Stockpile	-	500	1.0%	Cat 16M
2001-A-a-Mg1	Grade-Top-Existing Ground	9A Overburden	-	285	1.0%	Cat 16M
1900-A-a-Dz2	Grade-Sludge Disposal Area-Existing Ground	8C	-	-	0.0%	Cat D11T CD
2701-A-a-Dz2	Grade-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	Cat D11T CD
3300-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Unplanned Disturbance Area	-	-	1.0%	Cat D11T CD
2101-A-a-Dz2	Grade-North-Existing Ground	9AX	-	458	-29.0%	Cat D11T CD
2102-A-a-Dz2	Grade-South-Existing Ground	9AX	-	235	-29.0%	Cat D11T CD
2600-A-a-Dz2	Grade-Tailing Launder Line-Existing Ground	Tailing Launder Line	-	100	1.0%	Cat D11T CD
2802-A-a-Mg1	Grade-Sloped Areas-Existing Ground	Tailing Repositories Borrow Areas	-	-	-29.0%	Cat 16M
1001-E-c-Rp1	Rip-Top-Rough Graded Material	1A and 1B Leach	-	430	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1201-E-c-Rp1	Rip-Top-Rough Graded Material	2A Leach and 2B Waste	-	370	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1301-E-c-Rp1	Rip-Top-Rough Graded Material	3A / 3B	-	560	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1501-E-c-Rp1	Rip-Top-Rough Graded Material	5A Overburden	-	610	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2200-E-c-Rp1	Rip-Entire Pit-Rough Graded Material	San Salvador Pit	-	185	-5.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1401-E-c-Rp1	Rip-Top-Rough Graded Material	4C Leach	-	480	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1801-E-c-Rp1	Rip-Top-Rough Graded Material	2C, 4A, 4B, 7B Leach	-	740	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1601-E-c-Rp1	Rip-Top-Rough Graded Material	6B	-	350	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1701-E-c-Rp1	Rip-Top-Rough Graded Material	6C	-	180	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2301-E-c-Rp1	Rip-Top-Rough Graded Material	Savanna In-Pit Leach Stockpile	-	500	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2001-E-c-Rp1	Rip-Top-Rough Graded Material	9A Overburden	-	285	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
1900-E-c-Rp1	Rip-Sludge Disposal Area-Rough Graded Material	8C	-	-	0.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2701-E-c-Rp1	Rip-Surface Impoundments closed at year 99; some closed year 6-Rough Graded Material	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2600-E-c-Rp1	Rip-Tailing Launder Line-Rough Graded Material	Tailing Launder Line	-	100	1.0%	Cat D11T CD Multi-shank (w/ MSR-359H)
2701-K-a-Ex1	Perforate Liner-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	Cat 319D L
2702-K-a-Ex1	Perforate Liner-Surface Impoundments graded over at closure-Existing Ground	Surface Impoundments graded over at closure	-	-	1.0%	Cat 319D L
1000-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1A and 1B Leach	-	-	Cat D11T CD
1100-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1C	-	0.0%	Cat D11T CD
1200-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	-	-	Cat D11T CD
1300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	3A / 3B	-	-	Cat D11T CD
1500-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	5A Overburden	-	-	Cat D11T CD
2200-B-b-Dz2	Dozer Assist-Cover	Leach Stockpile	San Salvador Pit	185	-5.0%	Cat D11T CD
2300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	-	-	Cat D11T CD
1400-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	4C Leach	-	-	Cat D11T CD
1800-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	-	-	Cat D11T CD
1900-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	8C	-	0.0%	Cat D11T CD
1600-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6B	-	-	Cat D11T CD
1700-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6C	-	-	Cat D11T CD
2701-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Cntmnt-1	-	1.0%	Cat D11T CD
3300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Unplanned Disturbance Area	-	1.0%	Cat D11T CD
2100-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile Toe	9AX	-	-	Cat D11T CD
2600-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile	Tailing Launder Line	100	1.0%	Cat D11T CD
1302-B-f-Dz2	Dozer Assist-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-29.0%	Cat D11T CD
2201-B-f-Dz2	Dozer Assist-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	-	0.0%	Cat D11T CD
2900-B-b-Dz2	Dozer Assist-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	2,950	1.0%	Cat D11T CD
1000-C-b-Sh1	Load-Cover	Gila Borrow Area	1A and 1B Leach	-	-	Hitachi EX3600-5
1100-C-b-Sh1	Load-Cover	Gila Borrow Area	1C	-	0.0%	Hitachi EX3600-5
1200-C-b-Sh1	Load-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	-	-	Hitachi EX3600-5
1300-C-b-Sh1	Load-Cover	Gila Borrow Area	3A / 3B	-	-	Hitachi EX3600-5
1500-C-b-Sh1	Load-Cover	Gila Borrow Area	5A Overburden	-	-	Hitachi EX3600-5
2200-C-b-Sh1	Load-Cover	Leach Stockpile	San Salvador Pit	185	-5.0%	Hitachi EX3600-5
2300-C-b-Sh1	Load-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	-	-	Hitachi EX3600-5
1400-C-b-Sh1	Load-Cover	Gila Borrow Area	4C Leach	-	-	Hitachi EX3600-5
1800-C-b-Sh1	Load-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	-	-	Hitachi EX3600-5
1900-C-b-Sh1	Load-Cover	Gila Borrow Area	8C	-	0.0%	Hitachi EX3600-5
1600-C-b-Sh1	Load-Cover	Gila Borrow Area	6B	-	-	Hitachi EX3600-5
1700-C-b-Sh1	Load-Cover	Gila Borrow Area	6C	-	-	Hitachi EX3600-5
2701-C-b-Sh1	Load-Cover	Gila Borrow Area	Cntmnt-1	-	1.0%	Hitachi EX3600-5
3300-C-b-Sh1	Load-Cover	Gila Borrow Area	Unplanned Disturbance Area	-	1.0%	Hitachi EX3600-5
2100-C-b-Sh1	Load-Cover	9AX Stockpile Toe	9AX	-	-	Hitachi EX3600-5
2600-C-b-Ld2	Load-Cover	9AX Stockpile	Tailing Launder Line	100	1.0%	Cat 988H
1302-C-f-Sh1	Load-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-29.0%	Hitachi EX3600-5
2201-C-f-Sh1	Load-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	-	0.0%	Hitachi EX3600-5
2900-C-b-Ld2	Load-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	2,950	1.0%	Cat 988H
1302-D-f-Tk4	Haul-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	3,900	0.0%	Komatsu 730E
2201-D-f-Tk4	Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	1,300	-1.0%	Komatsu 730E
1000-D-b-Tk4	Haul-Cover	Gila Borrow Area	1A and 1B Leach	6,260	4.9%	Komatsu 730E
1100-D-b-Tk4	Haul-Cover	Gila Borrow Area	1C	11,833	2.5%	Komatsu 730E
1200-D-b-Tk4	Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	13,612	5.3%	Komatsu 730E
1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	11,221	1.3%	Komatsu 730E
1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	4,750	1.9%	Komatsu 730E
2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	12,570	1.8%	Komatsu 730E
2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	5,730	1.6%	Komatsu 730E
1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	17,830	5.0%	Komatsu 730E
1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	13,990	3.9%	Komatsu 730E
1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	5,730	1.6%	Komatsu 730E
1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	10,050	2.0%	Komatsu 730E
1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	11,833	2.5%	Komatsu 730E
2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	10,791	2.9%	Komatsu 730E
3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	10,791	2.9%	Komatsu 730E
2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	6,343	7.7%	Komatsu 730E
2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	10,791	2.9%	Cat 769D
2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	14,100	-1.8%	Cat 769D
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	1A and 1B Leach	-	-	-	Cat 16M
1100-A-d-Mg1	Grade-Top (Haul Road)-Placed Cover	1C	-	-	0.0%	Cat 16M
1200-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2A Leach and 2B Waste	-	-	-	Cat 16M
1300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	3A / 3B	-	-	-	Cat 16M
1500-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	5A Overburden	-	-	-	Cat 16M
2200-A-d-Mg1	Grade-Entire Pit-Placed Cover	San Salvador Pit	-	185	-5.0%	Cat 16M
2300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	Savanna In-Pit Leach Stockpile	-	-	-	Cat 16M
1400-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	4C Leach	-	-	-	Cat 16M
1800-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2C, 4A, 4B, 7B Leach	-	-	-	Cat 16M
1900-A-d-Mg1	Grade-Sludge Disposal Area-Placed Cover	8C	-	-	0.0%	Cat 16M
1600-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6B	-	-	-	Cat 16M
1700-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6C	-	-	-	Cat 16M
2701-A-d-Mg1	Grade-Surface Impoundments closed at year 99; some closed year 6-Placed Cover	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	Cat 16M
3300-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Unplanned Disturbance Area	-	-	1.0%	Cat 16M
2100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	9AX	-	-	-	Cat 16M
2600-A-d-Dz2	Grade-Tailing Launder Line-Placed Cover	Tailing Launder Line	-	100	1.0%	Cat D11T CD
2900-A-d-Mg1	Grade-Tailing Pumphouse-Placed Cover	Tailing Dam 1 Reclaim Water Pumphouse	-	2,950	1.0%	Cat 16M
1000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	1A and 1B Leach	-	-	-	-
1100-J-e-U2	Revegetate-Top (Haul Road)-Final Grade	1C	-	-	0.0%	-
1200-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	-	-	-
1300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	3A / 3B	-	-	-	-
1500-J-e-U2	Revegetate-Entire Stockpile-Final Grade	5A Overburden	-	-	-	-
2200-J-e-U2	Revegetate-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
2300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	-	-	-
1400-J-e-U2	Revegetate-Entire Stockpile-Final Grade	4C Leach	-	-	-	-
1800-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	-	-	-
1900-J-e-U2	Revegetate-Sludge Disposal Area-Final Grade	8C	-	-	0.0%	-
1600-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6B	-	-	-	-
1700-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6C	-	-	-	-
2000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9A Overburden	-	-	-	-
2600-J-e-U2	Revegetate-Tailing Launder Line-Final Grade	Tailing Launder Line	-	100	1.0%	-
2900-J-e-U2	Revegetate-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	2,950	1.0%	-
2701-J-e-U2	Revegetate-Surface Impoundments closed at year 99; some closed year 6-Final Grade	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	-
2702-J-e-U2	Revegetate-Surface Impoundments graded over at closure-Final Grade	Surface Impoundments graded over at closure	-	-	1.0%	-
3300-J-e-U2	Revegetate-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	-	1.0%	-
2100-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9AX	-	-	-	-
2803-J-e-U2	Revegetate-Revegetation Area-Final Grade	Tailing Repositories Borrow Areas	-	-	-	-
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	1A and 1B Leach	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1100-P-b-Comb1	Road Maintenance-Top (Haul Road)	Gila Borrow Area	1C	-	0.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1200-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	3A / 3B	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1500-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	5A Overburden	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2200-P-b-Comb1	Road Maintenance-Entire Pit	Leach Stockpile	San Salvador Pit	185	-5.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	Savanna In-Pit Leach Stockpile	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1400-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	4C Leach	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1800-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	2C, 4A, 4B, 7B Leach	-	-	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1900-P-b-Comb1	Road Maintenance-Sludge Disposal Area	Gila Borrow Area	8C	-	0.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.

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 stsockpile is volume weighted average of Gila Borrow Area (1/3) & 9AX Stockpile (2/3)

ID	Description	Source Location 1	Destination Location 2	Total Haul/Push Distance (ft)[1]	Grade (%)[2,3]	Equipment
1600-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6B	- -		Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1700-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6C	- -		Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2701-P-b-Comb1	Road Maintenance-Surface Impoundments closed at year 99; some closed year 6	Gila Borrow Area	Cntmnt-1	-	1.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
3300-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Gila Borrow Area	Unplanned Disturbance Area	-	1.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2100-P-b-Comb1	Road Maintenance-Entire Stockpile	9AX Stockpile Toe	9AX	- -		Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
1302-P-f-Comb1	Road Maintenance-Outslopes Pullback	3A/3B	3A / 3B	-	-29.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2201-P-f-Comb1	Road Maintenance-Pit Backfill	Leach Stockpile	San Salvador Pit	-	0.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2600-P-b-Comb1	Road Maintenance-Tailing Launder Line	9AX Stockpile	Tailing Launder Line	100	1.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
2900-P-b-Comb1	Road Maintenance-Tailing Pumphouse	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	2,950	1.0%	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.
3002-N-e-U19	Plug and Abandon Well-Wells-Final Grade	2-inch ID wells (avg. TD = 36 ft)	-	- -		-
3003-N-e-U19	Plug and Abandon Well-Wells-Final Grade	4-inch ID wells (avg. TD = 113 ft)	-	- -		-
3004-N-e-U19	Plug and Abandon Well-Wells-Final Grade	4-inch ID wells, avg. total depth = 172 ft (28% Year 19 and rest Year 99 of closure)	-	- -		-
2100-N-e-U19	Plug and Abandon Well-Entire Stockpile-Final Grade	9AX	-	- -		-
3005-O-e-U20	Replace Well-Wells-Final Grade	6-inch ID wells (avg. TD = 135 ft)	-	- -		-
3006-O-e-U20	Replace Well-Wells-Final Grade	286-2008-04 (5" x 200') Well	-	- -		-
3007-O-e-U20	Replace Well-Wells-Final Grade	286-2008-05 (5" x 200') Well	-	- -		-
3008-O-e-U20	Replace Well-Wells-Final Grade	286-2008-06 (4" x 60.5') Well	-	- -		-
3009-N-e-U19	Plug and Abandon Well-Wells-Final Grade	Exploration Holes	-	- -		-
3100-L-e-U33	Replace Infrastructure-Seep 5E Collection System-Final Grade	Seep 5E Collection System	-	- -		-
2501-L-e-U33	Replace Infrastructure-Preliminary Earthworks-Final Grade	3A Leach Stockpile	-	- -		-
2502-L-e-U33	Replace Infrastructure-Overflow Pond & Booster Station-Final Grade	3A Leach Stockpile	-	- -		-
2503-L-e-U33	Replace Infrastructure-Canyon 5 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2504-L-e-U33	Replace Infrastructure-Canyon 6 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2505-L-e-U33	Replace Infrastructure-Canyon 7 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2506-L-e-U33	Replace Infrastructure-Canyon 8 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2507-L-e-U33	Replace Infrastructure-Canyon 10 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2508-L-e-U33	Replace Infrastructure-Canyon 11 Deep Collection-Final Grade	3A Leach Stockpile	-	- -		-
2509-L-e-U33	Replace Infrastructure-Bolster Existing Surface PLS Catchments-Final Grade	3A Leach Stockpile	-	- -		-
2510-L-e-U33	Replace Infrastructure-Finger Drain System-Final Grade	3A Leach Stockpile	-	- -		-
2511-L-e-U33	Replace Infrastructure-Breach of Existing Seepage Collection Trenches-Final Grade	3A Leach Stockpile	-	- -		-
2512-L-e-U33	Replace Infrastructure-Concrete Pad for Above-Ground Tank-Final Grade	3A Leach Stockpile	-	- -		-
2513-L-e-U33	Replace Infrastructure-Electrical Hookup-Final Grade	3A Leach Stockpile	-	- -		-
2400-S-e-U29	Fencing-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	57,500 -		-
2400-U-e-U30	Vehicle Gates-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	57,500 -		-
2400-V-e-U31	Signs Every 500 ft-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	57,500 -		-
2900-S-e-U29	Fencing-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	2,950	1.0%	-
1000-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	1A and 1B Leach	-	- -		-
1200-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	- -		-
1300-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	3A / 3B	-	- -		-
1500-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	5A Overburden	-	- -		-
2200-F-e-U3	Grade Benches-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
1400-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	4C Leach	-	- -		-
1800-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	- -		-
1700-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	6C	-	- -		-
2000-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	9A Overburden	-	- -		-
2100-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	9AX	-	- -		-
1000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	1A and 1B Leach	-	- -		-
1200-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	- -		-
1300-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	3A / 3B	-	- -		-
1500-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	5A Overburden	-	- -		-
2200-G-e-U5	Construct Downdrains-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
1400-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	4C Leach	-	- -		-
1800-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	- -		-
1600-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6B	-	- -		-
1700-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6C	-	- -		-
2000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	9A Overburden	-	- -		-
1000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	1A and 1B Leach	-	- -		-
1200-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	- -		-
1300-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	3A / 3B	-	- -		-
1500-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	5A Overburden	-	- -		-
2200-Gb-e-U6	Construct Downdrain Dissipators-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
1400-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	4C Leach	-	- -		-
1800-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	- -		-
1600-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6B	-	- -		-
1700-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6C	-	- -		-
2000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	9A Overburden	-	- -		-
1000-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	1A and 1B Leach	-	- -		-
1200-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	- -		-
1300-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	3A / 3B	-	- -		-
1500-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	5A Overburden	-	- -		-
2200-H-e-U7a	Construct Channels w/ Riprap-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
1400-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	4C Leach	-	- -		-
1600-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	6B	-	- -		-
1800-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	- -		-
1700-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	6C	-	- -		-
2000-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	9A Overburden	-	- -		-
2100-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	9AX	-	- -		-
2800-Hb-e-U7b	Construct Channels w/o Riprap-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142 -		-
2800-R-e-U28	Construct Berms-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142 -		-
2600-T-e-U35	Build Grade Control Walls-Tailing Launder Line-Final Grade	Tailing Launder Line	-	100	1.0%	-
1000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	1A and 1B Leach	-	- -		-
1100-M-e-U	Post-Closure O&M-Top (Haul Road)-Final Grade	1C	-	-	0.0%	-
1200-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	- -		-
1300-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	3A / 3B	-	- -		-
1500-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	5A Overburden	-	- -		-
2200-M-e-U	Post-Closure O&M-Entire Pit-Final Grade	San Salvador Pit	-	185	-5.0%	-
2300-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	- -		-
1400-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	4C Leach	-	- -		-
1800-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	- -		-
1900-M-e-U	Post-Closure O&M-Sludge Disposal Area-Final Grade	8C	-	-	0.0%	-
1600-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6B	-	- -		-
1700-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6C	-	- -		-
2000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	9A Overburden	-	- -		-
2600-M-e-U	Post-Closure O&M-Tailing Launder Line-Final Grade	Tailing Launder Line	-	100	1.0%	-
2900-M-e-U	Post-Closure O&M-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	2,950	1.0%	-
2701-M-e-U	Post-Closure O&M-Surface Impoundments closed at year 99; some closed year 6-Final Grade	Surface Impoundments closed at year 99; some closed year 6	-	-	1.0%	-
2702-M-e-U	Post-Closure O&M-Surface Impoundments graded over at closure-Final Grade	Surface Impoundments graded over at closure	-	-	1.0%	-
3300-M-e-U	Post-Closure O&M-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	-	1.0%	-
2100-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	9AX	-	- -		-
2800-M-e-U	Post-Closure O&M-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142 -		-
3200-M-e-U	Post-Closure O&M-Demo Area-Final Grade	Building Demo Area	-	- -		-

Earthwork Quantity Worksheet

Notes and Assumptions:

1 - Acres and volumes based on 2015 Tyrone RCE Submittal

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]
1003-A-a-Dz2	Grade-Outslopes - Area outside of pullback-Existing Ground	1A and 1B Leach	-	256.0	-	140,000	0%	140,000
1002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	1A and 1B Leach	-	-	-	1,329,670	0%	1,329,670
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	451.0	-	8,060,000	0%	8,060,000
1304-A-a-Dz2	Grade-Outslopes (total area, volume outside of pullback)-Existing Ground	3A / 3B	-	422.0	-	3,500,000	0%	3,500,000
1303-A-f-Dz2	Grade-Outslopes - Regrade benches from pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-	1,590,064	0%	1,590,064
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	308.0	-	6,300,000	0%	6,300,000
2302-A-a-Dz2	Grade-Outslopes-Existing Ground	Savanna In-Pit Leach Stockpile	-	32.5	-	135,000	0%	135,000
1402-A-a-Dz2	Grade-Outslopes-Existing Ground	4C Leach	-	170.0	-	2,700,000	0%	2,700,000
1802-A-a-Dz2	Grade-Outslopes-Existing Ground	2C, 4A, 4B, 7B Leach	-	249.0	-	2,300,000	0%	2,300,000
1602-A-a-Dz2	Grade-Outslopes-Existing Ground	6B	-	15.0	-	183,000	0%	183,000
1702-A-a-Dz2	Grade-Outslopes-Existing Ground	6C	-	56.0	-	650,000	0%	650,000
2002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	9A Overburden	-	116.0	-	642,674	0%	642,674
1001-A-a-Mg1	Grade-Top-Existing Ground	1A and 1B Leach	-	17.0	-	-	0%	-
1201-A-a-Mg1	Grade-Top-Existing Ground	2A Leach and 2B Waste	-	36.0	-	-	0%	-
1301-A-a-Mg1	Grade-Top-Existing Ground	3A / 3B	-	33.0	-	-	0%	-
1501-A-a-Mg1	Grade-Top-Existing Ground	5A Overburden	-	63.0	-	-	0%	-
2200-A-a-Dz2	Grade-Entire Pit-Existing Ground	San Salvador Pit	-	115.0	-	1,600,000	0%	1,600,000
1401-A-a-Mg1	Grade-Top-Existing Ground	4C Leach	-	13.0	-	-	0%	-
1801-A-a-Mg1	Grade-Top-Existing Ground	2C, 4A, 4B, 7B Leach	-	126.0	-	-	0%	-
1601-A-a-Mg1	Grade-Top-Existing Ground	6B	-	39.0	-	-	0%	-
1701-A-a-Mg1	Grade-Top-Existing Ground	6C	-	10.0	-	-	0%	-
2301-A-a-Mg1	Grade-Top-Existing Ground	Savanna In-Pit Leach Stockpile	-	32.5	-	-	0%	-
2001-A-a-Mg1	Grade-Top-Existing Ground	9A Overburden	-	13.0	-	-	0%	-
1900-A-a-Dz2	Grade-Sludge Disposal Area-Existing Ground	8C	-	47.4	-	-	0%	-
2701-A-a-Dz2	Grade-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	21.2	-	-	0%	-
3300-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Unplanned Disturbance Area	-	125.0	-	-	0%	-
2101-A-a-Dz2	Grade-North-Existing Ground	9AX	-	47.8	-	451,017	0%	451,017
2102-A-a-Dz2	Grade-South-Existing Ground	9AX	-	15.9	-	150,339	0%	150,339
2600-A-a-Dz2	Grade-Tailing Launder Line-Existing Ground	Tailing Launder Line	-	7.4	-	117,000	15%	134,550
2802-A-a-Mg1	Grade-Sloped Areas-Existing Ground	Tailing Repositories Borrow Areas	-	25.5	-	-	8%	-
1001-E-c-Rp1	Rip-Top-Rough Graded Material	1A and 1B Leach	-	17.0	-	-	0%	-
1201-E-c-Rp1	Rip-Top-Rough Graded Material	2A Leach and 2B Waste	-	36.0	-	-	0%	-
1301-E-c-Rp1	Rip-Top-Rough Graded Material	3A / 3B	-	33.0	-	-	0%	-
1501-E-c-Rp1	Rip-Top-Rough Graded Material	5A Overburden	-	63.0	-	-	0%	-
2200-E-c-Rp1	Rip-Entire Pit-Rough Graded Material	San Salvador Pit	-	115.0	-	-	0%	-
1401-E-c-Rp1	Rip-Top-Rough Graded Material	4C Leach	-	13.0	-	-	0%	-
1801-E-c-Rp1	Rip-Top-Rough Graded Material	2C, 4A, 4B, 7B Leach	-	126.0	-	-	0%	-
1601-E-c-Rp1	Rip-Top-Rough Graded Material	6B	-	39.0	-	-	0%	-
1701-E-c-Rp1	Rip-Top-Rough Graded Material	6C	-	10.0	-	-	0%	-
2301-E-c-Rp1	Rip-Top-Rough Graded Material	Savanna In-Pit Leach Stockpile	-	32.5	-	-	0%	-
2001-E-c-Rp1	Rip-Top-Rough Graded Material	9A Overburden	-	13.0	-	-	0%	-
1900-E-c-Rp1	Rip-Sludge Disposal Area-Rough Graded Material	8C	-	47.4	-	-	0%	-
2701-E-c-Rp1	Rip-Surface Impoundments closed at year 99; some closed year 6-Rough Graded Material	Surface Impoundments closed at year 99; some closed year 6	-	21.2	-	-	0%	-
2600-E-c-Rp1	Rip-Tailing Launder Line-Rough Graded Material	Tailing Launder Line	-	7.4	-	-	0%	-
2701-K-a-Ex1	Perforate Liner-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	21.2	-	-	0%	-
2702-K-a-Ex1	Perforate Liner-Surface Impoundments graded over at closure-Existing Ground	Surface Impoundments graded over at closure	-	0.5	-	-	0%	-
1000-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1A and 1B Leach	273.0	36	1,223,444	8%	1,321,320
1100-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1C	17.0	36	76,204	8%	82,300
1200-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	487.0	36	2,182,444	8%	2,357,040
1300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	3A / 3B	455.0	36	2,039,074	8%	2,202,200
1500-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	5A Overburden	371.0	36	1,662,630	8%	1,795,640
2200-B-b-Dz2	Dozer Assist-Cover	Leach Stockpile	San Salvador Pit	115.0	36	515,370	8%	556,600
2300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	65.0	36	291,296	8%	314,600
1400-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	4C Leach	183.0	36	820,111	8%	885,720
1800-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	375.0	36	1,680,556	8%	1,815,000
1900-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	8C	47.4	36	212,243	8%	229,222
1600-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6B	54.0	36	242,000	8%	261,360
1700-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6C	66.0	36	295,778	8%	319,440
2701-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Cntmnt-1	21.2	36	95,142	8%	102,753
3300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Unplanned Disturbance Area	125.0	36	560,185	8%	605,000
2100-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile Toe	9AX	63.7	12	95,157	8%	102,769
2600-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile	Tailing Launder Line	7.4	10	8,923	8%	9,637
1302-B-f-Dz2	Dozer Assist-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-	17,500,000	0%	17,500,000
2201-B-f-Dz2	Dozer Assist-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	-	-	3,500,000	0%	3,500,000
2900-B-b-Dz2	Dozer Assist-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	7.0	48	42,000	8%	45,360
1000-C-b-Sh1	Load-Cover	Gila Borrow Area	1A and 1B Leach	273.0	36	1,223,444	8%	1,321,320
1100-C-b-Sh1	Load-Cover	Gila Borrow Area	1C	17.0	36	76,204	8%	82,300
1200-C-b-Sh1	Load-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	487.0	36	2,182,444	8%	2,357,040
1300-C-b-Sh1	Load-Cover	Gila Borrow Area	3A / 3B	455.0	36	2,039,074	8%	2,202,200
1500-C-b-Sh1	Load-Cover	Gila Borrow Area	5A Overburden	371.0	36	1,662,630	8%	1,795,640
2200-C-b-Sh1	Load-Cover	Leach Stockpile	San Salvador Pit	115.0	36	515,370	8%	556,600
2300-C-b-Sh1	Load-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	65.0	36	291,296	8%	314,600
1400-C-b-Sh1	Load-Cover	Gila Borrow Area	4C Leach	183.0	36	820,111	8%	885,720
1800-C-b-Sh1	Load-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	375.0	36	1,680,556	8%	1,815,000
1900-C-b-Sh1	Load-Cover	Gila Borrow Area	8C	47.4	36	212,243	8%	229,222
1600-C-b-Sh1	Load-Cover	Gila Borrow Area	6B	54.0	36	242,000	8%	261,360
1700-C-b-Sh1	Load-Cover	Gila Borrow Area	6C	66.0	36	295,778	8%	319,440
2701-C-b-Sh1	Load-Cover	Gila Borrow Area	Cntmnt-1	21.2	36	95,142	8%	102,753
3300-C-b-Sh1	Load-Cover	Gila Borrow Area	Unplanned Disturbance Area	125.0	36	560,185	8%	605,000
2100-C-b-Sh1	Load-Cover	9AX Stockpile Toe	9AX	63.7	12	95,157	8%	102,769
2600-C-b-Ld2	Load-Cover	9AX Stockpile	Tailing Launder Line	7.4	10	8,923	8%	9,637
1302-C-f-Sh1	Load-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-	17,500,000	0%	17,500,000
2201-C-f-Sh1	Load-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	-	-	3,500,000	0%	3,500,000
2900-C-b-Ld2	Load-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	7.0	48	42,000	8%	45,360
1302-D-f-Tk4	Haul-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	-	-	17,500,000	0%	17,500,000
2201-D-f-Tk4	Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	-	-	3,500,000	0%	3,500,000
1000-D-b-Tk4	Haul-Cover	Gila Borrow Area	1A and 1B Leach	273.0	36	1,223,444	8%	1,321,320
1100-D-b-Tk4	Haul-Cover	Gila Borrow Area	1C	17.0	36	76,204	8%	82,300
1200-D-b-Tk4	Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	487.0	36	2,182,444	8%	2,357,040
1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	455.0	36	2,039,074	8%	2,202,200
1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	371.0	36	1,662,630	8%	1,795,640
2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	115.0	36	515,370	8%	556,600
2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	65.0	36	291,296	8%	314,600
1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	183.0	36	820,111	8%	885,720
1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	375.0	36	1,680,556	8%	1,815,000
1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	47.4	36	212,243	8%	229,222
1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	54.0	36	242,000	8%	261,360
1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	66.0	36	295,778	8%	319,440
2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	21.2	36	95,142	8%	102,753
3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	125.0	36	560,185	8%	605,000
2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	63.7	12	95,157	8%	102,769
2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	7.4	10	8,923	8%	9,637
2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	7.0	48	42,000	8%	45,360
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	1A and 1B Leach	-	273.0	36	1,321,320	0%	1,321,320
1100-A-d-Mg1	Grade-Top (Haul Road)-Placed Cover	1C	-	17.0	36	82,300	0%	82,300
1200-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2A Leach and 2B Waste	-	487.0	36	2,357,040	0%	2,357,040
1300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	3A / 3B	-	455.0	36	2,202,200	0%	2,202,200
1500-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	5A Overburden	-	371.0	36	1,795,640	0%	1,795,640
2200-A-d-Mg1	Grade-Entire Pit-Placed Cover	San Salvador Pit	-	115.0	36	556,600	0%	556,600
2300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	Savanna In-Pit Leach Stockpile	-	65.0	36	314,600	0%	314,600
1400-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	4C Leach	-	183.0	36	885,720	0%	885,720
1800-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2C, 4A, 4B, 7B Leach	-	375.0	36	1,815,000	0%	1,815,000
1900-A-d-Mg1	Grade-Sludge Disposal Area-Placed Cover	8C	-	47.4	36	229,222	0%	229,222
1600-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6B	-	54.0	36	261,360	0%	261,360
1700-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6C	-	66.0	36	319,440	0%	319,440
2701-A-d-Mg1	Grade-Surface Impoundments closed at year 99; some closed year 6-Placed Cover	Surface Impoundments closed at year 99; some closed year 6	-	21.2	36	102,753	0%	102,753
3300-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Unplanned Disturbance Area	-	125.0	36	605,000	0%	605,000
2100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	9AX	-	63.7	12	102,769	0%	102,769
2600-A-d-Dz2	Grade-Tailing Launder Line-Placed Cover	Tailing Launder Line	-	7.4	10	9,637	0%	9,637
2900-A-d-Mg1	Grade-Tailing Pumphouse-Placed Cover	Tailing Dam 1 Reclaim Water Pumphouse	-	7.0	48	45,360	0%	45,360

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)

													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 (%)
1003-A-a-Dz2	Grade-Outslopes - Area outside of pullback-Existing Ground	1A and 1B Leach	-	Cat D11T CD	--	--	--	140,000	256	1,796	-	77.9	1.2	1.6	3,300	1.2	250	1,359	22	3	1.00	50	1.0	1.0	1.0	-29%
1002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	1A and 1B Leach	-	Cat D11T CD	--	--	--	1,329,670	-	4,354	-	305.4	1.2	1.6	3,300	1.2	90	3,295	22	3	1.00	50	1.0	1.0	1.0	-29%
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	Cat D11T CD	--	--	--	8,060,000	451	1,039	-	7,755.7	1.2	1.6	3,300	1.2	470	786	22	3	1.00	50	1.0	1.0	1.0	-29%
1304-A-a-Dz2	Grade-Outslopes (total area, volume outside of pullback)-Existing Ground	3A / 3B	-	Cat D11T CD	--	--	--	3,500,000	422	893	-	3,920.1	1.2	1.6	3,300	1.2	560	676	22	3	1.00	50	1.0	1.0	1.0	-29%
1303-A-f-Dz2	Grade-Outslopes - Regrade benches from pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Cat D11T CD	--	--	--	1,590,064	-	3,628	-	438.3	1.0	1.6	3,300	1.2	90	3,295	22	3	1.00	50	1.0	1.0	1.0	-29%
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	Cat D11T CD	--	--	--	6,300,000	308	921	-	6,837.3	1.2	1.6	3,300	1.2	540	697	22	3	1.00	50	1.0	1.0	1.0	-29%
2302-A-a-Dz2	Grade-Outslopes-Existing Ground	Savanna In-Pit Leach Stockpile	-	Cat D11T CD	--	--	--	135,000	33	2,644	-	51.1	1.2	1.6	3,300	1.2	160	2,001	22	3	1.00	50	1.0	1.0	1.0	-29%
1402-A-a-Dz2	Grade-Outslopes-Existing Ground	4C Leach	-	Cat D11T CD	--	--	--	2,700,000	170	1,123	-	2,405.3	1.2	1.6	3,300	1.2	430	849	22	3	1.00	50	1.0	1.0	1.0	-29%
1802-A-a-Dz2	Grade-Outslopes-Existing Ground	2C, 4A, 4B, 7B Leach	-	Cat D11T CD	--	--	--	2,300,000	249	1,146	-	2,007.6	1.2	1.6	3,300	1.2	420	867	22	3	1.00	50	1.0	1.0	1.0	-29%
1602-A-a-Dz2	Grade-Outslopes-Existing Ground	6B	-	Cat D11T CD	--	--	--	183,000	15	2,388	-	76.6	1.2	1.6	3,300	1.2	180	1,807	22	3	1.00	50	1.0	1.0	1.0	-29%
1702-A-a-Dz2	Grade-Outslopes-Existing Ground	6C	-	Cat D11T CD	--	--	--	650,000	56	1,431	-	454.3	1.2	1.6	3,300	1.2	325	1,083	22	3	1.00	50	1.0	1.0	1.0	-29%
2002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	9A Overburden	-	Cat D11T CD	--	--	--	642,674	116	4,354	-	147.6	1.2	1.6	3,300	1.2	90	3,295	22	3	1.00	50	1.0	1.0	1.0	-29%
2200-A-a-Dz2	Grade-Entire Pit-Existing Ground	San Salvador Pit	-	Cat D11T CD	--	--	--	1,600,000	115	1,623	-	985.7	1.2	1.1	3,300	1.2	185	1,764	22	3	1.00	50	1.0	1.0	1.0	-5%
1900-A-a-Dz2	Grade-Sludge Disposal Area-Existing Ground	8C	-	Cat D11T CD	--	--	--	-	47	-	6	8.5	1.2	1.0	3,300	1.2	-	-	22	3	1.00	50	1.0	1.0	1.0	0%
2701-A-a-Dz2	Grade-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	Cat D11T CD	--	--	--	-	21	-	5	3.9	1.2	1.0	3,300	1.2	-	-	22	3	1.00	50	1.0	1.0	1.0	1%
3300-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Unplanned Disturbance Area	-	Cat D11T CD	--	--	--	-	125	-	5	22.9	1.2	1.0	3,300	1.2	-	-	22	3	1.00	50	1.0	1.0	1.0	1%
2101-A-a-Dz2	Grade-North-Existing Ground	9AX	-	Cat D11T CD	--	--	--	451,017	48	974	-	462.9	1.2	1.6	3,600	1.2	458	804	22	3	1.00	50	1.0	1.0	1.0	-29%
2102-A-a-Dz2	Grade-South-Existing Ground	9AX	-	Cat D11T CD	--	--	--	150,339	16	1,737	-	86.5	1.2	1.6	3,600	1.2	235	1,434	22	3	1.00	50	1.0	1.0	1.0	-29%
2600-A-a-Dz2	Grade-Tailing Launder Line-Existing Ground	Tailing Launder Line	-	Cat D11T CD	--	--	--	134,550	7	2,465	-	54.6	1.2	1.0	3,300	1.2	100	3,007	22	3	1.00	50	1.0	1.0	1.0	1%
1000-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1A and 1B Leach	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	1,321,320	273	-	-	423.4	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1100-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1C	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	82,300	17	-	-	26.4	-	-	-	-	-	-	-	-	-	50	-	-	-	0%
1200-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	2,357,040	487	-	-	755.3	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	3A / 3B	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	2,202,200	455	-	-	721.5	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1500-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	5A Overburden	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	1,795,640	371	-	-	575.4	-	-	-	-	-	-	-	-	-	50	-	-	-	-
2200-B-b-Dz2	Dozer Assist-Cover	Leach Stockpile	San Salvador Pit	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	556,600	115	-	-	186.4	-	-	-	-	-	-	-	-	-	50	-	-	-	-5%
2300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	314,600	65	-	-	102.0	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1400-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	4C Leach	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	885,720	183	-	-	290.9	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1800-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	1,815,000	375	-	-	581.6	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1900-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	8C	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	229,222	47	-	-	74.4	-	-	-	-	-	-	-	-	-	50	-	-	-	0%
1600-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6B	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	261,360	54	-	-	83.8	-	-	-	-	-	-	-	-	-	50	-	-	-	-
1700-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6C	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	319,440	66	-	-	102.4	-	-	-	-	-	-	-	-	-	50	-	-	-	-
2701-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Crtmnt-1	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	102,753	21	-	-	35.9	-	-	-	-	-	-	-	-	-	50	-	-	-	1%
3300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Unplanned Disturbance Area	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	605,000	125	-	-	211.1	-	-	-	-	-	-	-	-	-	50	-	-	-	1%
2100-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile Toe	9AX	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	1	102,769	64	-	-	34.5	-	-	-	-	-	-	-	-	-	50	-	-	-	-
2600-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile	Tailing Launder Line	Cat D11T CD	Ld2	Cat 988H Loader	1	9,637	7	-	-	17.3	-	-	-	-	-	-	-	-	-	50	-	-	-	1%
1302-B-f-Dz2	Dozer Assist-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	2	17,500,000	-	-	-	11,665.3	1.0	1.6	3,300	1.2	-	-	22	3	1.00	50	1.0	1.0	1.0	-29%
2201-B-f-Dz2	Dozer Assist-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Cat D11T CD	Sh1	Hitachi EX3600-5 Shovel	2	3,500,000	-	-	-	2,487.5	1.0	1.0	3,300	1.2	-	-	22	3	1.00	50	1.0	1.0	1.0	0%
2900-B-b-Dz2	Dozer Assist-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat D11T CD	Ld2	Cat 988H Loader	1	45,360	7	-	-	73.1	-	-	-	-	-	-	-	-	-	50	-	-	-	1%
2600-A-d-Dz2	Grade-Tailing Launder Line-Placed Cover	Tailing Launder Line	-	Cat D11T CD	--	--	--	9,637	7	2,465	-	3.9	1.2	1.0	3,300	1.2	100	3,007	22	3	1.00	50	1.0	1.0	1.0	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 10 Loader Shovel
Equipment for hrs Sh1
Equipment for hrs Ld2

ID	Task Description	Source Location 1	Destination Location 2	Equipment	Operational Maintenance Time (hrs)
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	1A and 1B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	423
1100-P-b-Comb1	Road Maintenance-Top (Haul Road)	Gila Borrow Area	1C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	26
1200-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	755
1300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	3A / 3B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	722
1500-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	5A Overburden	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	575
2200-P-b-Comb1	Road Maintenance-Entire Pit	Leach Stockpile	San Salvador Pit	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	186
2300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	102
1400-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	4C Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	291
1800-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	582
1900-P-b-Comb1	Road Maintenance-Sludge Disposal Area	Gila Borrow Area	8C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	74
1600-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	84
1700-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	102
2701-P-b-Comb1	Road Maintenance-Surface Impoundments closed at year 99; some closed year 6	Gila Borrow Area	Cntmnt-1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	36
3300-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Gila Borrow Area	Unplanned Disturbance Area	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	211
2100-P-b-Comb1	Road Maintenance-Entire Stockpile	9AX Stockpile Toe	9AX	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	34
1302-P-f-Comb1	Road Maintenance-Outslopes Pullback	3A/3B	3A / 3B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	5,833
2201-P-f-Comb1	Road Maintenance-Pit Backfill	Leach Stockpile	San Salvador Pit	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	1,244
2600-P-b-Comb1	Road Maintenance-Tailing Launder Line	9AX Stockpile	Tailing Launder Line	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	17
2900-P-b-Comb1	Road Maintenance-Tailing Pumphouse	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	73

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											
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 or 100 Ft Passes/Acre**	**Ripped Width Plus Distance b/n Passes (ft)**
Rip-Top-Rough Graded Material	1A and 1B Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	17.00	2.9	5.8	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	2A Leach and 2B Waste	-	Cat D11T CD Multi-shank (w/ MSR-359H)	36.00	2.9	12.3	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	3A / 3B	-	Cat D11T CD Multi-shank (w/ MSR-359H)	33.00	2.9	11.3	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	5A Overburden	-	Cat D11T CD Multi-shank (w/ MSR-359H)	63.00	2.9	21.6	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Entire Pit-Rough Graded Material	San Salvador Pit	-	Cat D11T CD Multi-shank (w/ MSR-359H)	115.00	2.9	39.4	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	4C Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	13.00	2.9	4.5	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	2C, 4A, 4B, 7B Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	126.00	2.9	43.2	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	6B	-	Cat D11T CD Multi-shank (w/ MSR-359H)	39.00	2.9	13.4	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	6C	-	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
Rip-Top-Rough Graded Material	Savanna In-Pit Leach Stockpile	-	Cat D11T CD Multi-shank (w/ MSR-359H)	32.50	2.9	11.1	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Top-Rough Graded Material	9A Overburden	-	Cat D11T CD Multi-shank (w/ MSR-359H)	13.00	2.9	4.5	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Sludge Disposal Area-Rough Graded Material	8C	-	Cat D11T CD Multi-shank (w/ MSR-359H)	47.36	2.9	16.2	1,000	18	59	59	3	0.25	50	1.0	1.5	30
Rip-Surface Impoundments closed at year 99; some closed year 6-Rough Graded Material	Surface Impoundments closed at year 99; some closed year 6	-	Cat D11T CD Multi-shank (w/ MSR-359H)	21.23	2.4	8.7	100	18	59	59	3	0.25	50	1.0	14.8	30
Rip-Tailing Launder Line-Rough Graded Material	Tailing Launder Line	-	Cat D11T CD Multi-shank (w/ MSR-359H)	7.40	2.4	3.0	100	18	59	59	3	0.25	50	1.0	14.8	30

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

5	6	7	8	9	10	11			12	13		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)**
2701-K-a-Ex1	Perforate Liner-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	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
2702-K-a-Ex1	Perforate Liner-Surface Impoundments graded over at closure-Existing Ground	Surface Impoundments graded over at closure	-	Cat 319D L	0.5	ac	3.0	ft	31.7	0.16	50.00	0.70

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	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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)**	**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)**
1302-D-f-Tk4	Haul-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Komatsu 730E	Sh1	17,500,000	7.0	3	28.1	3,000.3	5,608.0	5,832.7	101.0	145.0	5.0	3,900	3,900	-	-	0.0%	0.0%	0.0%	2.5%	1,189	-	-
2201-D-f-Tk4	Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Komatsu 730E	Sh1	3,500,000	5.0	2	28.1	2,814.1	1,121.6	1,243.7	101.0	145.0	5.0	1,300	1,300	-	-	-1.0%	0.0%	0.0%	2.5%	396	-	-
1000-D-b-Tk4	Haul-Cover	Gila Borrow Area	1A and 1B Leach	Komatsu 730E	Sh1	1,321,320	10.9	5	28.1	3,224.2	423.4	423.4	101.0	145.0	5.0	6,260	2,320	2,170	1,770	2.2%	7.8%	0.0%	2.5%	707	661	539
1100-D-b-Tk4	Haul-Cover	Gila Borrow Area	1C	Komatsu 730E	Sh1	82,300	15.7	7	28.1	3,123.8	26.4	26.4	101.0	145.0	5.0	11,833	7,780	4,053	-	0.8%	5.9%	0.0%	2.5%	2,371	1,235	-
1200-D-b-Tk4	Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Komatsu 730E	Sh1	2,357,040	20.2	9	28.1	3,123.2	755.3	755.3	101.0	145.0	5.0	13,612	9,772	2,193	1,647	5.1%	1.4%	6.9%	2.5%	2,979	669	502
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	101.0	145.0	5.0	11,221	4,411	6,810	-	-7.0%	6.6%	0.0%	2.5%	1,344	2,076	-
1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	Komatsu 730E	Sh1	1,795,640	8.5	4	28.1	3,297.3	575.4	575.4	101.0	145.0	5.0	4,750	1,450	3,300	-	6.2%	0.0%	0.0%	2.5%	442	1,006	-
2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	Komatsu 730E	Sh1	556,600	18.8	8	28.1	2,985.9	178.4	186.4	101.0	145.0	5.0	12,570	7,780	3,020	1,770	0.8%	9.9%	-9.6%	2.5%	2,371	920	539
2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Komatsu 730E	Sh1	314,600	9.1	4	28.1	3,082.9	100.8	102.0	101.0	145.0	5.0	5,730	5,730	-	-	1.6%	0.0%	0.0%	2.5%	1,747	-	-
1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	Komatsu 730E	Sh1	885,720	23.1	10	28.1	3,044.9	283.8	290.9	101.0	145.0	5.0	17,830	7,780	3,020	7,030	0.8%	9.9%	2.6%	2.5%	2,371	920	2,143
1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Komatsu 730E	Sh1	1,815,000	20.0	9	28.1	3,164.9	581.6	581.6	101.0	145.0	5.0	13,990	7,780	6,210	-	0.8%	7.9%	0.0%	2.5%	2,371	1,893	-
1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	Komatsu 730E	Sh1	229,222	9.1	4	28.1	3,082.9	73.5	74.4	101.0	145.0	5.0	5,730	5,730	-	-	1.6%	0.0%	0.0%	2.5%	1,747	-	-
1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	Komatsu 730E	Sh1	261,360	13.4	6	28.1	3,132.3	83.8	83.8	101.0	145.0	5.0	10,050	7,780	2,270	-	0.8%	6.2%	0.0%	2.5%	2,371	692	-
1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	Komatsu 730E	Sh1	319,440	15.7	7	28.1	3,123.8	102.4	102.4	101.0	145.0	5.0	11,833	7,780	4,053	-	0.8%	5.9%	0.0%	2.5%	2,371	1,235	-
2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	Komatsu 730E	Sh1	102,753	14.7	6	28.1	2,865.8	32.9	35.9	101.0	145.0	5.0	10,791	5,873	3,832	1,086	1.3%	5.1%	1.1%	2.5%	1,790	1,168	331
3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	Komatsu 730E	Sh1	605,000	14.7	6	28.1	2,865.8	193.9	211.1	101.0	145.0	5.0	10,791	5,873	3,832	1,086	1.3%	5.1%	1.1%	2.5%	1,790	1,168	331
2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	Komatsu 730E	Sh1	102,769	14.1	6	28.1	2,979.9	32.9	34.5	101.0	145.0	5.0	6,343	3,639	2,704	-	6.0%	10.0%	0.0%	2.5%	1,109	824	-
2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	Cat 769D	Ld2	9,637	13.1	5	7.3	558.4	15.2	17.3	22.2	31.7	4.0	10,791	5,873	3,832	1,086	1.3%	5.1%	1.1%	2.5%	1,790	1,168	331
2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 769D	Ld2	45,360	35.2	15	7.3	620.5	71.6	73.1	22.2	31.7	4.0	14,100	4,610	5,820	3,670	-0.8%	-4.6%	1.4%	2.5%	1,405	1,774	1,119

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 stock
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	38	39	40	41	42	43	44	45	46	47	48	49
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 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-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Komatsu 730E	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	1.7	1.2	2.25	0.7	1.1	50	0.00145	0.00145	0.00145	0.00105	0.00105	0.00105
Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Komatsu 730E	1.5%	2.5%	2.5%	3.5%	2.5%	2.5%	0.4	0.5	2.25	0.7	1.1	50	0.00113	0.00145	0.00145	0.00124	0.00105	0.00105
Haul-Cover	Gila Borrow Area	1A and 1B Leach	Komatsu 730E	4.7%	10.3%	2.5%	0.3%	5.3%	2.5%	4.8	2.0	2.25	0.7	1.1	50	0.00201	0.00398	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	1C	Komatsu 730E	3.3%	8.4%	2.5%	1.7%	3.4%	2.5%	7.9	3.8	2.25	0.7	1.1	50	0.00163	0.00327	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Komatsu 730E	7.6%	3.9%	9.4%	2.6%	1.1%	4.4%	11.8	4.4	2.25	0.7	1.1	50	0.00296	0.00178	0.00362	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	4.5%	9.1%	2.5%	9.5%	4.1%	2.5%	9.6	4.7	2.25	0.7	1.1	50	0.00174	0.00352	0.00145	0.00189	0.00105	0.00105
Haul-Cover	Gila Borrow Area	5A Overburden	Komatsu 730E	8.7%	2.5%	2.5%	3.7%	2.5%	2.5%	2.9	1.5	2.25	0.7	1.1	50	0.00337	0.00145	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Leach Stockpile	San Salvador Pit	Komatsu 730E	3.3%	12.4%	7.1%	1.7%	7.4%	12.1%	9.7	5.1	2.25	0.7	1.1	50	0.00163	0.00482	0.00251	0.00105	0.00153	0.00224
Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Komatsu 730E	4.1%	2.5%	2.5%	0.9%	2.5%	2.5%	3.2	1.8	2.25	0.7	1.1	50	0.00185	0.00145	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	4C Leach	Komatsu 730E	3.3%	12.4%	5.1%	1.7%	7.4%	0.1%	12.9	6.1	2.25	0.7	1.1	50	0.00163	0.00482	0.00213	0.00105	0.00153	0.00105
Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Komatsu 730E	3.3%	10.4%	2.5%	1.7%	5.4%	2.5%	11.4	4.5	2.25	0.7	1.1	50	0.00163	0.00400	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	8C	Komatsu 730E	4.1%	2.5%	2.5%	0.9%	2.5%	2.5%	3.2	1.8	2.25	0.7	1.1	50	0.00185	0.00145	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	6B	Komatsu 730E	3.3%	8.7%	2.5%	1.7%	3.7%	2.5%	6.2	3.2	2.25	0.7	1.1	50	0.00163	0.00336	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	6C	Komatsu 730E	3.3%	8.4%	2.5%	1.7%	3.4%	2.5%	7.9	3.8	2.25	0.7	1.1	50	0.00163	0.00327	0.00145	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	Cntmnt-1	Komatsu 730E	3.8%	7.6%	3.6%	1.2%	2.6%	1.4%	7.2	3.5	2.25	0.7	1.1	50	0.00176	0.00297	0.00170	0.00105	0.00105	0.00105
Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	Komatsu 730E	3.8%	7.6%	3.6%	1.2%	2.6%	1.4%	7.2	3.5	2.25	0.7	1.1	50	0.00176	0.00297	0.00170	0.00105	0.00105	0.00105
Haul-Cover	9AX Stockpile Toe	9AX	Komatsu 730E	8.5%	12.5%	2.5%	3.5%	7.5%	2.5%	7.7	2.4	2.25	0.7	1.1	50	0.00330	0.00485	0.00145	0.00105	0.00154	0.00105
Haul-Cover	9AX Stockpile	Tailing Launder Line	Cat 769D	3.8%	7.6%	3.6%	1.2%	2.6%	1.4%	6.3	2.6	2.30	0.7	1.1	50	0.00151	0.00271	0.00145	0.00079	0.00079	0.00079
Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 769D	1.7%	2.1%	3.9%	3.3%	7.1%	1.1%	25.7	5.5	2.30	0.7	1.1	50	0.00659	0.00828	0.00154	0.00115	0.00168	0.00079

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	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
1100-C-b-Sh1	Load-Cover	Gila Borrow Area	1C	Hitachi EX3600-5	Tk4	82,300	0.45	3,120.6	26.4	26.4	28.1	50
1200-C-b-Sh1	Load-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Hitachi EX3600-5	Tk4	2,357,040	0.45	3,120.6	755.3	755.3	28.1	50
1300-C-b-Sh1	Load-Cover	Gila Borrow Area	3A / 3B	Hitachi EX3600-5	Tk4	2,202,200	0.45	3,120.6	705.7	721.5	28.1	50
1500-C-b-Sh1	Load-Cover	Gila Borrow Area	5A Overburden	Hitachi EX3600-5	Tk4	1,795,640	0.45	3,120.6	575.4	575.4	28.1	50
2200-C-b-Sh1	Load-Cover	Leach Stockpile	San Salvador Pit	Hitachi EX3600-5	Tk4	556,600	0.45	3,120.6	178.4	186.4	28.1	50
2300-C-b-Sh1	Load-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Hitachi EX3600-5	Tk4	314,600	0.45	3,120.6	100.8	102.0	28.1	50
1400-C-b-Sh1	Load-Cover	Gila Borrow Area	4C Leach	Hitachi EX3600-5	Tk4	885,720	0.45	3,120.6	283.8	290.9	28.1	50
1800-C-b-Sh1	Load-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Hitachi EX3600-5	Tk4	1,815,000	0.45	3,120.6	581.6	581.6	28.1	50
1900-C-b-Sh1	Load-Cover	Gila Borrow Area	8C	Hitachi EX3600-5	Tk4	229,222	0.45	3,120.6	73.5	74.4	28.1	50
1600-C-b-Sh1	Load-Cover	Gila Borrow Area	6B	Hitachi EX3600-5	Tk4	261,360	0.45	3,120.6	83.8	83.8	28.1	50
1700-C-b-Sh1	Load-Cover	Gila Borrow Area	6C	Hitachi EX3600-5	Tk4	319,440	0.45	3,120.6	102.4	102.4	28.1	50
2701-C-b-Sh1	Load-Cover	Gila Borrow Area	Cntmnt-1	Hitachi EX3600-5	Tk4	102,753	0.45	3,120.6	32.9	35.9	28.1	50
3300-C-b-Sh1	Load-Cover	Gila Borrow Area	Unplanned Disturbance Area	Hitachi EX3600-5	Tk4	605,000	0.45	3,120.6	193.9	211.1	28.1	50
2100-C-b-Sh1	Load-Cover	9AX Stockpile Toe	9AX	Hitachi EX3600-5	Tk4	102,769	0.45	3,120.6	32.9	34.5	28.1	50
2600-C-b-Ld2	Load-Cover	9AX Stockpile	Tailing Launder Line	Cat 988H	Tk2	9,637	0.58	633.8	15.2	17.3	7.3	50
1302-C-f-Sh1	Load-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Hitachi EX3600-5	Tk4	17,500,000	0.45	3,120.6	5,608.0	5,832.7	28.1	50
2201-C-f-Sh1	Load-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Hitachi EX3600-5	Tk4	3,500,000	0.45	3,120.6	1,121.6	1,243.7	28.1	50
2900-C-b-Ld2	Load-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 988H	Tk2	45,360	0.58	633.8	71.6	73.1	7.3	50

Sheet used for testing purposes and maintained for spreadsheet integrity. No Scrapers used in Tyrone RCE.

Tyrone Mine
Stockpile Spreadsheet Worksheet #11
5/1/2019

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)**

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
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
1201-A-a-Mg1	Grade-Top-Existing Ground	2A Leach and 2B Waste	-	Cat 16M	36	3	12.4	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1301-A-a-Mg1	Grade-Top-Existing Ground	3A / 3B	-	Cat 16M	33	3	11.4	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1501-A-a-Mg1	Grade-Top-Existing Ground	5A Overburden	-	Cat 16M	63	3	21.7	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1401-A-a-Mg1	Grade-Top-Existing Ground	4C Leach	-	Cat 16M	13	3	4.5	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1801-A-a-Mg1	Grade-Top-Existing Ground	2C, 4A, 4B, 7B Leach	-	Cat 16M	126	3	43.5	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1601-A-a-Mg1	Grade-Top-Existing Ground	6B	-	Cat 16M	39	3	13.5	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1701-A-a-Mg1	Grade-Top-Existing Ground	6C	-	Cat 16M	10	3	3.5	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
2301-A-a-Mg1	Grade-Top-Existing Ground	Savanna In-Pit Leach Stockpile	-	Cat 16M	33	3	11.2	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
2001-A-a-Mg1	Grade-Top-Existing Ground	9A Overburden	-	Cat 16M	13	3	4.5	1.0	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
2802-A-a-Mg1	Grade-Sloped Areas-Existing Ground	Tailing Repositories Borrow Areas	-	Cat 16M	25	5	5.5	1.6	1.0	3,300	1.20	16.00	2.00	2.50	50	1.00
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	1A and 1B Leach	-	Cat 16M	273	3	90.2	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1100-A-d-Mg1	Grade-Top (Haul Road)-Placed Cover	1C	-	Cat 16M	17	3	5.6	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1200-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2A Leach and 2B Waste	-	Cat 16M	487	3	160.8	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	3A / 3B	-	Cat 16M	455	3	150.3	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1500-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	5A Overburden	-	Cat 16M	371	3	122.5	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
2200-A-d-Mg1	Grade-Entire Pit-Placed Cover	San Salvador Pit	-	Cat 16M	115	3	34.5	1.1	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
2300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	Savanna In-Pit Leach Stockpile	-	Cat 16M	65	3	21.5	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1400-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	4C Leach	-	Cat 16M	183	3	60.4	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1800-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2C, 4A, 4B, 7B Leach	-	Cat 16M	375	3	123.8	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1900-A-d-Mg1	Grade-Sludge Disposal Area-Placed Cover	8C	-	Cat 16M	47	3	15.6	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1600-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6B	-	Cat 16M	54	3	17.8	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
1700-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6C	-	Cat 16M	66	3	21.8	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
2701-A-d-Mg1	Grade-Surface Impoundments closed at year 99; some closed year 6-Placed Cover	Surface Impoundments closed at year 99; some closed year 6	-	Cat 16M	21	3	7.2	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
3300-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Unplanned Disturbance Area	-	Cat 16M	125	3	42.1	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
2100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	9AX	-	Cat 16M	64	3	21.0	1.0	1.2	2,900	1.20	16.00	2.00	2.50	50	0.75
2900-A-d-Mg1	Grade-Tailing Pumphouse-Placed Cover	Tailing Dam 1 Reclaim Water Pumphouse	-	Cat 16M	7	3	2.4	1.0	1.2	2,900	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 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	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)
1003-A-a-Dz2	Grade-Outslopes - Area outside of pullback-Existing Ground	1A and 1B Leach	-	Cat D11T CD	$69.62	$254.44	$27.41	1	77.9	$5,426	$19,833	$2,137	$27,396	140,000	-
1002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	1A and 1B Leach	-	Cat D11T CD	$69.62	$254.44	$27.41	1	305.4	$21,261	$77,707	$8,371	$107,339	1,329,670	-
1202-A-a-Dz2	Grade-Outslopes-Existing Ground	2A Leach and 2B Waste	-	Cat D11T CD	$69.62	$254.44	$27.41	1	7,755.7	$539,914	$1,973,381	$212,584	$2,725,879	8,060,000	-
1304-A-a-Dz2	Grade-Outslopes (total area, volume outside of pullback)-Existing Ground	3A / 3B	-	Cat D11T CD	$69.62	$254.44	$27.41	1	3,920.1	$272,900	$997,449	$107,451	$1,377,800	3,500,000	-
1303-A-f-Dz2	Grade-Outslopes - Regrade benches from pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Cat D11T CD	$69.62	$254.44	$27.41	1	438.3	$30,509	$111,510	$12,012	$154,031	1,590,064	-
1502-A-a-Dz2	Grade-Outslopes-Existing Ground	5A Overburden	-	Cat D11T CD	$69.62	$254.44	$27.41	1	6,837.3	$475,979	$1,739,700	$187,411	$2,403,090	6,300,000	-
2302-A-a-Dz2	Grade-Outslopes-Existing Ground	Savanna In-Pit Leach Stockpile	-	Cat D11T CD	$69.62	$254.44	$27.41	1	51.1	$3,554	$12,990	$1,399	$17,944	135,000	-
1402-A-a-Dz2	Grade-Outslopes-Existing Ground	4C Leach	-	Cat D11T CD	$69.62	$254.44	$27.41	1	2,405.3	$167,445	$612,012	$65,929	$845,387	2,700,000	-
1802-A-a-Dz2	Grade-Outslopes-Existing Ground	2C, 4A, 4B, 7B Leach	-	Cat D11T CD	$69.62	$254.44	$27.41	1	2,007.6	$139,759	$510,819	$55,028	$705,607	2,300,000	-
1602-A-a-Dz2	Grade-Outslopes-Existing Ground	6B	-	Cat D11T CD	$69.62	$254.44	$27.41	1	76.6	$5,336	$19,502	$2,101	$26,938	183,000	-
1702-A-a-Dz2	Grade-Outslopes-Existing Ground	6C	-	Cat D11T CD	$69.62	$254.44	$27.41	1	454.3	$31,626	$115,593	$12,452	$159,672	650,000	-
2002-A-a-Dz2	Grade-Outslopes - Regrade benches from pullback-Existing Ground	9A Overburden	-	Cat D11T CD	$69.62	$254.44	$27.41	1	147.6	$10,276	$37,558	$4,046	$51,880	642,674	-
1001-A-a-Mg1	Grade-Top-Existing Ground	1A and 1B Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	5.9	$130	$549	$161	$840	-	17.0
1201-A-a-Mg1	Grade-Top-Existing Ground	2A Leach and 2B Waste	-	Cat 16M	$22.23	$93.51	$27.41	1	12.4	$276	$1,162	$341	$1,778	-	36.0
1301-A-a-Mg1	Grade-Top-Existing Ground	3A / 3B	-	Cat 16M	$22.23	$93.51	$27.41	1	11.4	$253	$1,065	$312	$1,630	-	33.0
1501-A-a-Mg1	Grade-Top-Existing Ground	5A Overburden	-	Cat 16M	$22.23	$93.51	$27.41	1	21.7	$483	$2,033	$596	$3,112	-	63.0
2200-A-a-Dz2	Grade-Entire Pit-Existing Ground	San Salvador Pit	-	Cat D11T CD	$69.62	$254.44	$27.41	1	985.7	$68,616	$250,792	$27,017	$346,426	1,600,000	-
1401-A-a-Mg1	Grade-Top-Existing Ground	4C Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	4.5	$100	$420	$123	$642	-	13.0
1801-A-a-Mg1	Grade-Top-Existing Ground	2C, 4A, 4B, 7B Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	43.5	$967	$4,066	$1,192	$6,225	-	126.0
1601-A-a-Mg1	Grade-Top-Existing Ground	6B	-	Cat 16M	$22.23	$93.51	$27.41	1	13.5	$299	$1,259	$369	$1,927	-	39.0
1701-A-a-Mg1	Grade-Top-Existing Ground	6C	-	Cat 16M	$22.23	$93.51	$27.41	1	3.5	$77	$323	$95	$494	-	10.0
2301-A-a-Mg1	Grade-Top-Existing Ground	Savanna In-Pit Leach Stockpile	-	Cat 16M	$22.23	$93.51	$27.41	1	11.2	$249	$1,049	$307	$1,606	-	32.5
2001-A-a-Mg1	Grade-Top-Existing Ground	9A Overburden	-	Cat 16M	$22.23	$93.51	$27.41	1	4.5	$100	$420	$123	$642	-	13.0
1900-A-a-Dz2	Grade-Sludge Disposal Area-Existing Ground	8C	-	Cat D11T CD	$69.62	$254.44	$27.41	1	8.5	$591	$2,161	$233	$2,985	-	47.4
2701-A-a-Dz2	Grade-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	Cat D11T CD	$69.62	$254.44	$27.41	1	3.9	$270	$989	$106	$1,366	-	21.2
3300-A-a-Dz2	Grade-Unplanned Disturbance Area-Existing Ground	Unplanned Disturbance Area	-	Cat D11T CD	$69.62	$254.44	$27.41	1	22.9	$1,593	$5,821	$627	$8,040	-	125.0
2101-A-a-Dz2	Grade-North-Existing Ground	9AX	-	Cat D11T CD	$69.62	$254.44	$27.41	1	462.9	$32,228	$117,794	$12,689	$162,711	451,017	-
2102-A-a-Dz2	Grade-South-Existing Ground	9AX	-	Cat D11T CD	$69.62	$254.44	$27.41	1	86.5	$6,025	$22,021	$2,372	$30,418	150,339	-
2600-A-a-Dz2	Grade-Tailing Launder Line-Existing Ground	Tailing Launder Line	-	Cat D11T CD	$69.62	$254.44	$27.41	1	54.6	$3,800	$13,890	$1,496	$19,186	134,550	-
2802-A-a-Mg1	Grade-Sloped Areas-Existing Ground	Tailing Repositories Borrow Areas	-	Cat 16M	$22.23	$93.51	$27.41	1	5.5	$121	$510	$150	$781	-	25.5
1001-E-c-Rp1	Rip-Top-Rough Graded Material	1A and 1B Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	5.8	$406	$1,512	$160	$2,078	-	17.0
1201-E-c-Rp1	Rip-Top-Rough Graded Material	2A Leach and 2B Waste	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	12.3	$860	$3,202	$338	$4,400	-	36.0
1301-E-c-Rp1	Rip-Top-Rough Graded Material	3A / 3B	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	11.3	$788	$2,935	$310	$4,033	-	33.0
1501-E-c-Rp1	Rip-Top-Rough Graded Material	5A Overburden	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	21.6	$1,504	$5,604	$592	$7,700	-	63.0
2200-E-c-Rp1	Rip-Entire Pit-Rough Graded Material	San Salvador Pit	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	39.4	$2,746	$10,229	$1,081	$14,056	-	115.0
1401-E-c-Rp1	Rip-Top-Rough Graded Material	4C Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	4.5	$310	$1,156	$122	$1,589	-	13.0
1801-E-c-Rp1	Rip-Top-Rough Graded Material	2C, 4A, 4B, 7B Leach	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	43.2	$3,008	$11,208	$1,185	$15,401	-	126.0
1601-E-c-Rp1	Rip-Top-Rough Graded Material	6B	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	13.4	$931	$3,469	$367	$4,767	-	39.0
1701-E-c-Rp1	Rip-Top-Rough Graded Material	6C	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	3.4	$239	$889	$94	$1,222	-	10.0
2301-E-c-Rp1	Rip-Top-Rough Graded Material	Savanna In-Pit Leach Stockpile	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	11.1	$776	$2,891	$306	$3,972	-	32.5
2001-E-c-Rp1	Rip-Top-Rough Graded Material	9A Overburden	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	4.5	$310	$1,156	$122	$1,589	-	13.0
1900-E-c-Rp1	Rip-Sludge Disposal Area-Rough Graded Material	8C	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	16.2	$1,131	$4,213	$445	$5,789	-	47.4
2701-E-c-Rp1	Rip-Surface Impoundments closed at year 99; some closed year 6-Rough Graded Material	Surface Impoundments closed at year 99; some closed year 6	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	8.7	$605	$2,254	$238	$3,098	-	21.2
2600-E-c-Rp1	Rip-Tailing Launder Line-Rough Graded Material	Tailing Launder Line	-	Cat D11T CD Multi-shank (w/ MSR-359H)	$69.62	$259.35	$27.41	1	3.0	$211	$786	$83	$1,080	-	7.4
2701-K-a-Ex1	Perforate Liner-Surface Impoundments closed at year 99; some closed year 6-Existing Ground	Surface Impoundments closed at year 99; some closed year 6	-	Cat 319D L	$12.29	$52.38	$27.70	1	31.2	$383	$1,632	$863	$2,877	-	21.2
2702-K-a-Ex1	Perforate Liner-Surface Impoundments graded over at closure-Existing Ground	Surface Impoundments graded over at closure	-	Cat 319D L	$12.29	$52.38	$27.70	1	0.7	$9	$37	$20	$65	-	0.5
1000-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1A and 1B Leach	Cat D11T CD	$69.62	$254.44	$27.41	1	423.4	$29,477	$107,737	$11,606	$148,820	1,321,320	-
1100-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	1C	Cat D11T CD	$69.62	$254.44	$27.41	1	26.4	$1,836	$6,711	$723	$9,269	82,300	-
1200-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Cat D11T CD	$69.62	$254.44	$27.41	1	755.3	$52,582	$192,187	$20,704	$265,473	2,357,040	-
1300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	3A / 3B	Cat D11T CD	$69.62	$254.44	$27.41	1	721.5	$50,228	$183,582	$19,776	$253,586	2,202,200	-
1500-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	5A Overburden	Cat D11T CD	$69.62	$254.44	$27.41	1	575.4	$40,058	$146,412	$15,772	$202,242	1,795,640	-
2200-B-b-Dz2	Dozer Assist-Cover	Leach Stockpile	San Salvador Pit	Cat D11T CD	$69.62	$254.44	$27.41	1	186.4	$12,977	$47,430	$5,109	$65,516	556,600	-
2300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Cat D11T CD	$69.62	$254.44	$27.41	1	102.0	$7,104	$25,965	$2,797	$35,867	314,600	-
1400-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	4C Leach	Cat D11T CD	$69.62	$254.44	$27.41	1	290.9	$20,250	$74,014	$7,973	$102,237	885,720	-
1800-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Cat D11T CD	$69.62	$254.44	$27.41	1	581.6	$40,490	$147,991	$15,942	$204,423	1,815,000	-
1900-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	8C	Cat D11T CD	$69.62	$254.44	$27.41	1	74.4	$5,176	$18,919	$2,038	$26,133	229,222	-
1600-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6B	Cat D11T CD	$69.62	$254.44	$27.41	1	83.8	$5,831	$21,311	$2,296	$29,437	261,360	-
1700-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	6C	Cat D11T CD	$69.62	$254.44	$27.41	1	102.4	$7,126	$26,046	$2,806	$35,978	319,440	-
2701-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Cntmnt-1	Cat D11T CD	$69.62	$254.44	$27.41	1	35.9	$2,496	$9,123	$983	$12,602	102,753	-
3300-B-b-Dz2	Dozer Assist-Cover	Gila Borrow Area	Unplanned Disturbance Area	Cat D11T CD	$69.62	$254.44	$27.41	1	211.1	$14,696	$53,715	$5,787	$74,198	605,000	-
2100-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile Toe	9AX	Cat D11T CD	$69.62	$254.44	$27.41	1	34.5	$2,401	$8,775	$945	$12,121	102,769	-
2600-B-b-Dz2	Dozer Assist-Cover	9AX Stockpile	Tailing Launder Line	Cat D11T CD	$69.62	$254.44	$27.41	1	17.3	$1,201	$4,391	$473	$6,066	9,637	-
1302-B-f-Dz2	Dozer Assist-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Cat D11T CD	$69.62	$254.44	$27.41	2	5,832.7	$812,082	$2,968,154	$319,747	$4,099,983	17,500,000	-
2201-B-f-Dz2	Dozer Assist-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Cat D11T CD	$69.62	$254.44	$27.41	2	1,243.7	$173,167	$632,924	$68,182	$874,273	3,500,000	-
2900-B-b-Dz2	Dozer Assist-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat D11T CD	$69.62	$254.44	$27.41	1	73.1	$5,089	$18,601	$2,004	$25,695	45,360	-
1000-C-b-Sh1	Load-Cover	Gila Borrow Area	1A and 1B Leach	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	423.4	$81,960	$215,093	$11,729	$308,782	1,321,320	-
1100-C-b-Sh1	Load-Cover	Gila Borrow Area	1C	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	26.4	$5,105	$13,397	$731	$19,233	82,300	-
1200-C-b-Sh1	Load-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	755.3	$146,205	$383,694	$20,923	$550,821	2,357,040	-
1300-C-b-Sh1	Load-Cover	Gila Borrow Area	3A / 3B	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	721.5	$139,658	$366,513	$19,986	$526,157	2,202,200	-
1500-C-b-Sh1	Load-Cover	Gila Borrow Area	5A Overburden	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	575.4	$111,382	$292,306	$15,939	$419,627	1,795,640	-
2200-C-b-Sh1	Load-Cover	Leach Stockpile	San Salvador Pit	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	186.4	$36,082	$94,692	$5,163	$135,937	556,600	-
2300-C-b-Sh1	Load-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	102.0	$19,753	$51,839	$2,827	$74,419	314,600	-
1400-C-b-Sh1	Load-Cover	Gila Borrow Area	4C Leach	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	290.9	$56,306	$147,766	$8,058	$212,129	885,720	-
1800-C-b-Sh1	Load-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	581.6	$112,583	$295,457	$16,111	$424,151	1,815,000	-
1900-C-b-Sh1	Load-Cover	Gila Borrow Area	8C	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	74.4	$14,392	$37,771	$2,060	$54,223	229,222	-
1600-C-b-Sh1	Load-Cover	Gila Borrow Area	6B	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	83.8	$16,212	$42,546	$2,320	$61,078	261,360	-
1700-C-b-Sh1	Load-Cover	Gila Borrow Area	6C	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	102.4	$19,815	$52,000	$2,836	$74,651	319,440	-
2701-C-b-Sh1	Load-Cover	Gila Borrow Area	Cntmnt-1	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	35.9	$6,940	$18,214	$993	$26,147	102,753	-
3300-C-b-Sh1	Load-Cover	Gila Borrow Area	Unplanned Disturbance Area	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	211.1	$40,863	$107,240	$5,848	$153,951	605,000	-
2100-C-b-Sh1	Load-Cover	9AX Stockpile Toe	9AX	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	34.5	$6,676	$17,519	$955	$25,150	102,769	-
2600-C-b-Ld2	Load-Cover	9AX Stockpile	Tailing Launder Line	Cat 988H	$35.57	$128.76	$27.70	1	17.3	$614	$2,222	$478	$3,314	9,637	-
1302-C-f-Sh1	Load-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	5,832.7	$1,128,999	$2,962,900	$161,565	$4,253,463	17,500,000	-
2201-C-f-Sh1	Load-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Hitachi EX3600-5	$193.56	$507.98	$27.70	1	1,243.7	$240,746	$631,804	$34,452	$907,001	3,500,000	-
2900-C-b-Ld2	Load-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 988H	$35.57	$128.76	$27.70	1	73.1	$2,600	$9,414	$2,025	$14,039	45,360	-
1302-D-f-Tk4	Haul-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Komatsu 730E	$78.34	$221.79	$24.27	3	5,832.7	$1,370,849	$3,880,899	$424,676	$5,676,424	17,500,000	-
2201-D-f-Tk4	Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Komatsu 730E	$78.34	$221.79	$24.27	2	1,243.7	$194,878	$551,704	$60,372	$806,954	3,500,000	-
1000-D-b-Tk4	Haul-Cover	Gila Borrow Area	1A and 1B Leach	Komatsu 730E	$78.34	$221.79	$24.27	5	423.4	$165,862	$469,559	$51,383	$686,804	1,321,320	-
1100-D-b-Tk4	Haul-Cover	Gila Borrow Area	1C	Komatsu 730E	$78.34	$221.79	$24.27	7	26.4	$14,463	$40,946	$4,481	$59,890	82,300	-

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 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	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)
1200-D-b-Tk4	Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Komatsu 730E	$78.34	$221.79	$24.27	9	755.3	$532,573	$1,507,723	$164,986	$2,205,281	2,357,040	-
1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	$78.34	$221.79	$24.27	8	721.5	$452,201	$1,280,188	$140,088	$1,872,476	2,202,200	-
1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	Komatsu 730E	$78.34	$221.79	$24.27	4	575.4	$180,322	$510,495	$55,862	$746,679	1,795,640	-
2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	Komatsu 730E	$78.34	$221.79	$24.27	8	186.4	$116,830	$330,747	$36,193	$483,769	556,600	-
2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Komatsu 730E	$78.34	$221.79	$24.27	4	102.0	$31,979	$90,534	$9,907	$132,420	314,600	-
1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	Komatsu 730E	$78.34	$221.79	$24.27	10	290.9	$227,891	$645,163	$70,598	$943,652	885,720	-
1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Komatsu 730E	$78.34	$221.79	$24.27	9	581.6	$410,099	$1,160,997	$127,045	$1,698,141	1,815,000	-
1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	Komatsu 730E	$78.34	$221.79	$24.27	4	74.4	$23,301	$65,964	$7,218	$96,483	229,222	-
1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	Komatsu 730E	$78.34	$221.79	$24.27	6	83.8	$39,369	$111,456	$12,196	$163,022	261,360	-
1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	Komatsu 730E	$78.34	$221.79	$24.27	7	102.4	$56,138	$158,928	$17,391	$232,457	319,440	-
2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Cntmnt-1	Komatsu 730E	$78.34	$221.79	$24.27	6	35.9	$16,854	$47,714	$5,221	$69,789	102,753	-
3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	Komatsu 730E	$78.34	$221.79	$24.27	6	211.1	$99,234	$280,933	$30,742	$410,908	605,000	-
2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	Komatsu 730E	$78.34	$221.79	$24.27	6	34.5	$16,211	$45,894	$5,022	$67,127	102,769	-
2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	Cat 769D	$22.79	$108.01	$24.27	5	17.3	$1,967	$9,321	$2,094	$13,382	9,637	-
2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 769D	$22.79	$108.01	$24.27	15	73.1	$24,993	$118,441	$26,615	$170,049	45,360	-
1000-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	1A and 1B Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	90.2	$2,004	$8,430	$2,471	$12,905	-	273.0
1100-A-d-Mg1	Grade-Top (Haul Road)-Placed Cover	1C	-	Cat 16M	$22.23	$93.51	$27.41	1	5.6	$125	$525	$154	$804	-	17.0
1200-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2A Leach and 2B Waste	-	Cat 16M	$22.23	$93.51	$27.41	1	160.8	$3,575	$15,038	$4,408	$23,021	-	487.0
1300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	3A / 3B	-	Cat 16M	$22.23	$93.51	$27.41	1	150.3	$3,340	$14,050	$4,118	$21,509	-	455.0
1500-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	5A Overburden	-	Cat 16M	$22.23	$93.51	$27.41	1	122.5	$2,723	$11,457	$3,358	$17,538	-	371.0
2200-A-d-Mg1	Grade-Entire Pit-Placed Cover	San Salvador Pit	-	Cat 16M	$22.23	$93.51	$27.41	1	34.5	$767	$3,228	$946	$4,942	-	115.0
2300-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	Savanna In-Pit Leach Stockpile	-	Cat 16M	$22.23	$93.51	$27.41	1	21.5	$477	$2,007	$588	$3,073	-	65.0
1400-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	4C Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	60.4	$1,343	$5,651	$1,656	$8,651	-	183.0
1800-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	2C, 4A, 4B, 7B Leach	-	Cat 16M	$22.23	$93.51	$27.41	1	123.8	$2,753	$11,580	$3,394	$17,727	-	375.0
1900-A-d-Mg1	Grade-Sludge Disposal Area-Placed Cover	8C	-	Cat 16M	$22.23	$93.51	$27.41	1	15.6	$348	$1,462	$429	$2,239	-	47.4
1600-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6B	-	Cat 16M	$22.23	$93.51	$27.41	1	17.8	$396	$1,668	$489	$2,553	-	54.0
1700-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	6C	-	Cat 16M	$22.23	$93.51	$27.41	1	21.8	$485	$2,038	$597	$3,120	-	66.0
2701-A-d-Mg1	Grade-Surface Impoundments closed at year 99; some closed year 6-Placed Cover	Surface Impoundments closed at year 99; some closed year 6	-	Cat 16M	$22.23	$93.51	$27.41	1	7.2	$159	$669	$196	$1,024	-	21.2
3300-A-d-Mg1	Grade-Unplanned Disturbance Area-Placed Cover	Unplanned Disturbance Area	-	Cat 16M	$22.23	$93.51	$27.41	1	42.1	$936	$3,939	$1,155	$6,030	-	125.0
2100-A-d-Mg1	Grade-Entire Stockpile-Placed Cover	9AX	-	Cat 16M	$22.23	$93.51	$27.41	1	21.0	$468	$1,967	$577	$3,011	-	63.7
2600-A-d-Dz2	Grade-Tailing Launder Line-Placed Cover	Tailing Launder Line	-	Cat D11T CD	$69.62	$254.44	$27.41	1	3.9	$272	$995	$107	$1,374	9,637	-
2900-A-d-Mg1	Grade-Tailing Pumphouse-Placed Cover	Tailing Dam 1 Reclaim Water Pumphouse	-	Cat 16M	$22.23	$93.51	$27.41	1	2.4	$52	$221	$65	$338	-	7.0
1000-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	1A and 1B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	423.4	$19,360	$65,377	$20,053	$104,791	-	-
1100-P-b-Comb1	Road Maintenance-Top (Haul Road)	Gila Borrow Area	1C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	26.4	$1,206	$4,072	$1,249	$6,527	-	-
1200-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	755.3	$34,536	$116,624	$35,772	$186,932	-	-
1300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	3A / 3B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	721.5	$32,990	$111,402	$34,171	$178,562	-	-
1500-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	5A Overburden	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	575.4	$26,310	$88,846	$27,252	$142,409	-	-
2200-P-b-Comb1	Road Maintenance-Entire Pit	Leach Stockpile	San Salvador Pit	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	186.4	$8,523	$28,782	$8,828	$46,133	-	-
2300-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	102.0	$4,666	$15,756	$4,833	$25,255	-	-
1400-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	4C Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	290.9	$13,300	$44,914	$13,776	$71,990	-	-
1800-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	581.6	$26,594	$89,804	$27,546	$143,944	-	-
1900-P-b-Comb1	Road Maintenance-Sludge Disposal Area	Gila Borrow Area	8C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	74.4	$3,400	$11,480	$3,521	$18,402	-	-
1600-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	83.8	$3,830	$12,932	$3,967	$20,728	-	-
1700-P-b-Comb1	Road Maintenance-Entire Stockpile	Gila Borrow Area	6C	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	102.4	$4,681	$15,806	$4,848	$25,334	-	-
2701-P-b-Comb1	Road Maintenance-Surface Impoundments closed at year 99; some closed year 6	Gila Borrow Area	Cntmnt-1	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	35.9	$1,639	$5,536	$1,698	$8,874	-	-
3300-P-b-Comb1	Road Maintenance-Unplanned Disturbance Area	Gila Borrow Area	Unplanned Disturbance Area	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	211.1	$9,653	$32,596	$9,998	$52,246	-	-
2100-P-b-Comb1	Road Maintenance-Entire Stockpile	9AX Stockpile Toe	9AX	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	34.5	$1,577	$5,325	$1,633	$8,535	-	-
1302-P-f-Comb1	Road Maintenance-Outslopes Pullback	3A/3B	3A / 3B	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	5,832.7	$266,690	$900,573	$276,235	$1,443,499	-	-
2201-P-f-Comb1	Road Maintenance-Pit Backfill	Leach Stockpile	San Salvador Pit	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	1,243.7	$56,869	$192,037	$58,904	$307,809	-	-
2600-P-b-Comb1	Road Maintenance-Tailing Launder Line	9AX Stockpile	Tailing Launder Line	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	17.3	$789	$2,665	$817	$4,271	-	-
2900-P-b-Comb1	Road Maintenance-Tailing Pumphouse	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	$45.72	$154.40	$47.36	1	73.1	$3,343	$11,288	$3,462	$18,093	-	-
								TOTAL		$9,821,732	$30,292,267	$3,361,580	$43,475,579	131,893,836	3,922

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-U2	Revegetate-Entire Stockpile-Final Grade	1A and 1B Leach	-	273.0	$ 3.85	$ 820.12	$ 1,051	$ 223,893
1100-J-e-U2	Revegetate-Top (Haul Road)-Final Grade	1C	-	17.0	$ 3.85	$ 820.12	$ 65	$ 13,945
1200-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	487.0	$ 3.85	$ 820.12	$ 1,874	$ 399,392
1300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	3A / 3B	-	455.0	$ 3.85	$ 820.12	$ 1,751	$ 373,155
1500-J-e-U2	Revegetate-Entire Stockpile-Final Grade	5A Overburden	-	371.0	$ 3.85	$ 820.12	$ 1,428	$ 304,265
2200-J-e-U2	Revegetate-Entire Pit-Final Grade	San Salvador Pit	-	115.0	$ 3.85	$ 820.12	$ 443	$ 94,314
2300-J-e-U2	Revegetate-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	65.0	$ 3.85	$ 820.12	$ 250	$ 53,308
1400-J-e-U2	Revegetate-Entire Stockpile-Final Grade	4C Leach	-	183.0	$ 3.85	$ 820.12	$ 704	$ 150,082
1800-J-e-U2	Revegetate-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	375.0	$ 3.85	$ 820.12	$ 1,443	$ 307,545
1900-J-e-U2	Revegetate-Sludge Disposal Area-Final Grade	8C	-	47.4	$ 3.85	$ 820.12	$ 182	$ 38,841
1600-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6B	-	54.0	$ 3.85	$ 820.12	$ 208	$ 44,286
1700-J-e-U2	Revegetate-Entire Stockpile-Final Grade	6C	-	66.0	$ 3.85	$ 820.12	$ 254	$ 54,128
2000-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9A Overburden	-	129.0	$ 3.85	$ 820.12	$ 496	$ 105,796
2600-J-e-U2	Revegetate-Tailing Launder Line-Final Grade	Tailing Launder Line	-	7.4	$ 3.85	$ 820.12	$ 28	$ 6,072
2900-J-e-U2	Revegetate-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	7.0	$ 3.85	$ 820.12	$ 27	$ 5,741
2701-J-e-U2	Revegetate-Surface Impoundments closed at year 99; some closed year 6-Final Grade	Surface Impoundments closed at year 99; some closed year 6	-	21.2	$ 3.85	$ 820.12	$ 82	$ 17,411
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
3300-J-e-U2	Revegetate-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	125.0	$ 3.85	$ 820.12	$ 481	$ 102,515
2100-J-e-U2	Revegetate-Entire Stockpile-Final Grade	9AX	-	63.7	$ 3.85	$ 820.12	$ 245	$ 52,242
2803-J-e-U2	Revegetate-Revegetation Area-Final Grade	Tailing Repositories Borrow Areas	-	74.7	$ 3.85	$ 820.12	$ 287	$ 61,263
			TOTAL	2,937			$ 11,301	$ 2,408,586

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 ($)	Direct w/o Fuel Cost ($)
3002-N-e-U19	Plug and Abandon Well-Wells-Final Grade	2-inch ID wells (avg. TD = 36 ft)	-	431	ft	$ -	$ 10.55	$ -	$ 4,545
3003-N-e-U19	Plug and Abandon Well-Wells-Final Grade	4-inch ID wells (avg. TD = 113 ft)	-	11,787	ft	$ -	$ 10.55	$ -	$ 124,306
3004-N-e-U19	Plug and Abandon Well-Wells-Final Grade	4-inch ID wells, avg. total depth = 172 ft (28% Year 19 and rest Year 99 of closure)	-	88,284	ft	$ -	$ 10.55	$ -	$ 931,045
2100-N-e-U19	Plug and Abandon Well-Entire Stockpile-Final Grade	9AX	-	405	ft	$ -	$ 10.55	$ -	$ 4,271
3005-O-e-U20	Replace Well-Wells-Final Grade	6-inch ID wells (avg. TD = 135 ft)	-	-	ft	$ -	$ 67.76	$ -	$ -
3006-O-e-U20	Replace Well-Wells-Final Grade	286-2008-04 (5" x 200') Well	-	200	ft	$ -	$ 67.76	$ -	$ 13,552
3007-O-e-U20	Replace Well-Wells-Final Grade	286-2008-05 (5" x 200') Well	-	200	ft	$ -	$ 67.76	$ -	$ 13,552
3008-O-e-U20	Replace Well-Wells-Final Grade	286-2008-06 (4" x 60.5') Well	-	61	ft	$ -	$ 67.76	$ -	$ 4,133
3009-N-e-U19	Plug and Abandon Well-Wells-Final Grade	Exploration Holes	-	63,240	ft	$ -	$ 10.55	$ -	$ 666,931
3100-L-e-U33	Replace Infrastructure-Seep 5E Collection System-Final Grade	Seep 5E Collection System	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2501-L-e-U33	Replace Infrastructure-Preliminary Earthworks-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2502-L-e-U33	Replace Infrastructure-Overflow Pond & Booster Station-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2503-L-e-U33	Replace Infrastructure-Canyon 5 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2504-L-e-U33	Replace Infrastructure-Canyon 6 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2505-L-e-U33	Replace Infrastructure-Canyon 7 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2506-L-e-U33	Replace Infrastructure-Canyon 8 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2507-L-e-U33	Replace Infrastructure-Canyon 10 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2508-L-e-U33	Replace Infrastructure-Canyon 11 Deep Collection-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2509-L-e-U33	Replace Infrastructure-Bolster Existing Surface PLS Catchments-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2510-L-e-U33	Replace Infrastructure-Finger Drain System-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2511-L-e-U33	Replace Infrastructure-Breach of Existing Seepage Collection Trenches-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2512-L-e-U33	Replace Infrastructure-Concrete Pad for Above-Ground Tank-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2513-L-e-U33	Replace Infrastructure-Electrical Hookup-Final Grade	3A Leach Stockpile	-	1	ea	$ -	$ 133,355.94	$ -	$ 133,356
2400-S-e-U29	Fencing-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	57,500	ft	$ -	$ 23.05	$ -	$ 1,325,375
2400-U-e-U30	Vehicle Gates-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	11	ft	$ -	$ 1,002.88	$ -	$ 11,032
2400-V-e-U31	Signs Every 500 ft-Conditional Waiver Pits-Final Grade	Main, Savanna, Gettysburg & Copper Mountain Pits	-	115	cy	$ -	$ 65.19	$ -	$ 7,497
2900-S-e-U29	Fencing-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	2,950	ft	$ -	$ 23.05	$ -	$ 67,998
1000-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	1A and 1B Leach	-	44,800	ft	$ 0.33	$ 1.35	$ 14,780.55	$ 60,641
1200-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	58,600	ft	$ 0.33	$ 1.35	$ 19,333.49	$ 79,321
1300-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	3A / 3B	-	65,200	ft	$ 0.33	$ 1.35	$ 21,510.99	$ 88,254
1500-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	5A Overburden	-	44,000	ft	$ 0.33	$ 1.35	$ 14,516.62	$ 59,558
2200-F-e-U3	Grade Benches-Entire Pit-Final Grade	San Salvador Pit	-	4,700	ft	$ 0.33	$ 1.35	$ 1,550.64	$ 6,362
1400-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	4C Leach	-	16,100	ft	$ 0.33	$ 1.35	$ 5,311.76	$ 21,793
1800-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	26,700	ft	$ 0.33	$ 1.35	$ 8,808.95	$ 36,141
1700-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	6C	-	4,100	ft	$ 0.33	$ 1.35	$ 1,352.68	$ 5,550
2000-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	9A Overburden	-	23,700	ft	$ 0.33	$ 1.35	$ 7,819.18	$ 32,080
2100-F-e-U3	Grade Benches-Entire Stockpile-Final Grade	9AX	-	12,300	ft	$ 0.33	$ 1.35	$ 4,058.05	$ 16,649
1000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	1A and 1B Leach	-	3,727	ft	$ -	$ 374.38	$ -	$ 1,395,315
1200-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	7,999	ft	$ -	$ 374.38	$ -	$ 2,994,668
1300-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	3A / 3B	-	6,069	ft	$ -	$ 374.38	$ -	$ 2,272,114
1500-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	5A Overburden	-	2,754	ft	$ -	$ 374.38	$ -	$ 1,031,043
2200-G-e-U5	Construct Downdrains-Entire Pit-Final Grade	San Salvador Pit	-	1,227	ft	$ -	$ 374.38	$ -	$ 459,365
1400-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	4C Leach	-	3,125	ft	$ -	$ 374.38	$ -	$ 1,169,938
1800-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	2,943	ft	$ -	$ 374.38	$ -	$ 1,101,801
1600-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6B	-	800	ft	$ -	$ 374.38	$ -	$ 299,504
1700-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	6C	-	550	ft	$ -	$ 374.38	$ -	$ 205,909
2000-G-e-U5	Construct Downdrains-Entire Stockpile-Final Grade	9A Overburden	-	2,300	ft	$ -	$ 374.38	$ -	$ 861,075
1000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	1A and 1B Leach	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
1200-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	5	ea	$ -	$ 14,556.48	$ -	$ 72,782
1300-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	3A / 3B	-	4	ea	$ -	$ 14,556.48	$ -	$ 58,226
1500-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	5A Overburden	-	2	ea	$ -	$ 14,556.48	$ -	$ 29,113
2200-Gb-e-U6	Construct Downdrain Dissipators-Entire Pit-Final Grade	San Salvador Pit	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
1400-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	4C Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
1800-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	3	ea	$ -	$ 14,556.48	$ -	$ 43,669
1600-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6B	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
1700-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	6C	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
2000-Gb-e-U6	Construct Downdrain Dissipators-Entire Stockpile-Final Grade	9A Overburden	-	1	ea	$ -	$ 14,556.48	$ -	$ 14,556
1000-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	1A and 1B Leach	-	55,993	ft	$ 1.38	$ 6.58	$ 77,146.12	$ 368,274
1200-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	75,870	ft	$ 1.38	$ 6.58	$ 104,532.28	$ 499,008
1300-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	3A / 3B	-	66,210	ft	$ 1.38	$ 6.58	$ 91,222.91	$ 435,473
1500-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	5A Overburden	-	50,830	ft	$ 1.38	$ 6.58	$ 70,032.63	$ 334,316
2200-H-e-U7a	Construct Channels w/ Riprap-Entire Pit-Final Grade	San Salvador Pit	-	8,817	ft	$ 1.38	$ 6.58	$ 12,147.90	$ 57,991
1400-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	4C Leach	-	19,550	ft	$ 1.38	$ 6.58	$ 26,935.63	$ 128,583
1600-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	6B	-	1,550	ft	$ 1.38	$ 6.58	$ 2,135.56	$ 10,195
1800-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	26,700	ft	$ 1.38	$ 6.58	$ 36,786.77	$ 175,610
1700-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	6C	-	12,487	ft	$ 1.38	$ 6.58	$ 17,204.36	$ 82,129
2000-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	9A Overburden	-	25,148	ft	$ 1.38	$ 6.58	$ 34,648.45	$ 165,402
2100-H-e-U7a	Construct Channels w/ Riprap-Entire Stockpile-Final Grade	9AX	-	12,300	ft	$ 1.38	$ 6.58	$ 16,946.71	$ 80,899
2800-Hb-e-U7b	Construct Channels w/o Riprap-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	13,501	ft	$ 0.10	$ 0.41	$ 1,381.33	$ 5,593
2800-R-e-U28	Construct Berms-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	3,142	ft	$ -	$ 0.06	$ -	$ 195
2600-T-e-U35	Build Grade Control Walls-Tailing Launder Line-Final Grade	Tailing Launder Line	-	1,002	ft	$ -	$ 165.59	$ -	$ 165,992
							TOTAL	$ 590,164	$ 20,111,871

Tyrone Mine

Reclamation Summary Stockpiles, Haul Roads, Reservoirs, and Disturbed Areas

			Current Value
DIRECT COSTS	Facility and Structure Removal		$5,040,149
	Earthmoving		$43,475,579
	Revegetation		$2,419,888
	Other		$20,702,035
	Subtotal, Direct Costs		**$71,637,651**
INDIRECT COSTS	**Subtotal, Indirect Costs**	**30.0%**	**$21,491,295**
TOTAL COST			**$93,128,947**
	Twelve Year Annual Expenditure		**$7,760,746**

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	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	
	Facility	**1A and 1B Leach**	**1C**	**2A Leach and 2B Waste**	**3A / 3B**	**4C Leach**	**5A Overburden**	**6B**	**6C**	**2C, 4A, 4B, 7B Leach**	**8C**	**9A Overburden**	**9AX**	**San Salvador Pit**	**Savanna In-Pit Leach Stockpile**	**Main, Savanna, Gettysburg & Copper Mountain Pits**	**3A Leach Stockpile**	**Tailing Launder Line**	**Surface Impoundments**	**Tailing Repositories Borrow Areas**	**Tailing Dam 1 Reclaim Water Pumphouse**	**Monitoring & Exploration Wells**	**Seep 5E Collection System**	**Building Demo Area**	**Unplanned Disturbance Area**	**All Previously Reclaimed**	**Total**
	Reclaimed Acres[4]	273.00	17.00	486.99	455.00	183.00	371.00	54.00	66.00	375.00	47.36	129.00	63.70	115.00	65.00	0.00	0.00	7.40	21.71	169.10	7.00	0.00	0.00	47.58	125.00	4580.40	**7659.25**
	Item	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	**Capital Cost**	
Direct Costs	Cover Material Excav, Haul, Grade[1]	$1,262,102	$95,723	$3,231,529	$2,852,290	$1,338,660	$1,528,495	$276,817	$371,540	$2,488,386	$197,479	$0	$115,945	$736,297	$271,033	$0	$0	$28,408	$118,435	$0	$228,213	$0	$0	$0	$697,333	$0	**$15,838,684**
	Pullback or Backfill	$0	$0	$0	$15,627,400	$0	$0	$0	$0	$0	$0	$0	$0	$2,896,038	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$18,523,438**
	Top/Outslope Adjustment Grading[2]	$137,653	$0	$2,732,058	$1,383,464	$847,618	$2,413,902	$33,631	$161,388	$727,232	$8,774	$54,112	$193,129	$360,482	$23,522	$0	$0	$20,266	$7,405	$781	$0	$0	$0	$0	$8,040	$0	**$9,113,458**
	Scarify, Seed & Mulch, Reveg[3]	$224,943	$14,011	$401,266	$374,906	$150,786	$305,692	$44,494	$54,382	$308,988	$39,023	$106,292	$52,487	$94,756	$53,558	$0	$0	$6,101	$17,888	$61,550	$5,768	$0	$0	$0	$102,996	$0	**$2,419,888**
	Channels & Benches[4]	$1,974,383	$0	$3,769,644	$2,966,801	$1,396,231	$1,538,580	$326,391	$326,701	$1,402,817	$0	$1,115,581	$118,553	$551,972	$0	$0	$0	$0	$0	$6,974	$0	$0	$0	$0	$0	$0	**$15,494,628**
	Demolition	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$5,040,149**
	Other[5]	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,271	$0	$0	$1,343,904	$1,733,627	$165,992	$0	$195	$67,998	$1,758,065	$133,356	$0	$0	**$5,207,407**
	Capital Cost Totals	**$3,599,081**	**$109,734**	**$10,134,497**	**$23,204,860**	**$3,733,295**	**$5,786,669**	**$681,333**	**$914,011**	**$4,927,423**	**$245,276**	**$1,275,984**	**$484,385**	**$4,639,545**	**$348,113**	**$1,343,904**	**$1,733,627**	**$220,766**	**$143,729**	**$69,500**	**$301,978**	**$1,758,065**	**$133,356**	**$0**	**$808,369**	**$0**	**$71,637,651**
	Capital Cost/Acre	**$13,183**	**$6,453**	**$20,810**	**$51,000**	**$20,401**	**$15,597**	**$12,617**	**$13,849**	**$13,140**	**$5,179**	**$9,891**	**$7,604**	**$40,344**	**$5,356**	-	-	**$29,816**	**$6,620**	**$411**	**$43,140**	-	-	**$0**	**$6,467**	**$0**	**$9,353**
Indirect Costs	Cover Material Excav, Haul, Grade1	$378,631	$28,717	$969,459	$855,687	$401,598	$458,548	$83,045	$111,462	$746,516	$59,244	$0	$34,783	$220,889	$81,310	$0	$0	$8,522	$35,531	$0	$68,464	$0	$0	$0	$209,200	$0	**$4,751,605**
	Pullback or Backfill	$0	$0	$0	$4,688,220	$0	$0	$0	$0	$0	$0	$0	$0	$868,811	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$5,557,031**
	Top/Outslope Adjustment Grading[2]	$41,296	$0	$819,617	$415,039	$254,285	$724,171	$10,089	$48,416	$218,170	$2,632	$16,233	$57,939	$108,145	$7,057	$0	$0	$6,080	$2,222	$234	$0	$0	$0	$0	$2,412	$0	**$2,734,037**
	Scarify, Seed & Mulch, Reveg[3]	$67,483	$4,203	$120,380	$112,472	$45,236	$91,708	$13,348	$16,315	$92,696	$11,707	$31,888	$15,746	$28,427	$16,067	$0	$0	$1,830	$5,367	$18,465	$1,730	$0	$0	$0	$30,899	$0	**$725,966**
	Channels & Benches[4]	$592,315	$0	$1,130,893	$890,040	$418,869	$461,574	$97,917	$98,010	$420,845	$0	$334,674	$35,566	$165,592	$0	$0	$0	$0	$0	$2,092	$0	$0	$0	$0	$0	$0	**$4,648,388**
	Demolition	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$1,512,045**
	Other[5]	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,281	$0	$0	$0	$403,171	$520,088	$49,798	$0	$58	$20,399	$527,420	$40,007	$0	$0	**$1,562,222**
	Indirect Cost Totals	**$1,079,724**	**$32,920**	**$3,040,349**	**$6,961,458**	**$1,119,989**	**$1,736,001**	**$204,400**	**$274,203**	**$1,478,227**	**$73,583**	**$382,795**	**$145,315**	**$1,391,864**	**$104,434**	**$403,171**	**$520,088**	**$66,230**	**$43,119**	**$20,850**	**$90,593**	**$527,420**	**$40,007**	**$0**	**$242,511**	**$0**	**$21,491,295**
	Indirect Cost/Acre	**$3,955**	**$1,936**	**$6,243**	**$15,300**	**$6,120**	**$4,679**	**$3,785**	**$4,155**	**$3,942**	**$1,554**	**$2,967**	**$2,281**	**$12,103**	**$1,607**	-	-	**$8,945**	**$1,986**	**$123**	**$12,942**	-	-	**$0**	**$1,940**	**$0**	**$2,806**
	Total Cost	**$4,678,805**	**$142,654**	**$13,174,846**	**$30,166,318**	**$4,853,284**	**$7,522,670**	**$885,733**	**$1,188,214**	**$6,405,650**	**$318,859**	**$1,658,780**	**$629,700**	**$6,031,409**	**$452,547**	**$1,747,075**	**$2,253,715**	**$286,996**	**$186,848**	**$90,350**	**$392,572**	**$2,285,485**	**$173,363**	**$0**	**$1,050,880**	**$0**	**$93,128,947**
	Total Cost Cover	$1,640,733	$124,440	$4,200,988	$3,707,977	$1,740,258	$1,987,043	$359,862	$483,002	$3,234,902	$256,723	$0	$150,728	$957,187	$352,343	$0	$0	$36,930	$153,966	$0	$296,677	$0	$0	$0	$906,533	$0	$20,590,289
	Pullback or Backfill	$0	$0	$0	$20,315,820	$0	$0	$0	$0	$0	$0	$0	$0	$3,764,949	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$24,080,469
	Total Cost Top/Outslope Adjustment	$178,948	$0	$3,551,675	$1,798,503	$1,101,904	$3,138,073	$43,721	$209,805	$945,402	$11,406	$70,345	$251,068	$468,626	$30,578	$0	$0	$26,346	$9,627	$1,015	$0	$0	$0	$0	$10,452	$0	$11,847,495
	Total Cost Earthwork	$1,819,681	$124,440	$7,752,663	$25,822,100	$2,842,161	$5,125,116	$403,583	$692,806	$4,180,304	$268,129	$70,345	$401,796	$5,190,662	$382,921	$0	$0	$63,276	$163,593	$1,015	$296,677	$0	$0	$0	$916,985	$0	$56,518,253
	Capital Cost Re-Veg	$292,426	$18,214	$521,645	$487,377	$196,022	$397,400	$57,843	$70,696	$401,685	$50,730	$138,179	$68,233	$123,183	$69,625	$0	$0	$7,931	$23,255	$80,016	$7,498	$0	$0	$0	$133,895	$0	$3,145,854
	Capital Cost Other[6]	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,552	$0	$0	$1,747,075	$2,253,715	$215,789	$0	$253	$88,397	$2,285,485	$173,363	$0	$0	$0	$6,769,629
	Total Cost/Acre	**$17,138**	**$8,389**	**$27,054**	**$66,300**	**$26,521**	**$20,277**	**$16,402**	**$18,003**	**$17,082**	**$6,733**	**$12,859**	**$9,885**	**$52,447**	**$6,962**	-	-	**$38,761**	**$8,607**	**$534**	**$56,082**	-	-	**$0**	**$8,407**	**$0**	**$12,159**
	Total Cost/Acre Cover	**$6,010**	**$7,318**	**$8,626**	**$8,149**	**$9,510**	**$5,356**	**$6,664**	**$7,318**	**$8,626**	**$5,421**	**$0**	**$2,366**	**$8,323**	**$5,421**	-	-	**$4,988**	**$7,092**	**$0**	**$42,382**	-	-	**$0**	**$7,252**	**$0**	$2,688
	Pullback or Backfill	**$0**	**$0**	**$0**	**$44,650**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$32,738**	**$0**	-	-	**$0**	**$0**	**$0**	**$0**	-	-	**$0**	**$0**	**$0**	$3,144
	Total Cost/Acre Top/Outslope Adjustment	**$655**	**$0**	**$7,293**	**$3,953**	**$6,021**	**$8,458**	**$810**	**$3,179**	**$2,521**	**$241**	**$545**	**$3,941**	**$4,075**	**$470**	-	-	**$3,558**	**$443**	**$6**	**$0**	-	-	**$0**	**$84**	**$0**	$1,547
	Total Cost/Acre Earthwork	**$6,665**	**$7,318**	**$15,919**	**$56,752**	**$15,531**	**$13,814**	**$7,474**	**$10,497**	**$11,147**	**$5,662**	**$545**	**$6,308**	**$45,136**	**$5,891**	-	-	**$8,546**	**$7,535**	**$6**	**$42,382**	-	-	**$0**	**$7,336**	**$0**	$7,379
	Capital Cost/Acre Re-Veg	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	**$1,071**	-	-	**$1,071**	**$1,071**	**$473**	**$1,071**	-	-	**$0**	**$1,071**	**$0**	$411
	Capital Cost/Acre Other[6]	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$87**	**$0**	**$0**	-	-	**$29,144**	**$0**	**$1**	**$12,628**	-	-	**$0**	**$0**	**$0**	$884

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 spseeding, 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

															Productivity for X Trucks (cy/hr)									
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)**	**Max Trucks Round Up**	**Max Trucks Round Down**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**
1302-D-f-Tk4	Haul-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	7.02	3.12	$ 535.68	28.09	17,500,000.00	4,000.46	3,000.34	9,001.03	8,000.92	7,000.80	6,000.69	5,000.57	4,000.46	3,000.34	2,000.23
2201-D-f-Tk4	Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	4.99	2.22	$ 535.68	28.09	3,500,000.00	4,221.11	2,814.08	12,663.34	11,256.30	9,849.27	8,442.23	7,035.19	5,628.15	4,221.11	2,814.08
1000-D-b-Tk4	Haul-Cover	Gila Borrow Area	1A and 1B Leach	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	10.89	4.84	$ 535.68	28.09	1,321,320.00	3,224.23	2,579.39	5,803.62	5,158.77	4,513.92	3,869.08	3,224.23	2,579.39	1,934.54	1,289.69
1100-D-b-Tk4	Haul-Cover	Gila Borrow Area	1C	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	15.73	6.99	$ 535.68	28.09	82,299.99	3,123.76	2,677.51	4,016.26	3,570.01	3,123.76	2,677.51	2,231.26	1,785.00	1,338.75	892.50
1200-D-b-Tk4	Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	20.23	8.99	$ 535.68	28.09	2,357,039.83	3,123.21	2,776.18	3,123.21	2,776.18	2,429.16	2,082.14	1,735.11	1,388.09	1,041.07	694.05
1300-D-b-Tk4	Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	18.40	8.18	$ 535.68	28.09	2,202,200.00	3,433.76	3,052.23	3,433.76	3,052.23	2,670.70	2,289.17	1,907.64	1,526.11	1,144.59	763.06
1500-D-b-Tk4	Haul-Cover	Gila Borrow Area	5A Overburden	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	8.52	3.79	$ 535.68	28.09	1,795,640.00	3,297.31	2,472.98	7,418.95	6,594.62	5,770.29	4,945.97	4,121.64	3,297.31	2,472.98	1,648.66
2200-D-b-Tk4	Haul-Cover	Leach Stockpile	San Salvador Pit	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	18.81	8.36	$ 535.68	28.09	556,600.00	3,359.18	2,985.94	3,359.18	2,985.94	2,612.70	2,239.46	1,866.21	1,492.97	1,119.73	746.49
2300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	9.11	4.05	$ 535.68	28.09	314,600.00	3,853.57	3,082.85	6,936.42	6,165.71	5,394.99	4,624.28	3,853.57	3,082.85	2,312.14	1,541.43
1400-D-b-Tk4	Haul-Cover	Gila Borrow Area	4C Leach	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	23.06	10.25	$ 535.68	28.09	885,720.00	3,349.38	3,044.89	2,740.40	2,435.91	2,131.42	1,826.93	1,522.44	1,217.96	913.47	608.98
1800-D-b-Tk4	Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	19.97	8.87	$ 535.68	28.09	1,815,000.00	3,164.89	2,813.24	3,164.89	2,813.24	2,461.58	2,109.93	1,758.27	1,406.62	1,054.96	703.31
1900-D-b-Tk4	Haul-Cover	Gila Borrow Area	8C	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	9.11	4.05	$ 535.68	28.09	229,222.40	3,853.57	3,082.85	6,936.42	6,165.71	5,394.99	4,624.28	3,853.57	3,082.85	2,312.14	1,541.43
1600-D-b-Tk4	Haul-Cover	Gila Borrow Area	6B	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	13.45	5.98	$ 535.68	28.09	261,360.00	3,132.29	2,610.24	4,698.43	4,176.38	3,654.33	3,132.29	2,610.24	2,088.19	1,566.14	1,044.10
1700-D-b-Tk4	Haul-Cover	Gila Borrow Area	6C	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	15.73	6.99	$ 535.68	28.09	319,440.00	3,123.76	2,677.51	4,016.26	3,570.01	3,123.76	2,677.51	2,231.26	1,785.00	1,338.75	892.50
2701-D-b-Tk4	Haul-Cover	Gila Borrow Area	Crtmnt-1	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	14.70	6.53	$ 535.68	28.09	102,753.20	3,343.45	2,865.82	4,298.72	3,821.09	3,343.45	2,865.82	2,388.18	1,910.54	1,432.91	955.27
3300-D-b-Tk4	Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	14.70	6.53	$ 535.68	28.09	605,000.00	3,343.45	2,865.82	4,298.72	3,821.09	3,343.45	2,865.82	2,388.18	1,910.54	1,432.91	955.27
2100-D-b-Tk4	Haul-Cover	9AX Stockpile Toe	9AX	Komatsu 730E	Sh1	50.00	5.00	0.45	2.25	14.14	6.28	$ 535.68	28.09	102,769.33	3,476.56	2,979.91	4,469.87	3,973.22	3,476.56	2,979.91	2,483.26	1,986.61	1,489.96	993.30
2600-D-b-Tk2	Haul-Cover	9AX Stockpile	Tailing Launder Line	Cat 769D	Ld2	50.00	4.00	0.58	2.30	13.05	5.68	$ 156.46	7.29	9,636.84	670.04	558.36	1,005.05	893.38	781.71	670.04	558.36	446.69	335.02	223.35
2900-D-b-Tk2	Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 769D	Ld2	50.00	4.00	0.58	2.30	35.24	15.32	$ 156.46	7.29	45,360.00	661.83	620.46	372.28	330.91	289.55	248.18	206.82	165.46	124.09	82.73

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 Time for X Trucks (hr)												Cost of Using X Trucks per Loader ($)												
Task Description	**Source Location 1**	**Destination Location 2**	**Equipment**	**Max Trucks Round Up**	**Max Trucks Round Down**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**Loader/ Shovel Task Time (hr)**	**Truck Cost ($/hr)**	**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-Outslopes Pullback-Backfill/Stockpile Material	3A/3B	3A / 3B	Komatsu 730E	4,374.50	5,832.67	1,944.22	2,187.25	2,499.71	2,916.33	3,499.60	4,374.50	5,832.67	8,749.00	5,607.98	$ 246.06	$ 8,523,719.17	$ 7,430,039.63	$ 15,423,240.46	$ 14,043,336.20	$ 12,663,431.94	$ 11,283,527.68	$ 9,903,623.43	$ 8,523,719.17	$ 7,430,039.63	$ 8,992,272.01	$ 7,430,039.63	3	3
Haul-Pit Backfill-Backfill/Stockpile Material	Leach Stockpile	San Salvador Pit	Komatsu 730E	829.17	1,243.75	276.39	310.94	355.36	414.58	497.50	621.87	829.17	1,243.75	1,121.60	$ 246.06	$ 1,428,762.98	$ 1,278,331.15	$ 3,084,648.09	$ 2,808,667.24	$ 2,532,686.39	$ 2,256,705.54	$ 1,980,724.69	$ 1,704,743.83	$ 1,428,762.98	$ 1,278,331.15	$ 1,278,331.15	2	2
Haul-Cover	Gila Borrow Area	1A and 1B Leach	Komatsu 730E	409.81	512.26	227.67	256.13	292.72	341.51	409.81	512.26	683.02	1,024.52	423.42	$ 246.06	$ 747,763.18	$ 778,600.58	$ 1,164,516.35	$ 1,060,328.06	$ 956,139.77	$ 851,951.47	$ 747,763.18	$ 778,600.58	$ 870,070.66	$ 1,053,010.80	$ 747,763.18	5	5
Haul-Cover	Gila Borrow Area	1C	Komatsu 730E	26.35	30.74	20.49	23.05	26.35	30.74	36.89	46.11	61.48	92.21	26.37	$ 246.06	$ 59,554.30	$ 61,845.48	$ 72,533.29	$ 66,043.80	$ 59,554.30	$ 61,845.48	$ 65,138.61	$ 70,078.29	$ 78,311.09	$ 94,776.70	$ 59,554.30	7	7
Haul-Cover	Gila Borrow Area (1/3) & 9AX Stockpile (2/3)	2A Leach and 2B Waste	Komatsu 730E	754.69	849.02	754.69	849.02	970.31	1,132.03	1,358.43	1,698.04	2,264.06	3,396.09	755.33	$ 246.06	$ 2,077,325.26	$ 2,126,096.54	$ 2,077,325.26	$ 2,126,096.54	$ 2,191,069.01	$ 2,277,698.96	$ 2,398,980.90	$ 2,580,903.80	$ 2,884,108.63	$ 3,490,518.30	$ 2,077,325.26	9	9
Haul-Cover	Gila Borrow Area	3A / 3B	Komatsu 730E	641.34	721.51	641.34	721.51	824.58	962.01	1,154.41	1,443.01	1,924.02	2,886.02	705.71	$ 246.06	$ 1,940,860.58	$ 1,806,774.46	$ 1,940,860.58	$ 1,806,774.46	$ 1,861,988.60	$ 1,935,607.45	$ 2,038,673.85	$ 2,193,273.44	$ 2,450,939.42	$ 2,966,271.38	$ 1,806,774.46	8	8
Haul-Cover	Gila Borrow Area	5A Overburden	Komatsu 730E	544.58	726.10	242.03	272.29	311.19	363.05	435.66	544.58	726.10	1,089.15	575.42	$ 246.06	$ 874,601.78	$ 924,958.35	$ 1,582,547.86	$ 1,440,958.64	$ 1,299,369.42	$ 1,157,780.21	$ 1,016,190.99	$ 874,601.78	$ 924,958.35	$ 1,119,439.13	$ 874,601.78	4	4
Haul-Cover	Leach Stockpile	San Salvador Pit	Komatsu 730E	165.69	186.41	165.69	186.41	213.04	248.54	298.25	372.81	497.08	745.63	178.37	$ 246.06	$ 490,547.18	$ 466,794.88	$ 490,547.18	$ 466,794.88	$ 481,059.91	$ 500,079.93	$ 526,707.98	$ 566,650.04	$ 633,220.14	$ 766,360.35	$ 466,794.88	8	8
Haul-Cover	Gila Borrow Area	Savanna In-Pit Leach Stockpile	Komatsu 730E	81.64	102.05	45.35	51.02	58.31	68.03	81.64	102.05	136.06	204.10	100.82	$ 246.06	$ 178,038.85	$ 155,106.11	$ 277,265.80	$ 252,459.06	$ 227,652.33	$ 202,845.59	$ 178,038.85	$ 155,106.11	$ 173,328.00	$ 209,771.76	$ 155,106.11	4	4
Haul-Cover	Gila Borrow Area	4C Leach	Komatsu 730E	264.44	290.89	323.21	363.61	415.55	484.81	581.78	727.22	969.63	1,454.44	283.83	$ 246.06	$ 920,290.86	$ 871,584.69	$ 888,898.44	$ 910,540.63	$ 938,366.31	$ 975,467.21	$ 1,027,408.46	$ 1,105,320.35	$ 1,235,173.50	$ 1,494,879.79	$ 871,584.69	10	10
Haul-Cover	Gila Borrow Area	2C, 4A, 4B, 7B Leach	Komatsu 730E	573.48	645.16	573.48	645.16	737.33	860.22	1,032.26	1,290.33	1,720.44	2,580.66	581.63	$ 246.06	$ 1,599,610.37	$ 1,615,601.42	$ 1,599,610.37	$ 1,615,601.42	$ 1,664,973.41	$ 1,730,802.72	$ 1,822,963.76	$ 1,961,205.32	$ 2,191,607.91	$ 2,652,413.11	$ 1,599,610.37	9	9
Haul-Cover	Gila Borrow Area	8C	Komatsu 730E	59.48	74.35	33.05	37.18	42.49	49.57	59.48	74.35	99.14	148.71	73.46	$ 246.06	$ 129,721.85	$ 113,012.70	$ 202,020.13	$ 183,945.56	$ 165,870.99	$ 147,796.42	$ 129,721.85	$ 113,012.70	$ 126,289.44	$ 152,842.93	$ 113,012.70	4	4
Haul-Cover	Gila Borrow Area	6B	Komatsu 730E	83.44	100.13	55.63	62.58	71.52	83.44	100.13	125.16	166.88	250.32	83.75	$ 246.06	$ 168,517.87	$ 176,826.34	$ 230,343.89	$ 209,735.22	$ 189,126.55	$ 168,517.87	$ 176,826.34	$ 190,235.69	$ 212,584.60	$ 257,282.41	$ 168,517.87	6	6
Haul-Cover	Gila Borrow Area	6C	Komatsu 730E	102.26	119.31	79.54	89.48	102.26	119.31	143.17	178.96	238.61	357.92	102.37	$ 246.06	$ 231,154.67	$ 240,047.68	$ 281,531.42	$ 256,343.05	$ 231,154.67	$ 240,047.68	$ 252,829.63	$ 272,002.57	$ 303,957.45	$ 367,867.23	$ 231,154.67	7	7
Haul-Cover	Gila Borrow Area	Cntmnt-1	Komatsu 730E	30.73	35.85	23.90	26.89	30.73	35.85	43.03	53.78	71.71	107.56	32.93	$ 246.06	$ 74,354.75	$ 72,141.60	$ 90,559.27	$ 82,457.01	$ 74,354.75	$ 72,141.60	$ 75,982.96	$ 81,745.01	$ 91,348.42	$ 110,555.25	$ 72,141.60	6	6
Haul-Cover	Gila Borrow Area	Unplanned Disturbance Area	Komatsu 730E	180.95	211.11	140.74	158.33	180.95	211.11	253.33	316.66	422.22	633.33	193.88	$ 246.06	$ 437,792.93	$ 424,762.12	$ 533,203.46	$ 485,498.19	$ 437,792.93	$ 424,762.12	$ 447,379.67	$ 481,306.00	$ 537,849.88	$ 650,937.63	$ 424,762.12	6	6
Haul-Cover	9AX Stockpile Toe	9AX	Komatsu 730E	29.56	34.49	22.99	25.87	29.56	34.49	41.38	51.73	68.97	103.46	32.93	$ 246.06	$ 74,366.43	$ 69,390.32	$ 90,573.49	$ 82,469.96	$ 74,366.43	$ 69,390.32	$ 73,085.18	$ 78,627.48	$ 87,864.64	$ 106,338.97	$ 69,390.32	6	6
Haul-Cover	9AX Stockpile	Tailing Launder Line	Cat 769D	14.38	17.26	9.59	10.79	12.33	14.38	17.26	21.57	28.77	43.15	15.20	$ 132.28	$ 14,446.44	$ 14,115.35	$ 20,480.16	$ 18,468.92	$ 16,457.68	$ 14,446.44	$ 14,115.35	$ 14,790.46	$ 15,915.64	$ 18,166.01	$ 14,115.35	5	5
Haul-Cover	Tailing Launder Line	Tailing Dam 1 Reclaim Water Pumphouse	Cat 769D	68.54	73.11	121.84	137.08	156.66	182.77	219.32	274.15	365.53	548.30	71.57	$ 132.28	$ 162,666.21	$ 156,494.06	$ 164,119.83	$ 166,502.89	$ 169,566.82	$ 173,652.06	$ 179,371.39	$ 187,950.39	$ 202,248.72	$ 230,845.39	$ 156,494.06	15	15

Sheet used for testing purposes and maintained for spreadsheet integrity. No Scrapers used in Tyrone RCE.

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 ($/hr)**	**Max Scrapers Round Up**	**Max Scrapers Round Down**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Lowest Cost ($)**	**Optimum Number of Scrapers Per Dozer**	**Optimum Number of Scrapers Per Dozer Within Max**

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, 2015
Reclamation End = January 1, 2115
No. Years Reclamation = 100
No. Years Veg Maint = 12
% loss per year = 2%
Borrow areas have only 2 years of veg maint

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
3401-M-e-U	Post-Closure O&M-Mining Area-Final Grade	1C Waste Stockpile	-	45.0	-	Dec-11	Dec-23	9	2%	8.1	$3.85	$820.12	$31	$6,640	2% of veg fails every year for 12 years
3402-M-e-U	Post-Closure O&M-Mining Area-Final Grade	1C Waste Stockpile	-	111.7	-	Dec-12	Dec-24	10	2%	22.3	$3.85	$820.12	$86	$18,319	2% of veg fails every year for 12 years
3403-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7A Far West Stockpile	-	34.0	-	Dec-10	Dec-22	8	2%	5.4	$3.85	$820.12	$21	$4,460	2% of veg fails every year for 12 years
3404-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Upper	-	38.2	-	Dec-10	Dec-22	8	2%	6.1	$3.85	$820.12	$24	$5,011	2% of veg fails every year for 12 years
3405-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Wing	-	7.7	-	Dec-10	Dec-22	8	2%	1.2	$3.85	$820.12	$5	$1,010	2% of veg fails every year for 12 years
3406-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AW Wing	-	4.0	-	Dec-11	Dec-23	9	2%	0.7	$3.85	$820.12	$3	$590	2% of veg fails every year for 12 years
3407-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AE Upper	-	18.3	-	Dec-11	Dec-23	9	2%	3.3	$3.85	$820.12	$13	$2,700	2% of veg fails every year for 12 years
3408-M-e-U	Post-Closure O&M-Mining Area-Final Grade	7AE Upper	-	27.2	-	Dec-12	Dec-24	10	2%	5.4	$3.85	$820.12	$21	$4,461	2% of veg fails every year for 12 years
3409-M-e-U	Post-Closure O&M-No Man's Land-Final Grade	No Man's Land	-	4.0	-	Dec-12	Dec-24	10	2%	0.8	$3.85	$820.12	$3	$656	2% of veg fails every year for 12 years
3410-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailings Series 1 (1, 1A, 1X) Dam	-	1,547.0	-	Sep-09	Sep-21	7	2%	208.0	$3.85	$820.12	$800	$170,553	2% of veg fails every year for 12 years
3411-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 2 Dam	-	606.0	-	Sep-09	Sep-21	7	2%	81.5	$3.85	$820.12	$313	$66,810	2% of veg fails every year for 12 years
3412-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 3x Dam	-	365.0	-	Dec-05	Dec-17	3	2%	21.3	$3.85	$820.12	$82	$17,457	2% of veg fails every year for 12 years
3413-M-e-U	Post-Closure O&M-Mangas Valley Tailing Area-Final Grade	Tailing 3 Dam	-	643.0	-	Dec-06	Dec-18	4	2%	50.3	$3.85	$820.12	$194	$41,292	2% of veg fails every year for 12 years
3414-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Burro Mountain Tailings Dam	-	58.0	-	Dec-04	Dec-16	2	2%	2.2	$3.85	$820.12	$9	$1,823	2% of veg fails every year for 12 years
3415-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Burro Mountain	-	1.3	-	Dec-05	Dec-17	3	2%	0.1	$3.85	$820.12	$0	$62	2% of veg fails every year for 12 years
3416-M-e-U	Post-Closure O&M-East Mine Area-Final Grade	Stockpile 1	-	500.0	-	Dec-09	Dec-21	7	2%	70.0	$3.85	$820.12	$269	$57,392	2% of veg fails every year for 12 years
3417-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Mill Initial	-	45.0	-	Apr-07	Apr-19	4	2%	3.8	$3.85	$820.12	$15	$3,134	2% of veg fails every year for 12 years
3418-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Mill (11 redo)	-	11.0	-	Aug-10	Aug-22	8	2%	1.7	$3.85	$820.12	$6	$1,372	2% of veg fails every year for 12 years
3419-M-e-U	Post-Closure O&M-Mining Area-Final Grade	Copper Mountain	-	514.0	-	Jan-15	Jan-27	12	2%	123.4	$3.85	$820.12	$475	$101,170	2% of veg fails every year for 12 years
1000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	1A and 1B Leach	-	273.0	Jan-22	Dec-27	Dec-39	12	2%	65.5	$3.85	$820.12	$252	$53,734	2% of veg fails every year for 12 years
1100-M-e-U	Post-Closure O&M-Top (Haul Road)-Final Grade	1C	-	17.0	Jan-17	Dec-19	Dec-31	12	2%	4.1	$3.85	$820.12	$16	$3,347	2% of veg fails every year for 12 years
1200-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	2A Leach and 2B Waste	-	487.0	Jan-17	Dec-27	Dec-39	12	2%	116.9	$3.85	$820.12	$450	$95,854	2% of veg fails every year for 12 years
1300-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	3A / 3B	-	455.0	Jan-17	Dec-28	Dec-40	12	2%	109.2	$3.85	$820.12	$420	$89,557	2% of veg fails every year for 12 years
1500-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	5A Overburden	-	371.0	Jan-17	Dec-27	Dec-39	12	2%	89.0	$3.85	$820.12	$343	$73,024	2% of veg fails every year for 12 years
2200-M-e-U	Post-Closure O&M-Entire Pit-Final Grade	San Salvador Pit	-	115.0	Jan-17	Dec-19	Dec-31	12	2%	27.6	$3.85	$820.12	$106	$22,635	2% of veg fails every year for 12 years
2300-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	Savanna In-Pit Leach Stockpile	-	65.0	Jan-18	Dec-19	Dec-31	12	2%	15.6	$3.85	$820.12	$60	$12,794	2% of veg fails every year for 12 years
1400-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	4C Leach	-	183.0	Jan-22	Dec-27	Dec-39	12	2%	43.9	$3.85	$820.12	$169	$36,020	2% of veg fails every year for 12 years
1800-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	2C, 4A, 4B, 7B Leach	-	375.0	Jan-22	Dec-27	Dec-39	12	2%	90.0	$3.85	$820.12	$346	$73,811	2% of veg fails every year for 12 years
1900-M-e-U	Post-Closure O&M-Sludge Disposal Area-Final Grade	8C	-	47.4	Jan-19	Dec-21	Dec-33	12	2%	11.4	$3.85	$820.12	$44	$9,322	2% of veg fails every year for 12 years
1600-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6B	-	54.0	Jan-22	Dec-27	Dec-39	12	2%	13.0	$3.85	$820.12	$50	$10,629	2% of veg fails every year for 12 years
1700-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	6C	-	66.0	Jan-22	Dec-28	Dec-40	12	2%	15.8	$3.85	$820.12	$61	$12,991	2% of veg fails every year for 12 years
2000-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	9A Overburden	-	129.0	Jan-17	Dec-19	Dec-31	12	2%	31.0	$3.85	$820.12	$119	$25,391	2% of veg fails every year for 12 years
2600-M-e-U	Post-Closure O&M-Tailing Launder Line-Final Grade	Tailing Launder Line	-	7.4	Jan-23	Dec-25	Dec-37	12	2%	1.8	$3.85	$820.12	$7	$1,457	2% of veg fails every year for 12 years
2900-M-e-U	Post-Closure O&M-Tailing Pumphouse-Final Grade	Tailing Dam 1 Reclaim Water Pumphouse	-	7.0	Jan-24	Dec-26	Dec-38	12	2%	1.7	$3.85	$820.12	$6	$1,378	2% of veg fails every year for 12 years
2701-M-e-U	Post-Closure O&M-Surface Impoundments closed at year 99; some closed year 6-Final Grade	Surface Impoundments closed at year 99; some closed year 6	-	21.2	Jan-23	Dec-27	Dec-39	12	2%	5.1	$3.85	$820.12	$20	$4,179	2% of veg fails every year for 12 years
2702-M-e-U	Post-Closure O&M-Surface Impoundments graded over at closure-Final Grade	Surface Impoundments graded over at closure	-	0.5	Jan-23	Dec-27	Dec-39	12	2%	0.1	$3.85	$820.12	$0	$94	2% of veg fails every year for 12 years
3300-M-e-U	Post-Closure O&M-Unplanned Disturbance Area-Final Grade	Unplanned Disturbance Area	-	125.0	Jan-17	Dec-19	Dec-31	12	2%	30.0	$3.85	$820.12	$115	$24,604	2% of veg fails every year for 12 years
2100-M-e-U	Post-Closure O&M-Entire Stockpile-Final Grade	9AX	-	63.7	Jan-28	Dec-28	Dec-40	12	2%	15.3	$3.85	$820.12	$59	$12,538	2% of veg fails every year for 12 years
2800-M-e-U	Post-Closure O&M-Borrow Areas-Final Grade	Tailing Repositories Borrow Areas	-	169.1	Jan-06	Jan-15	Dec-16	2	2%	6.8	$3.85	$820.12	$26	$5,547	2% of veg fails every year for 12 years
3200-M-e-U	Post-Closure O&M-Demo Area-Final Grade	Building Demo Area	-	47.6	Jan-17	Jan-20	Jan-32	12	2%	11.4	$3.85	$820.12	$44	$9,365	2% of veg fails every year for 12 years
			TOTAL O&M AREA	7659	**AC**				**TOTAL VEG M**	1321	**AC**	**TOTAL**	$5,082	$1,083,183	

Operations & Maintenance -Full Site Reclamation begins Jan-15 (Year 0)

EROSION CONTROL [1]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$2,923	$2,923	$2,923	$/day
Fuel Base	$382	$382	$382	
Time:	10	8	5	day/yr
Equiment Annual:	$29,234	$23,387	$14,617	$/yr
Fuel Annual:	$3,823	$3,058	$1,911	$/yr

Year	Annual Current Equipment Cost ($)	Annual Current Fuel. Cost ($)	Notes
0	$15,521	$2,029	Weighted based on total reclaimed area
1	$18,128	$2,370	Weighted based on total reclaimed area
2	$18,128	$2,370	Weighted based on total reclaimed area
3	$18,128	$2,370	Weighted based on total reclaimed area
4	$18,128	$2,370	Weighted based on total reclaimed area
5	$19,849	$2,595	Weighted based on total reclaimed area
6	$20,031	$2,619	Weighted based on total reclaimed area
7	$20,212	$2,643	Weighted based on total reclaimed area
8	$20,212	$2,643	Weighted based on total reclaimed area
9	$20,212	$2,643	Weighted based on total reclaimed area
10	$20,212	$2,643	Weighted based on total reclaimed area
11	$20,240	$2,647	Weighted based on total reclaimed area
12	$20,266	$2,650	Weighted based on total reclaimed area
13	$27,002	$3,531	Weighted based on total reclaimed area
14	$29,234	$3,823	Weighted based on total reclaimed area
15	$29,234	$3,823	
16	$29,234	$3,823	
17	$29,234	$3,823	
18	$29,234	$3,823	
19	$29,234	$3,823	
20	$23,387	$3,058	
21	$23,387	$3,058	
22	$23,387	$3,058	
23	$23,387	$3,058	
24	$23,387	$3,058	
25	$23,387	$3,058	
26	$23,387	$3,058	
27	$23,387	$3,058	
28	$23,387	$3,058	
29	$23,387	$3,058	
30	$23,387	$3,058	
31	$23,387	$3,058	
32	$23,387	$3,058	
33	$23,387	$3,058	
34	$23,387	$3,058	
35	$23,387	$3,058	
36	$23,387	$3,058	
37	$23,387	$3,058	
38	$23,387	$3,058	
39	$23,387	$3,058	
40	$14,617	$1,911	
41	$14,617	$1,911	
42	$14,617	$1,911	
43	$14,617	$1,911	
44	$14,617	$1,911	
45	$14,617	$1,911	
46	$14,617	$1,911	
47	$14,617	$1,911	
48	$14,617	$1,911	
49	$14,617	$1,911	
50	$14,617	$1,911	
51	$14,617	$1,911	
52	$14,617	$1,911	
53	$14,617	$1,911	
54	$14,617	$1,911	
55	$14,617	$1,911	
56	$14,617	$1,911	
57	$14,617	$1,911	
58	$14,617	$1,911	
59	$14,617	$1,911	
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62	$14,617	$1,911	
63	$14,617	$1,911	
64	$14,617	$1,911	
65	$14,617	$1,911	
66	$14,617	$1,911	
67	$14,617	$1,911	
68	$14,617	$1,911	
69	$14,617	$1,911	
70	$14,617	$1,911	
71	$14,617	$1,911	
72	$14,617	$1,911	
73	$14,617	$1,911	
74	$14,617	$1,911	
75	$14,617	$1,911	
76	$14,617	$1,911	
77	$14,617	$1,911	
78	$14,617	$1,911	
79	$14,617	$1,911	
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81	$14,617	$1,911	
82	$14,617	$1,911	
83	$14,617	$1,911	
84	$14,617	$1,911	
85	$14,617	$1,911	
86	$14,617	$1,911	
87	$14,617	$1,911	
88	$14,617	$1,911	
89	$14,617	$1,911	
90	$14,617	$1,911	
91	$14,617	$1,911	
92	$14,617	$1,911	
93	$14,617	$1,911	
94	$14,617	$1,911	
95	$14,617	$1,911	
96	$14,617	$1,911	
97	$14,617	$1,911	
98	$14,617	$1,911	
99	$14,617	$1,911	
Capital Cost	$1,796,414	$234,901	

ROAD MAINTENANCE [2]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$4,946	$4,946	$4,946	$/month
Fuel Base	$1,240	$1,240	$1,240	
Time:	4	4	4	months/yr
Equipment Annual:	$19,784	$19,784	$19,784	$/yr
Fuel Annual:	$4,961	$4,961	$4,961	$/yr

Year	Annual Current Euipment Cost ($)	Annual Current Fuel. Cost ($)	Notes
0	$10,504	$2,634	Weighted based on total reclaimed area
1	$12,268	$3,076	Weighted based on total reclaimed area
2	$12,268	$3,076	Weighted based on total reclaimed area
3	$12,268	$3,076	Weighted based on total reclaimed area
4	$12,268	$3,076	Weighted based on total reclaimed area
5	$13,433	$3,369	Weighted based on total reclaimed area
6	$13,556	$3,399	Weighted based on total reclaimed area
7	$13,678	$3,430	Weighted based on total reclaimed area
8	$13,678	$3,430	Weighted based on total reclaimed area
9	$13,678	$3,430	Weighted based on total reclaimed area
10	$13,678	$3,430	Weighted based on total reclaimed area
11	$13,697	$3,435	Weighted based on total reclaimed area
12	$13,715	$3,439	Weighted based on total reclaimed area
13	$18,274	$4,583	Weighted based on total reclaimed area
14	$19,784	$4,961	Weighted based on total reclaimed area
15	$19,784	$4,961	
16	$19,784	$4,961	
17	$19,784	$4,961	
18	$19,784	$4,961	
19	$19,784	$4,961	
20	$19,784	$4,961	
21	$19,784	$4,961	
22	$19,784	$4,961	
23	$19,784	$4,961	
24	$19,784	$4,961	
25	$19,784	$4,961	
26	$19,784	$4,961	
27	$19,784	$4,961	
28	$19,784	$4,961	
29	$19,784	$4,961	
30	$19,784	$4,961	
31	$19,784	$4,961	
32	$19,784	$4,961	
33	$19,784	$4,961	
34	$19,784	$4,961	
35	$19,784	$4,961	
36	$19,784	$4,961	
37	$19,784	$4,961	
38	$19,784	$4,961	
39	$19,784	$4,961	
40	$19,784	$4,961	
41	$19,784	$4,961	
42	$19,784	$4,961	
43	$19,784	$4,961	
44	$19,784	$4,961	
45	$19,784	$4,961	
46	$19,784	$4,961	
47	$19,784	$4,961	
48	$19,784	$4,961	
49	$19,784	$4,961	
50	$19,784	$4,961	
51	$19,784	$4,961	
52	$19,784	$4,961	
53	$19,784	$4,961	
54	$19,784	$4,961	
55	$19,784	$4,961	
56	$19,784	$4,961	
57	$19,784	$4,961	
58	$19,784	$4,961	
59	$19,784	$4,961	
60	$19,784	$4,961	
61	$19,784	$4,961	
62	$19,784	$4,961	
63	$19,784	$4,961	
64	$19,784	$4,961	
65	$19,784	$4,961	
66	$19,784	$4,961	
67	$19,784	$4,961	
68	$19,784	$4,961	
69	$19,784	$4,961	
70	$19,784	$4,961	
71	$19,784	$4,961	
72	$19,784	$4,961	
73	$19,784	$4,961	
74	$19,784	$4,961	
75	$19,784	$4,961	
76	$19,784	$4,961	
77	$19,784	$4,961	
78	$19,784	$4,961	
79	$19,784	$4,961	
80	$19,784	$4,961	
81	$19,784	$4,961	
82	$19,784	$4,961	
83	$19,784	$4,961	
84	$19,784	$4,961	
85	$19,784	$4,961	
86	$19,784	$4,961	
87	$19,784	$4,961	
88	$19,784	$4,961	
89	$19,784	$4,961	
90	$19,784	$4,961	
91	$19,784	$4,961	
92	$19,784	$4,961	
93	$19,784	$4,961	
94	$19,784	$4,961	
95	$19,784	$4,961	
96	$19,784	$4,961	
97	$19,784	$4,961	
98	$19,784	$4,961	
99	$19,784	$4,961	
Capital Cost	$1,888,373	$473,556	

Total Capital Cost Erosion Control, Road Maintenance, Tailing Cover Maintenance, and Groundwater Monitoring **$5,756,909** **$708,457**

[1] Erosion Control
Equipment - EquipmentWatch
Labor -2019 NM Department of Labor Type H (Heavy Engineering) labor rates.

	#	$/hour	$/day		
Labor Foreman (outside)	1	$23.84	$190.72		
Laborers	2	$23.09	$369.44		
Equipment Operators (med)	1	$27.52	$220.16		
Truck Drivers (heavy)	2	$24.27	$388.32		
		equipment $/hr	**fuel $/hr**	**equipment $/day**	**fuel $/day**
Cat 966H	1	$73.11	$19.61	$584.90	$156.87
Cat 725	2	$73.11	$14.09	$1,169.82	$225.39
				Equipment Cost	**Fuel Cost**
			Total Direct Cost	**$2,923**	**$382** **$/day**

[2] Road Maintenance Crew
Equipment - EquipmentWatch
Labor -2019 NM Department of Labor Type H (Heavy Engineering) labor rates.

	Equipment Cost ($/hr)	Fuel Cost ($/hr)	Labor Rate ($/hr)	Equipment Subtotal 24 hrs/month ($/month)	Fuel Subtotal 24 hrs/month ($/month)
Cat 14M Motor Grader	$86.71	$19.40	$27.41	$2,739	$658
6,000-gal Water Truck	$67.69	$26.33	$24.27	$2,207	$582

	Equipment Cost	**Fuel Cost**	
Total Direct Cost	**$4,946**	**$1,240**	**$/month**

TAILING COVER MAINTENANCE [3]

	Years 0-1	Years 2-6	
Equipment Base:	$2,144	$2,144	$/day
Fuel Base	$270	$270	$/day
Time:	10	10	day/yr
Equiment Annual:	$21,442.94	$21,442.94	$/yr
Fuel Annual:	$2,696	$2,696	$/yr

Year	Annual Current Cost ($)	Notes
0	$21,443	
1	$21,443	
2	$21,443	
3	$21,443	
4	$21,443	
5	$21,443	
6	$21,443	
7	$0	
8	$0	
9	$0	
10	$0	
11	$0	
12	$0	
13	$0	
14	$0	
15	$0	
16	$0	
17	$0	
18	$0	
19	$0	
20	$0	
21	$0	
22	$0	
23	$0	
24	$0	
25	$0	
26	$0	
27	$0	
28	$0	
29	$0	
30	$0	
31	$0	
32	$0	
33	$0	
34	$0	
35	$0	
36	$0	
37	$0	
38	$0	
39	$0	
40	$0	
41	$0	
42	$0	
43	$0	
44	$0	
45	$0	
46	$0	
47	$0	
48	$0	
49	$0	
50	$0	
51	$0	
52	$0	
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90	$0	
91	$0	
92	$0	
93	$0	
94	$0	
95	$0	
96	$0	
97	$0	
98	$0	
99	$0	
Capital Cost	$150,101	

GROUNDWATER MONITORING [4]

	Years 0-19	Years 20-39	Years 40-99	
Equipment Base:	$825	$825	$825	$/day
Aqueous Chemistry Base:	$1,458	$1,458	$1,458	$/day
Time:	20	10	5	day/yr
Equipment Annual:	$16,508.80	$8,254	$4,127	$/yr
Aqueous Chemistry Annual:	$29,150	$14,575	$7,288	$/yr

Year	Annual Current Cost ($)	Notes	Total Reclaimed Area per Year (acres)	Percent Reclaimed
0	$31,985	Weighted based on total reclaimed area	4,066	53%
1	$34,585	Weighted based on total reclaimed area	4,750	62%
2	$34,585	Weighted based on total reclaimed area	4,750	62%
3	$34,585	Weighted based on total reclaimed area	4,750	62%
4	$34,585	Weighted based on total reclaimed area	4,750	62%
5	$36,301	Weighted based on total reclaimed area	5,201	68%
6	$36,482	Weighted based on total reclaimed area	5,248	69%
7	$36,662	Weighted based on total reclaimed area	5,295	69%
8	$36,662	Weighted based on total reclaimed area	5,295	69%
9	$36,662	Weighted based on total reclaimed area	5,295	69%
10	$36,662	Weighted based on total reclaimed area	5,295	69%
11	$36,691	Weighted based on total reclaimed area	5,303	69%
12	$36,717	Weighted based on total reclaimed area	5,310	69%
13	$43,434	Weighted based on total reclaimed area	7,075	92%
14	$45,659	Weighted based on total reclaimed area	7,659	100%
15	$45,659			
16	$45,659			
17	$45,659			
18	$45,659			
19	$45,659			
20	$22,829			
21	$22,829			
22	$22,829			
23	$22,829			
24	$22,829			
25	$22,829			
26	$22,829			
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36	$22,829			
37	$22,829			
38	$22,829			
39	$22,829			
40	$11,415			
41	$11,415			
42	$11,415			
43	$11,415			
44	$11,415			
45	$11,415			
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47	$11,415			
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92	$11,415			
93	$11,415			
94	$11,415			
95	$11,415			
96	$11,415			
97	$11,415			
98	$11,415			
99	$11,415			
Direct Cost	$1,922,021			

[3] Tailing Cover Maintenance
Equipment - EquipmentWatch
Labor -2019 NM Department of Labor Type H (Heavy Engineering) labor rates.
Modified Crew B-13A (1 Labor Foreman, 2 laborers, 1 equip. operators (med.), 1 truck drivers (heavy), 1 crawler loader (4 cy), 1 dump trucks (8 cy, 220 HP))

	#	$/hour	$/day		
Labor Foreman (outside)	1	$23.84	$190.72		
Laborers	2	$23.09	$369.44		
Equipment Operators (med)	1	$27.52	$220.16		
Truck Drivers (heavy)	1	$24.27	$194.16		
		equipment $/hr	**fuel $/hr**	**equipment $/day**	**fuel $/day**
Cat 966H	1	$73.11	$19.61	$584.90	$156.87
Cat 725	1	$73.11	$14.09	$584.91	$112.69

	Equipment Cost	Fuel Cost	
Total Direct Cost	**$2,144**	**$270**	**$/day**

[3] Groundwater Monitoring
Equipment - EquipmentWatch
Labor -2019 NM Department of Labor Type H (Heavy Engineering) labor rates.
Aqueous Chemistry Sample Numbers - From the CCP in consultation with NMED and the DP-1340 requirements

	#	$/hour	$/day
Labor Foreman (outside)	1	$23.84	$190.72
Laborers	1	$23.09	$184.72
		$/year	**$/day**
Rental Equipment	1	$8,000.00	$400.00
Misc. Field Equipment	1	$1,000.00	$50.00
Aqueous Chemistry Years 0-19	53	$29,150.00	$1,457.50
Aqueous Chemistry Years 20-39	27	$14,575.00	$1,457.50
Aqueous Chemistry Years 40-99	13	$7,287.50	$1,457.50

	Equipment & Fuel Cost	Aqueous Chemistry Cost
Total Direct Cost Years 0-19	**$825**	**$1,458**
Total Direct Cost Years 20-39	**$825**	**$1,458**
Total Direct Cost Years 40-99	**$825**	**$1,458**

Tyrone Mine
O&M Worksheet #3
5/1/2019

Tyrone Mine

Operations and Maintenance Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$0
	Earthmoving		$0
	Vegetation		$1,088,265
	Other		$6,465,366
	Subtotal, Direct Costs		**$7,553,631**
INDIRECT COSTS	**Subtotal, Indirect Costs**	**17.5%**	**$1,321,886**
TOTAL COST			**$8,875,517**

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

Building Demolition

Tyrone Tag No.	Description	Number	Dimensions (ft) L	W	H	Diameter	PMLU?	Demo?	Building Demolition Demo Quantity	Unit	Unit Cost ($/unit)	Item Cost ($)
Mine Maintenance Facilities Area												
MM-06	Jerome Building	1	204	63	50	-	Wildlife Habitat	Y	642,600	cf	$0.25	$160,650
MM-07	Plant Warehouse	1	250	100	28	-	Wildlife Habitat	Y	700,000	cf	$0.25	$175,000
MM-09	Electric Shop	1	120	51	50	-	Wildlife Habitat	Y	306,000	cf	$0.25	$76,500
MM-10	Pipe Shop	1	145	41	40	-	Wildlife Habitat	Y	237,800	cf	$0.25	$59,450
MM-11	Carpenter Shop	1	119	69	27	-	Wildlife Habitat	Y	221,697	cf	$0.25	$55,424
MM-12	Lumber Storage	1	102	61	33	-	Wildlife Habitat	Y	205,326	cf	$0.25	$51,332
MM-13	Shovel Repair	1	121	70	66	-	Wildlife Habitat	Y	559,020	cf	$0.25	$139,755
MM-14	Environmental Lab/Field Offices	1	112	27	17	-	Wildlife Habitat	Y	51,408	cf	$0.25	$12,852
SX-EW Plant Area												
-	Tank house	1	150	465	30	-	Wildlife Habitat	Y	2,511,000	cf	$0.25	$627,750
-	SX/EW Plant Area Shop	1	31	71	30	-	Wildlife Habitat	Y	66,030	cf	$0.25	$16,508
-	Leach Crew Office	1	15	15	15	-	Wildlife Habitat	Y	3,375	cf	$0.25	$844
-	SX/EW Warehouse	1	48	150	20	-	Wildlife Habitat	Y	144,000	cf	$0.25	$36,000
-	Gonzales Cells	1	25	52	10	-	Wildlife Habitat	Y	13,000	cf	$0.25	$3,250
-	Jamison Cells	1	35	44	10	-	Wildlife Habitat	Y	15,400	cf	$0.25	$3,850
-	Organic Tanks	4	-	-	16	32	Wildlife Habitat	Y	96,265	gal	$6,959.75	$27,839
-	Mixer/Settler Tanks	8	200	366	10	-	Wildlife Habitat	Y	5,856,000	cf	$0.25	$1,464,000
-	Tank Farm	5	-	-	10	19	Wildlife Habitat	Y	21,211	gal	$1,533.49	$7,667
-	Water Tank	1	-	-	16	30	Wildlife Habitat	Y	84,608	gal	$6,116.97	$6,117
-	Acid Tanks	2	-	-	16	20	Wildlife Habitat	Y	37,604	gal	$2,718.65	$5,437
-	MCC Building	1	14	30	12	-	Wildlife Habitat	Y	5,040	cf	$0.25	$1,260
-	Tool room and Storage	1	60	70	12	-	Wildlife Habitat	Y	50,400	cf	$0.25	$12,600
-	Chlorinator Room	1	19	66	12	-	Wildlife Habitat	Y	15,048	cf	$0.25	$3,762
-	2A West Raff Tank	1	-	-	16	22	Wildlife Habitat	Y	45,500	gal	$3,289.57	$3,290
-	Rectifiers	1	20	24	12	-	Wildlife Habitat	Y	5,760	cf	$0.25	$1,440
-	Workroom	1	66	75	12	-	Wildlife Habitat	Y	59,400	cf	$0.25	$14,850
-	Pump Mixer Control Room	1	41	41	12	-	Wildlife Habitat	Y	20,172	cf	$0.25	$5,043
-	Cobalt Sulfate Tank	1	-	-	16	18	Wildlife Habitat	Y	30,459	gal	$2,202.11	$2,202
-	Reagent Tanks	2	-	-	12	12	Wildlife Habitat	Y	10,153	gal	$1,005.97	$2,012
-	Tool room and Storage	1	8	32	12	-	Wildlife Habitat	Y	3,072	cf	$0.25	$768
-	Diluent Storage Tank	1	-	-	16	18	Wildlife Habitat	Y	30,459	gal	$2,202.11	$2,202
-	Pacesetter Filters (2)	1	48	80	12	-	Wildlife Habitat	Y	46,080	cf	$0.25	$11,520
-	Wash Pad	1	45	68	-	-	Wildlife Habitat	Y	3,060	sf	$0.62	$1,897
Lubrication Shop Area												
-	Prill Tanks	2	-	-	35	20	Waiver Area	Y	82,258	gal	$5,947.05	$11,894
-	Lubrication Shop	1	110	60	35	-	Waiver Area	Y	231,000	cf	$0.25	$57,750
-	Southwest Energy Building	1	42	42	19	-	Not Specified	Y	33,516	cf	$0.25	$8,379
-	Electric Power Substation	1	52	36	10	-	Waiver Area	Y	18,720	cf	$0.25	$4,680
-	Powder Magazines	3	10	10	10	-	Waiver Area	Y	3,000	cf	$0.25	$750
-	Storage Sheds	1	110	60	10	-	Waiver Area	Y	66,000	cf	$0.25	$16,500
-	Lube shop Addition	1	50	70	17	-	-	Y	59,500	cf	$0.25	$14,875
-	#2 Fuel Dock Concrete Slab for Haul Trucks	1	14	42	-	-	-	Y	588	sf	$0.62	$365
Acid Unloading Facility & Former Precipitation Area												
-	Acid Unloading Facility	1	20	10	20	-	Wildlife Habitat	Y	4,000	cf	$0.25	$1,000
Mill and Concentrator Area												
MC-15	Warehouse and Core Storage	1	235	101	33	-	Wildlife Habitat	Y	783,255	cf	$0.25	$195,814
MC-20	Reagent Building	1	150	50	16	-	Wildlife Habitat	Y	120,000	cf	$0.25	$30,000
MC-21	Fuel Station	1	60	50	-	-	Wildlife Habitat	Y	3,000	sf	$0.62	$1,860
MC-22	Tire Shop	1	79	44	23	-	Wildlife Habitat	Y	79,948	cf	$0.25	$19,987
MC-27	Inactive Diesel Storage Tanks	2	-	-	15	20	Wildlife Habitat	Y	35,253	gal	$2,548.74	$5,097
2B Leach / Little Rock Haul Road Fuel Dock Area												
-	Fuel Dock	1	70	40	-	-	Wildlife Habitat	Y	2,800	sf	$0.62	$1,736
Tailing Launder Line Area												
-	Tailing Dam 1 Reclaim Water Pumphouse[5]	1	80	30	15	-	Wildlife Habitat	Y	36,000	cf	$0.25	$9,000
											Demolition Total Direct Cost	$3,372,758

ID	Unit Cost ($/unit)[1]	Units	RS Means Line Item	Description
Structure Demolition	$0.25	$/cf	024116.13 0100	Building demolition, large urban projects, mixture of types, excludes foundation demolition, dump fees
Concrete Slab Demolition	$0.62	$/sf floor	024116.17-0400	Building footing and foundation demolition 6" thick plain concrete
Storage Tank Demolition[3]	$1,005.97	$/each	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
Storage Tank Demolition[3]	$2,168.93	$/each	130505.75-0540	Steel tank, single wall, above ground, 15,000 thru 30,000 gallon, selective demolition, excluding foundation, pumps or piping

1. RS Means Online 2019; RS Means Location adjustment: New Mexico Las Cruces
2. Increased volume by 20% for large equipment (Tank house)
3. Unit cost for each tank demo is scaled based on tank size
4. Pumps/sumps were demolished, now storage
5. See "2 Demo" sheet for substation demo

Building Demolition - Cover

Soil Cover Depth ft: 3

Tyrone Tag No.	Description	Number	Dimensions (ft)				PMLU?	Cover?	Cover			
			L	W	H	Diameter			Cover Quantity	Unit	Unit Cost ($/unit)	Item Cost ($)
Mine Maintenance Facilities Area												
MM-06	Jerome Building	1	204	63	50	-	Wildlife Habitat	Y	1,428	cy	$1.22	$1,740
MM-07	Plant Warehouse	1	250	100	28	-	Wildlife Habitat	Y	2,778	cy	$1.22	$3,384
MM-09	Electric Shop	1	120	51	50	-	Wildlife Habitat	Y	680	cy	$1.22	$828
MM-10	Pipe Shop	1	145	41	40	-	Wildlife Habitat	Y	661	cy	$1.22	$805
MM-11	Carpenter Shop	1	119	69	27	-	Wildlife Habitat	Y	912	cy	$1.22	$1,112
MM-12	Lumber Storage	1	102	61	33	-	Wildlife Habitat	Y	691	cy	$1.22	$842
MM-13	Shovel Repair	1	121	70	66	-	Wildlife Habitat	Y	941	cy	$1.22	$1,147
MM-14	Environmental Lab/Field Offices	1	112	27	17	-	Wildlife Habitat	Y	336	cy	$1.22	$409
SX-EW Plant Area												
-	Tank house	1	150	465	30	-	Wildlife Habitat	Y	7,750	cy	$1.22	$9,442
-	SX/EW Plant Area Shop	1	31	71	30	-	Wildlife Habitat	Y	245	cy	$1.22	$298
-	Leach Crew Office	1	15	15	15	-	Wildlife Habitat	Y	25	cy	$1.22	$30
-	SX/EW Warehouse	1	48	150	20	-	Wildlife Habitat	Y	800	cy	$1.22	$975
-	Gonzales Cells	1	25	52	10	-	Wildlife Habitat	Y	144	cy	$1.22	$176
-	Jamison Cells	1	35	44	10	-	Wildlife Habitat	Y	171	cy	$1.22	$208
-	MCC Building	1	14	30	12	-	Wildlife Habitat	Y	47	cy	$1.22	$57
-	Tool room and Storage	1	60	70	12	-	Wildlife Habitat	Y	467	cy	$1.22	$569
-	Chlorinator Room	1	19	66	12	-	Wildlife Habitat	Y	139	cy	$1.22	$170
-	Rectifiers	1	20	24	12	-	Wildlife Habitat	Y	53	cy	$1.22	$65
-	Workroom	1	66	75	12	-	Wildlife Habitat	Y	550	cy	$1.22	$670
-	Pump Mixer Control Room	1	41	41	12	-	Wildlife Habitat	Y	187	cy	$1.22	$228
-	Tool room and Storage	1	8	32	12	-	Wildlife Habitat	Y	28	cy	$1.22	$35
-	Pacesetter Filters (2)	1	48	80	12	-	Wildlife Habitat	Y	427	cy	$1.22	$520
-	Wash Pad	1	45	68	-	-	Wildlife Habitat	Y	340	cy	$1.22	$414
Lubrication Shop Area												
-	Lubrication Shop	1	110	60	35	-	Waiver Area	Y	733	cy	$1.22	$893
-	Southwest Energy Building	1	42	42	19	-	Not Specified	Y	196	cy	$1.22	$239
-	Electric Power Substation	1	52	36	10	-	Waiver Area	Y	208	cy	$1.22	$253
-	Powder Magazines	3	10	10	10	-	Waiver Area	Y	33	cy	$1.22	$41
-	Storage Sheds	1	110	60	10	-	Waiver Area	Y	733	cy	$1.22	$893
-	Lube shop Addition	1	50	70	17	-	-	Y	389	cy	$1.22	$474
-	#2 Fuel Dock Concrete Slab for Haul Trucks	1	14	42	-	-	-	Y	65	cy	$1.22	$80
Acid Unloading Facility & Former Precipitation Area												
-	Acid Unloading Facility	1	20	10	20	-	Wildlife Habitat	Y	22	cy	$1.22	$27
-	Former Precipitation Plant	1	400	100	-	-	Wildlife Habitat	Y	4,444	cy	$1.22	$5,415
Mill and Concentrator Area												
MC-20	Reagent Building	1	150	50	16	-	Wildlife Habitat	Y	833	cy	$1.22	$1,015
MC-21	Fuel Station	1	60	50	-	-	Wildlife Habitat	Y	333	cy	$1.22	$406
MC-01	Tailing Thickeners	1	1500	800	-	-	Industrial	Y	133,333	cy	$1.22	$162,443
2B Leach / Little Rock Haul Road Fuel Dock Area												
-	Fuel Dock	1	70	40	-	-	Wildlife Habitat	Y	311	cy	$1.22	$379
Tailing Launder Line Area												
-	Tailing Dam 1 Reclaim Water Pumphouse	1	80	30	15	-	Wildlife Habitat	Y	267	cy	$1.22	$325

Cover Total Direct Cost: $197,006

Item	Unit Cost $/cy	Description
Load and Haul cover material	$1.22	Site-Wide Weighted Average Unit Cover Material Excav, Haul, Grade Cost ($/cy)

Building Demolition - Vegetation

Tyrone Tag No.	Description	Number	Dimensions (ft)				PMLU?	Veg?	Vegetation			
			L	W	H	Diameter			Area	Unit	Unit Cost ($/unit)	Item Cost ($)
Mine Maintenance Facilities Area												
MM-06	Jerome Building	1	204	63	50	-	Wildlife Habitat	Y	0.295	ac	$823.97	$243
MM-07	Plant Warehouse	1	250	100	28	-	Wildlife Habitat	Y	0.574	ac	$823.97	$473
MM-09	Electric Shop	1	120	51	50	-	Wildlife Habitat	Y	0.140	ac	$823.97	$116
MM-10	Pipe Shop	1	145	41	40	-	Wildlife Habitat	Y	0.136	ac	$823.97	$112
MM-11	Carpenter Shop	1	119	69	27	-	Wildlife Habitat	Y	0.188	ac	$823.97	$155
MM-12	Lumber Storage	1	102	61	33	-	Wildlife Habitat	Y	0.143	ac	$823.97	$118
MM-13	Shovel Repair	1	121	70	66	-	Wildlife Habitat	Y	0.194	ac	$823.97	$160
MM-14	Environmental Lab/Field Offices	1	112	27	17	-	Wildlife Habitat	Y	0.069	ac	$823.97	$57
									-			
SX-EW Plant Area									-			
-	Tank house	1	150	465	30	-	Wildlife Habitat	Y	1.601	ac	$823.97	$1,319
-	SX/EW Plant Area Shop	1	31	71	30	-	Wildlife Habitat	Y	0.051	ac	$823.97	$42
-	Leach Crew Office	1	15	15	15	-	Wildlife Habitat	Y	0.005	ac	$823.97	$4
-	SX/EW Warehouse	1	48	150	20	-	Wildlife Habitat	Y	0.165	ac	$823.97	$136
-	Gonzales Cells	1	25	52	10	-	Wildlife Habitat	Y	0.030	ac	$823.97	$25
-	Jamison Cells	1	35	44	10	-	Wildlife Habitat	Y	0.035	ac	$823.97	$29
-	Organic Tanks	4	-	-	16	32	Wildlife Habitat	Y	0.074	ac	$823.97	$61
-	Mixer/Settler Tanks	8	200	366	10	-	Wildlife Habitat	Y	13.444	ac	$823.97	$11,077
-	Tank Farm	5	-	-	10	19	Wildlife Habitat	Y	0.033	ac	$823.97	
-	Water Tank	1	-	-	16	30	Wildlife Habitat	Y	0.016	ac	$823.97	$13
-	Acid Tanks	2	-	-	16	20	Wildlife Habitat	Y	0.014	ac	$823.97	$12
-	MCC Building	1	14	30	12	-	Wildlife Habitat	Y	0.010	ac	$823.97	$8
-	Tool room and Storage	1	60	70	12	-	Wildlife Habitat	Y	0.096	ac	$823.97	$79
-	Chlorinator Room	1	19	66	12	-	Wildlife Habitat	Y	0.029	ac	$823.97	$24
-	Rectifiers	1	20	24	12	-	Wildlife Habitat	Y	0.011	ac	$823.97	$9
-	Workroom	1	66	75	12	-	Wildlife Habitat	Y	0.114	ac	$823.97	$94
-	Pump Mixer Control Room	1	41	41	12	-	Wildlife Habitat	Y	0.039	ac	$823.97	$32
-	Cobalt Sulfate Tank	1	-	-	16	18	Wildlife Habitat	Y	0.006	ac	$823.97	$5
-	Reagent Tanks	2	-	-	12	12	Wildlife Habitat	Y	0.005	ac	$823.97	$4
-	Tool room and Storage	1	8	32	12	-	Wildlife Habitat	Y	0.006	ac	$823.97	$5
-	Diluent Storage Tank	1	-	-	16	18	Wildlife Habitat	Y	0.006	ac	$823.97	$5
-	Pacesetter Filters (2)	1	48	80	12	-	Wildlife Habitat	Y	0.088	ac	$823.97	$73
-	Wash Pad	1	45	68	-	-	Wildlife Habitat	Y	0.070	ac	$823.97	$58
									-			
Lubrication Shop Area									-			
-	Prill Tanks	2	-	-	35	20	Waiver Area	Y	0.014	ac	$823.97	$12
-	Lubrication Shop	1	110	60	35	-	Waiver Area	Y	0.152	ac	$823.97	$125
-	Southwest Energy Building	1	42	42	19	-	Not Specified	Y	0.040	ac	$823.97	$33
-	Electric Power Substation	1	52	36	10	-	Waiver Area	Y	0.043	ac	$823.97	$35
-	Powder Magazines	3	10	10	10	-	Waiver Area	Y	0.007	ac	$823.97	$6
-	Storage Sheds	1	110	60	10	-	Waiver Area	Y	0.152	ac	$823.97	$125
-	Lube shop Addition	1	50	70	17	-	-	Y	0.080	ac	$823.97	$66
-	#2 Fuel Dock Concrete Slab for Haul Trucks	1	14	42	-	-	-	Y	0.013	ac	$823.97	$11
									-			
Acid Unloading Facility & Former Precipitation Area									-			
-	Acid Unloading Facility	1	20	10	20	-	Wildlife Habitat	Y	0.005	ac	$823.97	$4
-	Former Precipitation Plant	1	400	100	-	-	Wildlife Habitat	Y	0.918	ac	$823.97	$757
									-			
Mill and Concentrator Area									-			
MC-15	Warehouse and Core Storage	1	235	101	33	-	Wildlife Habitat	Y	0.545	ac	$823.97	$449
MC-20	Reagent Building	1	150	50	16	-	Wildlife Habitat	Y	0.172	ac	$823.97	$142
MC-21	Fuel Station	1	60	50	-	-	Wildlife Habitat	Y	0.069	ac	$823.97	$57
MC-27	Inactive Diesel Storage Tanks	2	-	-	15	20	Wildlife Habitat	Y	0.014	ac	$823.97	$12
MC-01	Tailing Thickeners	1	1500	800	-	-	Industrial	Y	27.548	ac	$823.97	$22,699
2B Leach / Little Rock Haul Road Fuel Dock Area												
-	Fuel Dock	1	70	40	-	-	Wildlife Habitat	Y	0.064	ac	$823.97	$53
									-			
Tailing Launder Line Area									-			
-	Tailing Dam 1 Reclaim Water Pumphouse	1	80	30	15	-	Wildlife Habitat	Y	0.055	ac	$823.97	$45

Revegetation unit cost: $ 823.97 $/acre

Data Sources:
See "Revegetation_UC"

Revegetation Total Direct Cost: $ 39,178

Building Demolition - Waste Requiring Special Handling

										Wastes Requiring Special Handling										
										Cleanup& Disposal				Transportaion						
Tyrone Tag No.	Description	Number	Dimensions (ft)				PMLU?	Wastes?												
			L	W	H	Diameter			Quantity	Unit	Quantity	Unit	Unit Cost ($/unit)	Item Cost ($)	Drums	Trips	Miles	Unit Cost ($/unit)	Item Cost ($)
Mine Maintenance Facilities Area																			
MM-06	Jerome Building	1	204	63	50	-	Wildlife Habitat	Y	103	cy	74	tons	$335.20	$34,585	330	4	337	$4.78	$6,648
MM-07	Plant Warehouse	1	250	100	28	-	Wildlife Habitat	Y	112	cy	81	tons	$335.20	$37,674	360	4	337	$4.78	$7,242
MM-09	Electric Shop	1	120	51	50	-	Wildlife Habitat	Y	49	cy	35	tons	$335.20	$16,469	157	2	337	$4.78	$3,166
MM-10	Pipe Shop	1	145	41	40	-	Wildlife Habitat	Y	38	cy	27	tons	$335.20	$12,798	122	2	337	$4.78	$2,460
MM-11	Carpenter Shop	1	119	69	27	-	Wildlife Habitat	Y	36	cy	26	tons	$335.20	$11,932	114	1	337	$4.78	$2,294
MM-12	Lumber Storage	1	102	61	33	-	Wildlife Habitat	Y	33	cy	24	tons	$335.20	$11,051	105	1	337	$4.78	$2,124
MM-13	Shovel Repair	1	121	70	66	-	Wildlife Habitat	Y	90	cy	65	tons	$335.20	$30,087	287	4	337	$4.78	$5,784
MM-14	Environmental Lab/Field Offices	1	112	27	17	-	Wildlife Habitat	Y	8	cy	6	tons	$335.20	$2,767	26	0	337	$4.78	$532
SX-EW Plant Area																			
-	Tank house	1	150	465	30	-	Wildlife Habitat	Y	336	cy	242	tons	$335.20	$112,619	1075	13	337	$4.78	$21,649
-	SX/EW Plant Area Shop	1	31	71	30	-	Wildlife Habitat	Y	11	cy	8	tons	$335.20	$3,554	34	0	337	$4.78	$683
-	Leach Crew Office	1	15	15	15	-	Wildlife Habitat	Y	1	cy	0	tons	$335.20	$182	2	0	337	$4.78	$35
-	SX/EW Warehouse	1	48	150	20	-	Wildlife Habitat	Y	23	cy	17	tons	$335.20	$7,750	74	1	337	$4.78	$1,490
-	Gonzales Cells	1	25	52	10	-	Wildlife Habitat	Y	2	cy	2	tons	$335.20	$700	7	0	337	$4.78	$134
-	Jamison Cells	1	35	44	10	-	Wildlife Habitat	Y	2	cy	2	tons	$335.20	$829	8	0	337	$4.78	$159
-	Organic Tanks	4	-	-	16	32	Wildlife Habitat	Y	62	cy	45	tons	$335.20	$20,724	198	2	337	$4.78	$3,984
-	Mixer/Settler Tanks	8	200	366	10	-	Wildlife Habitat	Y	940	cy	677	tons	$335.20	$315,171	3009	38	337	$4.78	$60,585
-	Tank Farm	5	-	-	10	19	Wildlife Habitat	Y	17	cy	12	tons	$335.20	$5,708	54	1	337	$4.78	$1,097
-	Water Tank	1	-	-	16	30	Wildlife Habitat	Y	14	cy	10	tons	$335.20	$4,554	43	1	337	$4.78	$875
-	Acid Tanks	2	-	-	16	20	Wildlife Habitat	Y	12	cy	9	tons	$335.20	$4,048	39	0	337	$4.78	$778
-	MCC Building	1	14	30	12	-	Wildlife Habitat	Y	1	cy	1	tons	$335.20	$271	3	0	337	$4.78	$52
-	Tool room and Storage	1	60	70	12	-	Wildlife Habitat	Y	8	cy	6	tons	$335.20	$2,713	26	0	337	$4.78	$521
-	Chlorinator Room	1	19	66	12	-	Wildlife Habitat	Y	2	cy	2	tons	$335.20	$810	8	0	337	$4.78	$156
-	2A West Raff Tank	1	-	-	16	22	Wildlife Habitat	Y	7	cy	5	tons	$335.20	$2,449	23	0	337	$4.78	$471
-	Rectifiers	1	20	24	12	-	Wildlife Habitat	Y	1	cy	1	tons	$335.20	$310	3	0	337	$4.78	$60
-	Workroom	1	66	75	12	-	Wildlife Habitat	Y	10	cy	7	tons	$335.20	$3,197	31	0	337	$4.78	$615
-	Pump Mixer Control Room	1	41	41	12	-	Wildlife Habitat	Y	3	cy	2	tons	$335.20	$1,086	10	0	337	$4.78	$209
-	Cobalt Sulfate Tank	1	-	-	16	18	Wildlife Habitat	Y	5	cy	4	tons	$335.20	$1,639	16	0	337	$4.78	$315
-	Reagent Tanks	2	-	-	12	12	Wildlife Habitat	Y	3	cy	2	tons	$335.20	$1,093	10	0	337	$4.78	$210
-	Tool room and Storage	1	8	32	12	-	Wildlife Habitat	Y	0	cy	0	tons	$335.20	$165	2	0	337	$4.78	$32
-	Diluent Storage Tank	1	-	-	16	18	Wildlife Habitat	Y	5	cy	4	tons	$335.20	$1,639	16	0	337	$4.78	$315
-	Pacesetter Filters (2)	1	48	80	12	-	Wildlife Habitat	Y	7	cy	5	tons	$335.20	$2,480	24	0	337	$4.78	$477
-	Wash Pad	1	45	68	-	-	Wildlife Habitat	Y	0	cy	0	tons	$335.20	$165	2	0	337	$4.78	$32
Acid Unloading Facility & Former Precipitation Area																			
-	Acid Unloading Facility	1	20	10	20	-	Wildlife Habitat	Y	1	cy	0	tons	$335.20	$215	2	0	337	$4.78	$41
-	Former Precipitation Plant	1	400	100	-	-	Wildlife Habitat	Y	6	cy	5	tons	$335.20	$2,153	21	0	337	$4.78	$414
Mill and Concentrator Area																			
MC-15	Warehouse and Core Storage	1	235	101	33	-	Wildlife Habitat	Y	126	cy	91	tons	$335.20	$42,155	402	5	337	$4.78	$8,103
MC-20	Reagent Building	1	150	50	16	-	Wildlife Habitat	Y	19	cy	14	tons	$335.20	$6,458	62	1	337	$4.78	$1,242
MC-21	Fuel Station	1	60	50	-	-	Wildlife Habitat	Y	0	cy	0	tons	$335.20	$161	2	0	337	$4.78	$31
MC-22	Tire Shop	1	79	44	23	-	Wildlife Habitat	Y	13	cy	9	tons	$335.20	$4,303	41	1	337	$4.78	$827
MC-27	Inactive Diesel Storage Tanks	2	-	-	15	20	Wildlife Habitat	Y	11	cy	8	tons	$335.20	$3,795	36	0	337	$4.78	$729
2B Leach / Little Rock Haul Road Fuel Dock Area																			
-	Fuel Dock	1	70	40	-	-	Wildlife Habitat	Y	0	cy	0	tons	$335.20	$151	1	0	337	$4.78	$29
Tailing Launder Line Area																			
-	Tailing Dam 1 Reclaim Water Pumphouse	1	80	30	15	-	Wildlife Habitat	Y	6	cy	4	tons	$335.20	$1,938	18	0	337	$4.78	$372

Total Cost $849,518

Item	Min. Base Cost	Max. Base Cost	Ave. Base Cost	Units	Means Line Item
	$/unit	$/unit	$/unit		
Cleanup & Disposal of Wastes Requiring Special Handling	$162.26	$508.13	$335.20	$/ton	Means Line Item 028120.10 1120/1130
Transport of Wastes Requiring Special Handling (Truckload = 80 drums or 25 cy or 18 tons)	$3.37	$6.19	$4.78	$/mile	Means Line Item 028120.10 1260/1270

R.S. Means Online Heavy Construction Cost Data, 2019
Volume of wastes requiring special handling is assumed to be in the same proportion to the structural material volume as for other FMI New Mexico operations 0.0001606 cy/cf
Disposal Location: Veolia 5736 W Jefferson St, Phoenix, AZ 85043 337 miles

Tyrone Mine

Facility Demolition Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$3,372,758
	Cover		$197,006
	Ripping & Revegetation		$39,178
	Waste Requiring Special Handling		$849,518
	Subtotal, Direct Costs		**$4,458,460**
INDIRECT COSTS	**Subtotal, Indirect Costs**	**30.0%**	**$1,337,538**
TOTAL COST			**$5,795,998**

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

Component	Current Cost
Earthwork & Demo	$93,128,947
Other O&M	$7,596,805
Veg O&M	$1,278,712
Total	**$102,004,464**

	Earthwork			
Year	Earthwork Current Cost	Vegetation Maint. Current Cost	O&M Current Cost	Total Earthwork Current Cost
1	1,000,000	15,000	98,836	1,113,836
2	4,000,000	15,000	107,948	4,122,948
3	7,094,079	56,760	107,948	7,258,786
4	7,094,079	56,760	107,948	7,258,786
5	7,094,079	56,760	107,948	7,258,786
6	7,094,079	56,760	113,964	7,264,802
7	7,094,079	56,760	114,598	7,265,437
8	7,094,079	56,760	90,035	7,240,873
9	7,094,079	56,760	90,035	7,240,873
10	7,094,079	56,760	90,035	7,240,873
11	7,094,079	56,760	90,035	7,240,873
12	7,094,079	56,760	90,133	7,240,972
13	7,094,079	56,760	90,227	7,241,065
14	7,094,079	56,760	113,766	7,264,605
15	3,000,000	56,760	121,566	3,178,325
16	-	56,760	121,566	178,325
17	-	56,760	121,566	178,325
18	-	56,760	121,566	178,325
19	-	56,760	121,566	178,325
20	-	56,760	121,566	178,325
21	-	56,760	86,973	143,733
22	-	56,760	86,973	143,733
23	-	56,760	86,973	143,733
24	-	56,760	86,973	143,733
25	-	-	86,973	86,973
26	-	-	86,973	86,973
27	-	-	86,973	86,973
28	-	-	86,973	86,973
29	-	-	86,973	86,973
30	-	-	86,973	86,973
31	-	-	86,973	86,973
32	-	-	86,973	86,973
33	-	-	86,973	86,973
34	-	-	86,973	86,973
35	-	-	86,973	86,973
36	-	-	86,973	86,973
37	-	-	86,973	86,973
38	-	-	86,973	86,973
39	-	-	86,973	86,973
40	-	-	86,973	86,973
41	-	-	61,908	61,908
42	-	-	61,908	61,908
43	-	-	61,908	61,908
44	-	-	61,908	61,908
45	-	-	61,908	61,908
46	-	-	61,908	61,908
47	-	-	61,908	61,908
48	-	-	61,908	61,908
49	-	-	61,908	61,908
50	-	-	61,908	61,908
51	-	-	61,908	61,908
52	-	-	61,908	61,908
53	-	-	61,908	61,908
54	-	-	61,908	61,908
55	-	-	61,908	61,908
56	-	-	61,908	61,908
57	-	-	61,908	61,908
58	-	-	61,908	61,908
59	-	-	61,908	61,908
60	-	-	61,908	61,908
61	-	-	61,908	61,908
62	-	-	61,908	61,908
63	-	-	61,908	61,908
64	-	-	61,908	61,908
65	-	-	61,908	61,908
66	-	-	61,908	61,908
67	-	-	61,908	61,908
68	-	-	61,908	61,908
69	-	-	61,908	61,908
70	-	-	61,908	61,908
71	-	-	61,908	61,908
72	-	-	61,908	61,908
73	-	-	61,908	61,908
74	-	-	61,908	61,908
75	-	-	61,908	61,908
76	-	-	61,908	61,908
77	-	-	61,908	61,908
78	-	-	61,908	61,908
79	-	-	61,908	61,908
80	-	-	61,908	61,908
81	-	-	61,908	61,908
82	-	-	61,908	61,908
83	-	-	61,908	61,908
84	-	-	61,908	61,908
85	-	-	61,908	61,908
86	-	-	61,908	61,908
87	-	-	61,908	61,908
88	-	-	61,908	61,908
89	-	-	61,908	61,908
90	-	-	61,908	61,908
91	-	-	61,908	61,908
92	-	-	61,908	61,908
93	-	-	61,908	61,908
94	-	-	61,908	61,908
95	-	-	61,908	61,908
96	-	-	61,908	61,908
97	-	-	61,908	61,908
98	-	-	61,908	61,908
99	-	-	61,908	61,908
100	-	-	61,908	61,908
Total	93,128,947	1,278,712	7,596,805	102,004,464

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	25.63	59.97	216.23	27.70	243.93	0.23	0.06	0.28
Load filter	Cat 992K	0.65	50	76.92	14.00	1076.92	25.63	59.97	216.23	27.70	243.93	0.23	0.06	0.28
Transfer riprap for placing	Cat 992K	0.65	50	76.92	14.00	1076.92	25.63	59.97	216.23	27.70	243.93	0.23	0.06	0.28
Transfer filter for placing	Cat 992K	0.65	50	76.92	14.00	1076.92	25.63	59.97	216.23	27.70	243.93	0.23	0.06	0.28

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	7.78	1.10	3.26	6.73	19.57	50	2.55	145	370	33.48	78.34	221.79	24.27	246.06	0.66	0.21	0.88
Haul filter from source to site	Komatsu 730E	0.70	7.78	1.10	3.26	6.73	19.57	50	2.55	145	370	33.48	78.34	221.79	24.27	246.06	0.66	0.21	0.88

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	14.09	73.11	24.27	97.38	0.69	0.10	0.79
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	14.09	73.11	24.27	97.38	0.69	0.10	0.79

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	16.8948	63.65	27.41	91.06	0.30	0.06	0.35
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	16.8948	63.65	27.41	91.06	0.40	0.07	0.47

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	$ 128.76	$ 35.57	1	$ 27.70	1	$ 156.46	$ 35.57
Cat 769D	$ 108.01	$ 22.79	3	$ 24.27	3	$ 396.83	$ 68.37
1 Deck Screening Plant (5X16, 48X60)	$ 40.59	$ 11.35	1	$ 23.09	1	$ 63.68	$ 11.35
3 Deck Screening Plant (5X16, 42X60)	$ 41.16	$ 11.35	1	$ 23.09	1	$ 64.25	$ 11.35
Cat 980H	$ 77.56	$ 25.27	2	$ 27.70	2	$ 210.53	$ 50.54
Cat 992K	$ 216.23	$ 59.97	0	$ 27.70	0	$ -	$ -
Cat 966H	$ 73.11	$ 19.61	1	$ 27.70	1	$ 100.81	$ 19.61
Off-Hwy Water Tanker Truck,6,000-gal.	$ 67.69	$ 26.33	1	$ 24.27	1	$ 91.96	$ 26.33
Supervisor	$ -	-	0	$ 23.84	1	$ 23.84	$ -

Direct Costs	Equipment	Fuel	
	$ 1,108	$ 223	$/hr
	8	8	hr/work day
	$ 8,867	$ 1,785	$/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	$ 7.22	$ 1.45	$/cy
Filter Delivery and placement	$ 2.11	$ 0.48	$/cy
Rip Rap Delivery and placement	$ 2.20	$ 0.50	$/cy

1. Riprap and filter haul uses site-wide borrow haul time average

ASSUMPTIONS

Work Day

8 hrs

50 min hour

Equipment Rates

Source: 2019 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)	$ 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 3 Deck Portable Screening Plant w/ 5x16 screen & 42"x60' conveyor + 1 Operator	$ 64.25	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)	$ 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	

	Equipment	Fuel	Total	
Total Unit Cost	$ 11.53	$ 2.43	$ 13.96	$/cy

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	2061	-	1.2	1.0	2900	1.0	87	3396	0.75	50	1.0	1.0	1.0	-	-	9.26	0.0045	$69.62	$254.44	$27.41	$281.85	$1.27	$0.31	
Finish Grade	Cat D6T XL, SU Blade	-	0.0009	1.2	1.0	2900	1.0	-	-	0.75	50	1.0	1.0	1.0	3	1.0	-	0.0009	$18.25	$65.52	$27.41	$92.93	$0.09	$0.02	
																							$1.35	$0.33	**$1.68 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	2061	-	1.2	1.0	2900	1.0	87	3396	0.75	50	1.0	1.0	1.0	-	-	9.26	0.0045	$69.62	$254.44	$27.41	$281.85	$1.27	$0.31	
Finish Grade	Cat D6T XL, SU Blade	-	0.0009	1.2	1.0	2900	1.0	-	-	0.75	50	1.0	1.0	1.0	3	1.0	-	0.0009	$18.25	$65.52	$27.41	$92.93	$0.09	$0.02	
																							$1.35	$0.33	**$1.68 Total**

Channel Unit Cost

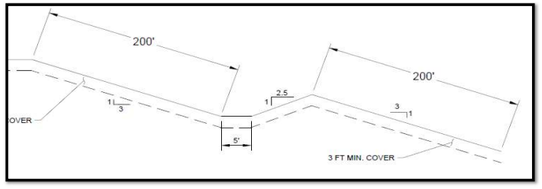
Earthwork

	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	1123	1.20	1.0	2900	1.00	175	1851	0.75	50	1.00	1.00	1.00	0.0007	69.62	254.44	27.41	281.85	0.20	0.05	
Channels	Waste	Cat D11T CD	0.78	1001	1.20	1.0	2900	1.00	200	1649	0.75	50	1.00	1.00	1.00	0.0008	69.62	254.44	27.41	281.85	0.22	0.05	
																					0.41	0.10	0.52 Total

Filter	0.22	cy/ft	$	2.04	$ 0.42
Rip Rap	0.44	cy/ft	$	4.12	$ 0.85
Total Unit Cost				$6.58	$1.38 $7.95 $/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[2]	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	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**

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**

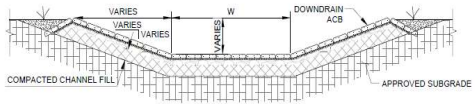
Install Cutoff Wall

Cutoff Wall (cast in place concrete)	cubic yard	$/cubic yard	**$/dissipater[3]**
RSMeans (2019)	14	$ 254.97	**$3,569.58**

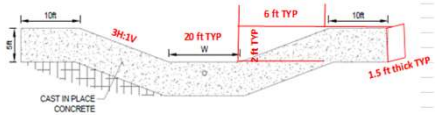
Total Dissipator Cost ($/each)	**$14,556.48**

DOWNDRAIN Dimensions:		
Left Side Slope:[2]	3	H:1V
Left Side Slope:[2]	3	H:1V
Depth:[2]	2	ft
Perimeter:[2]	31	ft
Excavation Area[2]	52	sf
ACB Area[2]	31	sf

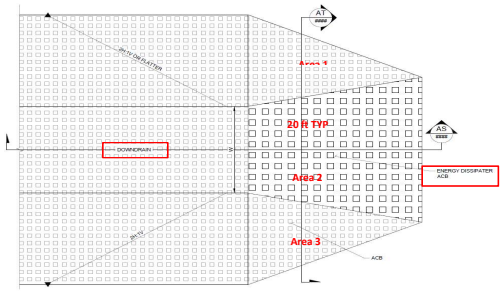
DISSIPATERS	**ACB[2]**				**Cutoff Wall[2,4]**		
	Surface Area 1	**Surface Area 2**	**Surface Area 3**	**Total**	**Cross-Sectional Area**	**Thickness**	**Volume**
	(sf)	**(sf)**	**(sf)**	**(sf)**	**(sf)**	**(ft)**	**(cy)**
	253	320	253	825	260	1.5	14



N.T.S AU 022A TYPICAL DOWNDRAIN SECTION



N.T.S AX 022A TYPICAL CUTTOFF WALL SECTION



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. 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'

Plastic Pipe Demolition Unit Cost

R.S. Means Item 026510300320	$306.69	9,000-12,000 gal (avg. 10,500 gal) tank sludge removal cost
	$0.03	sludge removal cost per gal
	$0.22	sludge removal cost per cf
	$0.02	sludge removal per foot of 7" pipe, assuming 1/3 full

Cost Cover Material Excav, Haul, Grade

Location	Cover Material Volume (cy)	Cost Cover Material Excav, Haul, Grade	Unit Cost ($/cy)
1A and 1B Leach	1,321,320	$1,262,102	$0.96
1C	82,300	$95,723	$1.16
2A Leach and 2B Waste	2,357,040	$3,231,529	$1.37
3A / 3B	2,202,200	$2,852,290	$1.30
4C Leach	885,720	$1,338,660	$1.51
5A Overburden	1,795,640	$1,528,495	$0.85
6B	261,360	$276,817	$1.06
6C	319,440	$371,540	$1.16
2C, 4A, 4B, 7B Leach	1,815,000	$2,488,386	$1.37
8C	229,222	$197,479	$0.86
9A Overburden	-	$0	$0.00
9AX	102,769	$115,945	$1.13
San Salvador Pit	556,600	$736,297	$1.32
Savanna In-Pit Leach Stockpile	314,600	$271,033	$0.86
Main, Savanna, Gettysburg & Copper Mountai	-	$0	$0.00
3A Leach Stockpile	-	$0	$0.00
Tailing Launder Line	9,637	$28,408	$2.95
Surface Impoundments	-	$118,435	$0.00
Tailing Repositories Borrow Areas	-	$0	$0.00
Tailing Dam 1 Reclaim Water Pumphouse	45,360	$228,213	$5.03
Monitoring & Exploration Wells	-	$0	$0.00
Seep 5E Collection System	-	$0	$0.00
Unplanned Disturbance Area	605,000	$697,333	$1.15
	12,903,208		

$1.22	Site-Wide Weighted Average Unit Cover Material Excav, Haul, Grade Cost ($/cy)
$1.82	Cover Material Excav, Haul, Grade Cost per ft of pipe ($/ft)

Total Cost	$1.84

Assumptions:

All pipes are 6"-8" (average 7")
Pipe demo cost includes flushing
Cover Material Volumes located in Tab 4
Cost Cover Material located in Tab 17b
Cover material unit cost assumes 40 sf of cover per foot of pipeline - 3' of cover over a 7' pipeline with 3:1 side slopes (and 27 cf per cy)

Plastic Pipe Demolition Unit Cost

R.S. Means Item 026510300320	$306.69	9,000-12,000 gal (avg. 10,500 gal) tank sludge removal cost
	$0.03	sludge removal cost per gal
	$0.22	sludge removal cost per cf
	$0.31	sludge removal per foot of 28" pipe, assuming 1/3 full

Cost Cover Material Excav, Haul, Grade

Location	Cover Material Volume (cy)	Cost Cover Material Excav, Haul, Grade	Unit Cost ($/cy)
1A and 1B Leach	1,321,320	$1,262,102	$0.96
1C	82,300	$95,723	$1.16
2A Leach and 2B Waste	2,357,040	$3,231,529	$1.37
3A / 3B	2,202,200	$2,852,290	$1.30
4C Leach	885,720	$1,338,660	$1.51
5A Overburden	1,795,640	$1,528,495	$0.85
6B	261,360	$276,817	$1.06
6C	319,440	$371,540	$1.16
2C, 4A, 4B, 7B Leach	1,815,000	$2,488,386	$1.37
8C	229,222	$197,479	$0.86
9A Overburden	-	$0	$0.00
9AX	102,769	$115,945	$1.13
San Salvador Pit	556,600	$736,297	$1.32
Savanna In-Pit Leach Stockpile	314,600	$271,033	$0.86
Main, Savanna, Gettysburg & Copper Mountai	-	$0	$0.00
3A Leach Stockpile	-	$0	$0.00
Tailing Launder Line	9,637	$28,408	$2.95
Surface Impoundments	-	$118,435	$0.00
Tailing Repositories Borrow Areas	-	$0	$0.00
Tailing Dam 1 Reclaim Water Pumphouse	45,360	$228,213	$5.03
Monitoring & Exploration Wells	-	$0	$0.00
Seep 5E Collection System	-	$0	$0.00
Unplanned Disturbance Area	605,000	$697,333	$1.15
	12,903,208		

$1.22	Site-Wide Weighted Average Unit Cover Material Excav, Haul, Grade Cost ($/cy)
$4.17	Cover Material Excav, Haul, Grade Cost per ft of pipe ($/ft)

Total Cost	$4.48

Assumptions:

All pipes are 20"-36" (average 28")
Pipe demo cost includes flushing
Cover Material Volumes located in Tab 4
Cost Cover Material located in Tab 17b
Cover material unit cost assumes 92 sf of cover per foot of pipeline - 3' of cover over a 7' pipeline with 3:1 side slopes (and 27 cf per cy)

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 2019 rates.

Tractor used for each operation is Deere 7430		**Cost**	**Unit**	**Information or Calculation**
EQW base rate for tractor rental	$	5,210.05	$ per month	EQW for Deere 7430
EQW base rate for tractor rental	$	29.60	$ per hour	= ($/month)/176
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)
EQW lube material cost	$	2.84	$ per hour	EQW for Deere 7430
EQW field parts cost	$	0.61	$ per hour	EQW for Deere 7430
EQW tire material cost	$	2.42	$ per hour	EQW for Deere 7430
EQW fuel burn rate		5.98	gallons per hour	EQW for Deere 7430
Local fuel cost	$	2.34	$ per gallon	Local quote
Fuel cost	$	13.99	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
NM Department of labor equipment operator rate	$	24.27	$ per hour	NM Department of Labor (NMDOL)
Total tractor cost	**$**	**76.27**	**$ 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	**$**	**3.85**	**$ per acre**	**Already included in total tractor cost… Fuel cost/acre = (fuel cost/hour) x (travel time hour/acre)**

Operation

Scarifying				
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	$	0.57	$ 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 cost	$	0.16	$ per hour	EQW for ripper
Ground Engaging Component cost	$	0.78	$ per hour	EQW for ripper
Total cost with tractor+operator included	**$**	**83.03**	**per hour**	**= total tractor cost + (rake without tractor, with ratio)**
Discing				
Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
Ground Engaging Component (GEC) cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor included	**$**	**80.55**	**per hour**	**= total tractor cost + (disc harrow, with ratio)**
Drill seeding (assume similar to discing)				
Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
Ground Engaging Component cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor+operator included	**$**	**80.55**	**per hour**	
Mulching				
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	$	1.25	$ per hour	EQW for trailer mounted mulcher (Finn B260), incl mechanic's wage $23.09 (NMDOL, 2019)
Lube material cost	$	1.60	$ 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	$	2.34	$ per gallon	Local quote
Fuel cost	$	9.66	$ per hour	= (EQW fuel burn rate) x (local fuel cost)
NM Department of labor equipment operator rate	$	24.27	$ per hour	NM Department of Labor (NMDOL)
Total cost with tractor+operator included	**$**	**126.12**	**per hour**	
Crimping (assume similar to discing)				
Disc harrow attachment, for tractor	$	616.33	per month	RS Means 01 54 33 20 1500
Disc harrow attachment, for tractor	$	3.50	per hour	= ($/month)/176
Ground Engaging Component cost	$	0.78	$ per hour	Assume similar to GEC cost for ripper (EQW)
Total cost with tractor+operator included	**$**	**80.55**	**per hour**	
Summary for operations				
Total cost for all operations combined (hour)	$	450.79	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)	$	120.12	per acre	---
Total cost for all operations combined w/ fuel(acre)	$	123.97	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	$	210.00	per acre	From supplier (Rocky Mountain Reclamation)
Hay mulch	$	490.00	per acre	From supplier (Rocky Mountain Reclamation): Mulch is applied at a rate of 2 tons per acre

Summary for operations + materials

Total revegetation unit cost	$	823.97	per acre	Total is for all operations (combined) + seed material + hay mulch material + fuel

Seepage Collection Unit Cost

Tyrone RCE udpate (2019)				2012 cost	2012 cost	Escalation (annual) rate =	Escalated from 2012 to 2019 rates 2%
Interceptor Trenches				**2013 RCE**	**2013 RCE**		**2019 cost**
Replacement Seepage Collection Systems	Seep 5E Collection	1	lump sum	19,271	19,271	Costs based on Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates. (Seep_5E_Collection_Replacement.xlsx)	22,137
3A Seepage Collection System							
Preliminary Earthworks		1	lump sum	15,900	15,900	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	18,264
Overflow Pond & Booster Station		1	lump sum	130,100	130,100	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	149,444
Canyon 5 Deep Collection		1	lump sum	133,125	133,125	Estimated to be average of Canyon 7, 8, 10 & 11 Deep Collection Systems	152,919
Canyon 6 Deep Collection		1	lump sum	133,125	133,125	Estimated to be average of Canyon 7, 8, 10 & 11 Deep Collection Systems	152,919
Canyon 7 Deep Collection		1	lump sum	135,400	135,400	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	155,532
Canyon 8 Deep Collection		1	lump sum	105,900	105,900	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	121,646
Canyon 10 Deep Collection		1	lump sum	154,500	154,500	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	177,472
Canyon 11 Deep Collection		1	lump sum	136,700	136,700	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	157,025
Bolster Existing Surface PLS Catchments		1	lump sum	231,500	231,500	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	265,921
Finger Drain System		1	lump sum	72,700	72,700	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	83,509
Breach of Existing Seepage Collection Trenches		1	lump sum	189,600	189,600	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	217,791
Concrete Pad for Above-Ground Tank		1	lump sum	9,900	9,900	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	11,372
Electrical Hookup		1	lump sum	157,600	157,600	Costs obtained from Golder Associates Inc,. Scope of Work; No. 3A Stockpile Seepage and PLS Control Systems; 2006 and escalated to 2012 rates.	181,033
						Average Replacement Cost:	133,356

Tyrone Trestle Demo Unit Cost (RS Means)

Use in RCE	Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location	Date of Data Access
Demolition - steel trestle	024116330200	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide	S.F.	$ -	$ 4.06	$ 3.55	$ 7.61	Year 2019	NEW MEXICO / LAS CRUCES (880)	4/12/2019
Demolition - steel trestle	024119180200	Selective demolition, disposal only, urban buildings with salvage value allowed, steel frame, includes loading and 5 mile haul to dump	C.Y.	$ -	$ 4.14	$ 4.70	$ 8.84	Year 2019	NEW MEXICO / LAS CRUCES (880)	4/12/2019

Calculation of Steel Trestle Demolition Cost

Data:	Quantities:	Notes:
Trestle full length (ft)	260	assumed similar to pedestrian steel bridge
Trestle legs length (ft)	160	2 legs at 80 ft each
Trestle width (ft)	13.5	
Trestle height (ft)	7.5	steel height above bridge deck
Haul distance (ft)	3.2	1-way to disposal (16,981 ft)

Quantities for Cost Calculation:

Horizontal (trestle platform/bridge) area at 13.5 ft wide is 13.5 x 260 =	3510	sf
One 10-ft section of trestle length demolishes to volume (with voids) of 10-ft x 10-ft x 4-ft (high) = 15 cy/10	390	cy
One 40-ft section of trestle leg demolishes to volume (with voids) of 10-ft x 10-ft x 4-ft = 15 cy/40 ft	60	cy
Total volume to haul =	450	cy

Cost:

Demolition of steel trestle	$	26,711.10
Hauling to disposal (unit rate for 5-mile haul covers 3.2 mile hau	$	3,978.00
Total steel trestle demolition cost =	**$**	**30,689.10**

Table 10: Channel/Bench Grading and Excavation Costs

Berm Grading Unit Cost

Berm Grading - 1.5H:1V

Task Description	Equipment	Productivity (cy/hr)	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	Volume (cy/ft)	Productivity (hrs/ft)	Fuel Cost ($/hr)	Equipment Cost ($/hr)	Operator Cost (IV) ($/hr)	Dozer Cost ($/hr)	Berm Equipment Cost ($/ft)	Berm Fuel Cost ($/ft)	
Excavate	Cat D9T, SU Blade	645	1.2	1.02	2900	1.0	100	1062	0.75	50	1.0	1.0	1.0	0.13	0.0002	$33.58	$198.37	$27.41	$225.78	$0.05	$0.01	
Finish Grade	Cat D9T, SU Blade	1158	1.2	1.02	2900	1.0	50	1909	0.75	50	1.0	1.0	1.0	0.043333	0.0000	$33.58	$198.37	$27.41	$225.78	$0.01	$0.00	
																				$0.05	$0.01	**$0.06 Total**

[1]Berm height: 1 ft.

Substation Demolition Unit Cost

Transformer demolition

RS Means 260505101570: Transformer, dry type, primary, 3 phase, to 600 V, 750 kVA, electrical demolition, remove, including removal of supports, wire & conduit terminations

- RS Means includes Crew R-3 of 2 electricians + 0.5 Crane operator (and crane) for 18 hours

$ 1,024.07 each

Power pole demolition

There are 5 power poles. Assume the cost to remove this small number of poles is allocated with other pole removals elsewhere in the RCE

Structure demolition

Masonry/brick building with no foundation

Use building demo cost of $0.25/cf developed from RS Means (see Building Demo sheet)

Building demo at 400 sf x 30 ft high = 12000 cf @ $0.25/cf = $3,000

$3,000 each

Drain oil from transformer

Transformer capacity = 1,200 gallons, which requires 1200/55 = 22 55-gallon drums

The oil is contained in 55-gallon drums and handled as waste requiring special handling (shipped off-site)

Based on cost at other FMI New Mexico operations ($229,331 for 30 loads @ 80 drums/load), cost/load = 229,331/30 = $7,644/load

$7,644 per load

Steam clean transformer after draining the oil

RS Means 015433406300: Rent steam cleaner 100 gph, Incl. Hourly Oper. Cost.

Assume this is needed for 1 week: $322.48 per week

$322.48 per week

Disposal of oil residue from cleaning

Use oil absorbent booms (https://www.newpig.com/pig-oil-only-absorbent-boom/p/BOM406)

Assume 5 bags of oil absorbent booms (8 booms per bag) are need to absorb the oil residue from cleaning

Cost (4/17/19) is $96/bag for 5 to 11 bags, yielding a total cost of $480

$480 booms

Assume 2 55-gallon drums will contain all booms used; these drums will be handled as waste requiring special handling

Assume these 2 drums fit on the same load as the 22 drums of transformer oil, so no additional cost to ship off-site

$0

$ 12,470.55 total estimated cost for substation demo

Specific inputs in EquipmentWatch that are adjusted

EquipmentWatch Line Item	**Description of EquipmentWatch Changes to Eliminate Duplicate Costs**
Mechanics Wages	Per New Mexico law, the $23.09/hour Mechanics labor rate is based on the most current New Mexico Department of Labor (DOL) Type H (Heavy Engineering) labor rates. FICA, Medicare, Social Security, Unemployment Taxes, and Workmans' Comp are accounted for in Overhead.
Sales Tax	The Sales Tax is set at $0/hour because New Mexico does not charge sales tax on state contracts. Sales Tax adjusted from 5.1% to 0%
Maximum work hours per month	Per EquipmentWatch BlueBook Rental calculations, a standard value of 176 hr/ month is assumed to be the maximum working hours per month. This value is used to determine the hourly cost of equipment use based on the monthly rental rate. This value is adjusted outside of EquipmentWatch in the Equipment worksheet.
Annual Field Repair Parts Cost	Annual Field Repair Parts Cost includes major equipment components. The Annual Field Repair costs are set to $0/yr because Tyrone will be renting equipment. This is input as a value <$1 because EquipmentWatch doesn't accept $0 as an input. Note that normal wear and tear costs are still included in the total equipment cost with Miscellaneous Supply Parts.
Annual Use Hours	The Annual Use Hours are adjusted in EquipmentWatch to eliminate the EquipmentWatch 50 minute work hour.
Fuel Rate	The Fuel Rate is set to $1/gal as the starting point to calculate fuel consumption and then fuel cost. Example Calculation for CAT 14M: First, the Fuel Rate is set to $1/gal. Then, Equipment Watch calculates fuel cost to be $8.29/hr. Fuel consumption is calculated as ($8.29/hr)/($1.00/gal) = 8.29 gal/hr. Fuel consumption is then multiplied by the Fuel Quote value ($2.34/gal) to yield a Fuel Cost for 14M of $19.40/hr.

Standard costs are used for other EquipmentWatch components

Definitions

Field Repair	Operating cost includes field repair defined as routine, daily servicing of the equipment and would include repairing, replacing or adjusting small components such as pumps, carburetors, injectors, batteries, filters, belts, gaskets, and hoses.The cost of extraordinary operating expendables is not included. Certain ground engaging components, such as hammer and drill bits, drill steel, augers, saw blades, and tooth-bits, are normally excluded from the "Estimated Operating Cost/Hr." because of their highly variable wear patterns. It is recommended that these costs be recovered separately
Field Repair - Labor	Field repair labor costs are accrued on a machine working-hour basis to offset charges incurred to perform normal field repair and maintenance. Costs listed under this heading represent an annual average over the economic life of the equipment.For adjustments and comparisons, the average labor cost per hour can be related to the average mechanic's wage (including fringe benefits) published.
Field Repair - Parts	Field repair parts costs are accrued on a machine working-hour basis to offset the costs for supplying parts necessary to keep the equipment operating in good condition. These parts consist of anything short of a major component overhaul or replacement. This annual cost includes “miscellaneous supply parts” referred to in the cost adjustment section. Costs listed under this heading represent an annual average over the economic life of the equipment.
Miscellaneous Supply Parts	Miscellaneous Supply Parts are parts normally stocked in bulk for an entire fleet, rather than for individual machines, this cost includes cables, hoses, steel etc.
Ground Engaging Components (GEC)	These costs include repair and/or replacement, either in whole or part, of ground engaging components such as pads, drums, teeth and cutting edges.
Tires	Tire costs include the repair and/or replacement of tires. Listed tire costs are based on the current price of tires, typical contractor discounts, and the tire life listed which reflects average working conditions.
Fuel	Fuel costs are calculated using average load factors, equipment horsepower, and the price of fuel per gallon. Actual fuel consumption will depend on variations in load factors, elevation, engine performance, operator efficiency, and terrain.
Lube	Lubrication includes the costs of oils, grease, coolants and filters. Labor and ancillary equipment involved in servicing is also included. (e.g. The cost of a lube truck and operator is included in this cost). For dual engine models, costs for both equipment and carrier are included.

Abbreviation	Name
ac	acre
ACB	Articulated Concrete Blocks
bcy	bulk cubic yards
cy	cubic yards
cf	cubic feet
ea	each
EQW	EquipmentWatch
ft	feet (or linear feet)
gal	gallon
hr	hour
lb	pound
lcy	loose cubic yards
MMD	Mining and Minerals Division
NMA	North Mine Area
NM	New Mexico
NMDOL	New Mexico Department of Labor
O&M	Operation and Maintenance
Reveg	Revegetate
sf	square feet
SOW	Scope of Work (see references)
UC	Unit Cost
yr	year

Item	Activity	Description
A	Grade	Rough grading original material or fine grading cover material
B	Dozer Assist	Dozer is used to assist loader or shovel at cover stockpile or assist scrapers during rough grading
C	Load	Cover material is loaded at borrow areas onto haul trucks
D	Haul	Haul trucks transport cover material from borrow areas to destination stockpiles
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 before revegetation.
F	Grade Benches	Benches are graded at stockpiles and tailings after fine grading
G	Construct Downdrains	Downdrains are constructed after fine grading and consist of articulated concrete blocks (ACB's)
Gb	Construct Downdrain Dissipators	Energy dissipators are specified as part of the downdrains
H	Construct Channels w/ Riprap	Channels are constructed after final grading. Construction includes excavation and wasting, riprap production, riprap and filter placement, and final grading.
Hb	Construct Channels w/o Riprap	Channels are constructed after final grading. Construction includes excavation and wasting and final grading.
I	Construct Top/Outslope Channels	Top and outslope channels are included with H and Hb for this RCE
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
K	Perforate Liner	Reservoir liners are perforated prior to reclamation
L	Replace Infrastructure	Replacing infrastructure is not part of this RCE
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
N	Plug and Abandon Well	Well borehole is backfilled with cement grout
O	Replace Well	Includes borehole drilling, casing, and cementing
P	Road Maintenance	Dust suppression and road maintenance with water truck and motor grader
Q	Construct Haul Road	For shorter hauls etc.
R	Construct Berms	Berming for stormwater runoff control
S	Fencing	Fencing for pits
T	Build Grade Control Walls	Grade control in each drainage of Tailing Launder Line removal
U	Vehicle Gates	Limited access at 1-mile intervals around open pits
V	Signs Every 500 ft	Warning signs posted every 500 feet around open pits

Item	Material	Description
a	Existing Ground	Existing ground before rough grading
b	Cover	Cover material from cover stockpiles, before being placed at destination location
c	Rough Graded Material	Exisiting ground after rough grading
d	Placed Cover	Cover material after being placed at destination location
e	Final Grade	Facility material and cover material after rough grading and fine grading
f	Backfill/Stockpile Material	Material used to backfill pit/ponds or stockpile material used in pullback

Not all activites are used in this RCE. Other activities are kept for alternatives and testing purposes and to maintain spreadsheet integrity

Appendix B

Supporting Data for Cost Estimation

Appendix B.1

2019 Labor Rates (NMDOL)

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

Appendix B.2

Equipment Watch Data

EquipmentWatch

www.equipmentwatch.com

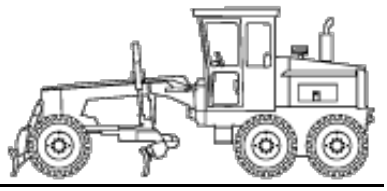
All prices shown in US$

Adjustments for MANDYLILLA11 in All Saved Models

January 17, 2019

Caterpillar 14M (disc. 2015)
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
46,796 lbs.



Configuration for 14M (disc. 2015)

Power Mode	**Diesel**	Net Horsepower	**259 hp**
Operator Protection	**EROPS**	Moldboard Size	**14 ft**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$30.16/hr	$28.25/hr	-6.3%
Cost of Facilities Capital (CFC)	$9.87/hr	$8.14/hr	-17.5%
Overhead	$15.01/hr	$12.24/hr	-18.5%
Overhaul Labor	$7.57/hr	$2.42/hr	-68%
Overhaul Parts	$17.21/hr	$14.02/hr	-18.5%
Total Hourly Ownership Cost:	**$79.82/hr**	**$65.07/hr**	**-18.5%**

User Defined Adjustments: Annual Use Hours (1,400hrs -> 1,718hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$6.30/hr	$2.02/hr	-67.9%
Field Parts	$16.69/hr	$2.27/hr	-86.4%
Ground Engaging Component (GEC)	$1.38/hr	$1.16/hr	-15.9%
Tire	$7.04/hr	-	-
Electrical/Fuel	$27.10/hr	$8.29/hr	-69.4%
Lube	$6.57/hr	-	-
Total Operating Ownership Cost:	**$65.08/hr**	**$27.35/hr**	**-58%**

User Defined Adjustments: Annual Field Repair Parts Cost ($19,471.51 -> $0.42) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$79.82/hr	$65.07/hr	-18.5%
Hourly Operating Costs	$65.08/hr	$27.35/hr	-58%
Total Hourly Cost	**$144.90**	**$92.42/hr**	**-36.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$55.04/hr	$48.63/hr	-11.6%
Idle	$106.92/hr	$73.36/hr	-31.4%

Revised Date: 1st Half 2019

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EquipmentWatch

www.equipmentwatch.com

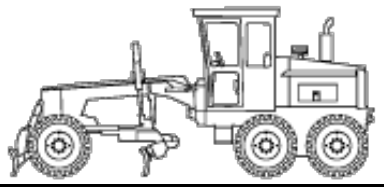
All prices shown in US$

Adjustments for MANDYLILLA11 in All Saved Models

January 17, 2019

Caterpillar 14M (disc. 2015)
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
46,796 lbs.



Configuration for 14M (disc. 2015)

Net Horsepower	**259 hp**	Moldboard Size	**14 ft**

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	$13,845.00	$4,709.00	$1,577.00
Adjustments			
Region (New Mexico: 86%)	($1,938.30)	($659.26)	($220.78)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$11,906.70**	**$4,049.74**	**$1,356.22**

Date Last Updated: Oct 01, 2018

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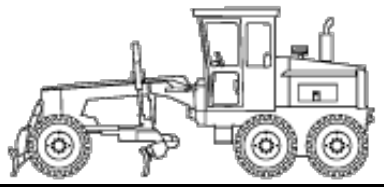
All prices shown in US$

Adjustments for Grader 16M 3A in All Saved Models

January 17, 2019

Caterpillar 16M
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
59,435 lbs.



Configuration for 16M

Power Mode	**Diesel**	Net Horsepower	**297 hp**
Operator Protection	**EROPS**	Moldboard Size	**16 ft**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$43.66/hr	$40.89/hr	-6.3%
Cost of Facilities Capital (CFC)	$14.28/hr	$11.78/hr	-17.5%
Overhead	$10.94/hr	$8.92/hr	-18.5%
Overhaul Labor	$7.57/hr	$2.42/hr	-68%
Overhaul Parts	$24.76/hr	$20.18/hr	-18.5%
Total Hourly Ownership Cost:	**$101.21/hr**	**$84.19/hr**	**-16.8%**

User Defined Adjustments: Annual Use Hours (1,400hrs -> 1,718hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$6.30/hr	$2.02/hr	-67.9%
Field Parts	$24.01/hr	$3.26/hr	-86.4%
Ground Engaging Component (GEC)	$2.00/hr	$1.76/hr	-12%
Tire	$10.13/hr	-	-
Electrical/Fuel	$31.08/hr	$9.50/hr	-69.4%
Lube	$8.69/hr	-	-
Total Operating Ownership Cost:	**$82.21/hr**	**$35.36/hr**	**-57%**

User Defined Adjustments: Annual Field Repair Parts Cost ($28,017.41 -> $0.41) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$101.21/hr	$84.19/hr	-16.8%
Hourly Operating Costs	$82.21/hr	$35.36/hr	-57%
Total Hourly Cost	**$183.42**	**$119.55/hr**	**-34.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$68.88/hr	$61.59/hr	-10.6%
Idle	$132.29/hr	$93.69/hr	-29.2%

Revised Date: 1st Half 2019

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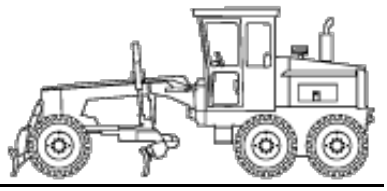
All prices shown in US$

Adjustments for Grader 16M 3A in All Saved Models

January 16, 2019

Caterpillar 16M
Articulated Frame Graders

Size Class:
250 HP & Over
Weight:
59,435 lbs.



Configuration for 16M

Net Horsepower	**297 hp**	Moldboard Size	**16 ft**

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	$13,845.00	$4,709.00	$1,577.00
Adjustments			
Region (New Mexico: 86%)	($1,938.30)	($659.26)	($220.78)
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$11,906.70**	**$4,049.74**	**$1,356.22**

Date Last Updated: Oct 01, 2018

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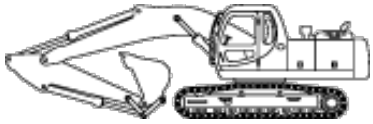
All prices shown in US$

Custom Cost Evaluator

February 15, 2019

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators



Size Class:
19.1 - 21.0 MTons
Weight:
43,872 lbs.

Configuration for 319D L (disc. 2012)

Power Mode	**Diesel**	Net Horsepower	**125 hp**
Bucket Capacity - Heaped	**1 cu yd**	Operating Weight	**19.9 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$16.20/hr	$15.16/hr	-6.4%
Cost of Facilities Capital (CFC)	$3.99/hr	$3.29/hr	-17.5%
Overhead	$3.75/hr	$3.04/hr	-18.9%
Overhaul Labor	$11.81/hr	$3.75/hr	-68.2%
Overhaul Parts	$7.21/hr	$5.84/hr	-19%
Total Hourly Ownership Cost:	**$42.96/hr**	**$31.08/hr**	**-27.7%**

User Defined Adjustments: Annual Use Hours (1,295hrs -> 1,599hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$14.31/hr	$4.55/hr	-68.2%
Field Parts	$7.37/hr	$1.19/hr	-83.9%
Ground Engaging Component (GEC)	$1.15/hr	$0.94/hr	-18.3%
Tire	$0.00/hr	-	-
Electrical/Fuel	$17.17/hr	$5.25/hr	-69.4%
Lube	$3.47/hr	-	-
Total Operating Ownership Cost:	**$43.47/hr**	**$15.40/hr**	**-64.6%**

User Defined Adjustments: Annual Field Repair Parts Cost ($7,630.58 -> $0.58) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$42.96/hr	$31.08/hr	-27.7%
Hourly Operating Costs	$43.47/hr	$15.40/hr	-64.6%
Total Hourly Cost	**$86.43**	**$46.48/hr**	**-46.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$23.94/hr	$21.49/hr	-10.2%
Idle	$60.13/hr	$36.33/hr	-39.6%

Revised Date: 1st Half 2019

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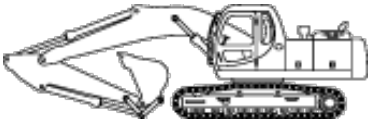
All prices shown in US$

Adjustments for MANDYLILLA9 in All Saved Models

January 16, 2019

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators



Size Class:
19.1 - 21.0 MTons
Weight:
43,872 lbs.

Configuration for 319D L (disc. 2012)

Bucket Capacity - Heaped	**1 cu yd**	Net Horsepower	**125 hp**
Operating Weight	**19.9 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	$6,835.00	$2,573.00	$956.00
Adjustments			
Region (New Mexico: 109%)	$615.15	$231.57	$86.04
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$7,450.15**	**$2,804.57**	**$1,042.04**

Date Last Updated: Oct 01, 2018

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EquipmentWatch

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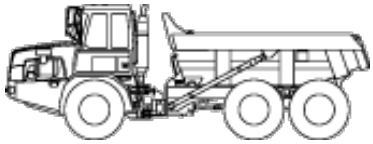
All prices shown in US$

Adjustments for MANDYLILLA17 in All Saved Models

January 17, 2019

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps



Size Class:
20 - 25 MTons
Weight:
49,075 lbs.

Configuration for 725 (disc. 2014)

Net Horsepower	**301 hp**	Power Mode	**Diesel**
Rated Payload	**23.6 mt**	Body Capacity (Struck--Heaped)	**14.3 cu yd - 18.8 cu yd**
Axle Configuration	**6 X 6**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$27.02/hr	$25.45/hr	-5.8%
Cost of Facilities Capital (CFC)	$5.58/hr	$4.92/hr	-11.8%
Overhead	$6.58/hr	$5.71/hr	-13.2%
Overhaul Labor	$12.72/hr	$4.33/hr	-66%
Overhaul Parts	$10.37/hr	$9.01/hr	-13.1%
Total Hourly Ownership Cost:	**$62.27/hr**	**$49.42/hr**	**-20.6%**

User Defined Adjustments: Annual Use Hours (1,850hrs -> 2,131hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$9.86/hr	$3.36/hr	-65.9%
Field Parts	$6.50/hr	$0.94/hr	-85.5%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$7.11/hr	-	-
Electrical/Fuel	$19.69/hr	$6.02/hr	-69.4%
Lube	$5.74/hr	-	-
Total Operating Ownership Cost:	**$48.90/hr**	**$23.17/hr**	**-52.6%**

User Defined Adjustments: Annual Field Repair Parts Cost ($10,027.26 -> $0.26) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$62.27/hr	$49.42/hr	-20.6%
Hourly Operating Costs	$48.90/hr	$23.17/hr	-52.6%
Total Hourly Cost	**$111.17**	**$72.59/hr**	**-34.7%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$39.18/hr	$36.08/hr	-7.9%
Idle	$81.96/hr	$55.44/hr	-32.4%

Revised Date: 1st Half 2019

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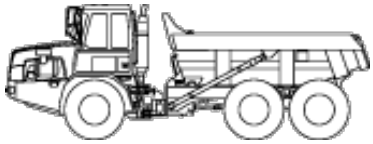
Adjustments for MANDYLILLA17 in All Saved Models

January 16, 2019

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps

Size Class:
20 - 25 MTons
Weight:
49,075 lbs.



Configuration for 725 (disc. 2014)

Axle Configuration	**6 X 6**	Body Capacity (Struck--Heaped)	**14.3 cu yd - 18.8 cu yd**
Net Horsepower	**301 hp**	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	$9,120.00	$3,277.00	$1,093.00
Adjustments			
Region (New Mexico: 108%)	$729.60	$262.16	$87.44
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$9,849.60**	**$3,539.16**	**$1,180.44**

Date Last Updated: Oct 01, 2018

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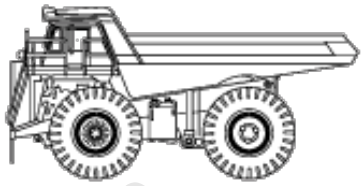
Adjustments for 3A 769D Truck in All Saved Models

January 17, 2019

Caterpillar 769D (disc. 2007)
Mechanical Drive Rear Dumps

Size Class:
30 - 39 MTons
Weight:
66,800 lbs.



Configuration for 769D (disc. 2007)

Body Capacity (Struck–Heaped)	**22.2 cu yd - 31.7 cu yd**	Power Mode	**Diesel**
Net Horsepower	**487 hp**	Rated Payload	**36.4 mt**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$33.52/hr	$31.57/hr	-5.8%
Cost of Facilities Capital (CFC)	$8.12/hr	$7.19/hr	-11.5%
Overhead	$5.20/hr	$4.55/hr	-12.5%
Overhaul Labor	$15.90/hr	$5.46/hr	-65.7%
Overhaul Parts	$16.64/hr	$14.56/hr	-12.5%
Total Hourly Ownership Cost:	**$79.38/hr**	**$63.33/hr**	**-20.2%**

User Defined Adjustments: Annual Use Hours (1,850hrs -> 2,114hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.56/hr	$4.31/hr	-65.7%
Field Parts	$10.14/hr	$1.48/hr	-85.4%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$13.72/hr	-	-
Electrical/Fuel	$31.85/hr	$9.74/hr	-69.4%
Lube	$8.77/hr	-	-
Total Operating Ownership Cost:	**$77.04/hr**	**$38.02/hr**	**-50.6%**

User Defined Adjustments: Annual Field Repair Parts Cost ($15,635.76 -> $0.76) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$79.38/hr	$63.33/hr	-20.2%
Hourly Operating Costs	$77.04/hr	$38.02/hr	-50.6%
Total Hourly Cost	**$156.42**	**$101.35/hr**	**-35.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$46.84/hr	$43.31/hr	-7.5%
Idle	$111.23/hr	$73.07/hr	-34.3%

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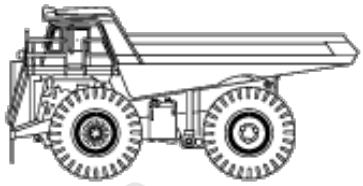
Adjustments for 3A 769D Truck in All Saved Models

January 16, 2019

Caterpillar 769D (disc. 2007)
Mechanical Drive Rear Dumps

Size Class:
30 - 39 MTons
Weight:
66,800 lbs.



Configuration for 769D (disc. 2007)

Body Capacity (Struck–Heaped)	**22.2 cu yd - 31.7 cu yd**	Net Horsepower	**487 hp**
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	$13,700.00	$4,600.00	$1,150.00
Adjustments			
Region (New Mexico: 102%)	$342.50	$115.00	$28.75
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$14,042.50**	**$4,715.00**	**$1,178.75**

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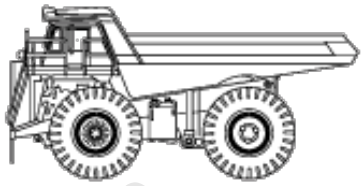
Adjustments for MANDYLILLA18 in All Saved Models

January 17, 2019

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
309,950 lbs.



Configuration for 730E

Net Horsepower	**1860 hp**	Power Mode	**Diesel**
Body Capacity (Struck–Heaped)	**101 cu yd - 145 cu yd**	Wheel Motor Model	**GE788**
Rated Payload	**183.7 mt**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$57.76/hr	$54.40/hr	-5.8%
Cost of Facilities Capital (CFC)	$18.12/hr	$17.55/hr	-3.1%
Overhead	$29.49/hr	$28.51/hr	-3.3%
Overhaul Labor	$54.07/hr	$20.51/hr	-62.1%
Overhaul Parts	$23.65/hr	$22.86/hr	-3.3%
Total Hourly Ownership Cost:	**$183.09/hr**	**$143.83/hr**	**-21.4%**

User Defined Adjustments: Annual Use Hours (1,850hrs -> 1,914hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$31.49/hr	$11.94/hr	-62.1%
Field Parts	$11.14/hr	$1.80/hr	-83.8%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$21.21/hr	-	-
Electrical/Fuel	$109.48/hr	$33.48/hr	-69.4%
Lube	$20.49/hr	-	-
Total Operating Ownership Cost:	**$193.81/hr**	**$88.92/hr**	**-54.1%**

User Defined Adjustments: Annual Field Repair Parts Cost ($17,180.45 -> $0.45) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$183.09/hr	$143.83/hr	-21.4%
Hourly Operating Costs	$193.81/hr	$88.92/hr	-54.1%
Total Hourly Cost	**$376.90**	**$232.75/hr**	**-38.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$105.37/hr	$100.46/hr	-4.7%
Idle	$292.57/hr	$177.31/hr	-39.4%

Revised Date: 1st Half 2019

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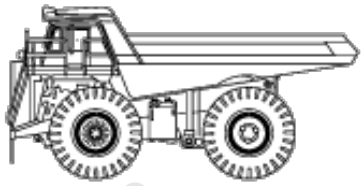
All prices shown in US$

Adjustments for MANDYLILLA18 in All Saved Models

January 16, 2019

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
309,950 lbs.



Configuration for 730E

Net Horsepower	**1860 hp**	Power Mode	**Diesel**
Body Capacity (Struck–Heaped)	**101 cu yd - 145 cu yd**	Wheel Motor Model	**GE788**
Rated Payload	**183.7 mt**		

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	$32,225.00	$9,025.00	$2,255.00	$340.00	$193.80	$376.90
Adjustments						
Region (Las Cruces, New Mexico: 91.1%)	($2,868.02)	($803.22)	($200.69)	($30.26)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$29,356.98**	**$8,221.78**	**$2,054.31**	**$309.74**	**$193.80**	**$360.60**

Non-Active Use Rates

	Hourly
Standby Rate	$88.40
Idling Rate	$276.28

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	31%	$9,989.75/mo
Overhaul (ownership)	47%	$15,145.75/mo
CFC (ownership)	9%	$2,900.25/mo
Indirect (ownership)	13%	$4,189.25/mo
Fuel (operating) @ 3.27	56%	$109.48/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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Adjustments for 3A 966H Loader in All Saved Models

January 16, 2019

Caterpillar 966H (disc. 2015)
4-Wd Articulated Wheel Loaders

Size Class:
250 - 274 HP
Weight:
52,254 lbs.



Configuration for 966H (disc. 2015)

Power Mode	**Diesel**	Net Horsepower	**262 hp**
Operator Protection	**EROPS**	Bucket Capacity - Heaped	**5.5 cu yd**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$20.82/hr	$19.42/hr	-6.7%
Cost of Facilities Capital (CFC)	$6.60/hr	$5.53/hr	-16.2%
Overhead	$5.17/hr	$4.27/hr	-17.4%
Overhaul Labor	$10.18/hr	$3.30/hr	-67.6%
Overhaul Parts	$6.20/hr	$5.12/hr	-17.4%
Total Hourly Ownership Cost:	**$48.97/hr**	**$37.64/hr**	**-23.1%**

User Defined Adjustments: Annual Use Hours (1,445hrs -> 1,751hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.42/hr	$4.02/hr	-67.6%
Field Parts	$6.84/hr	$0.84/hr	-87.7%
Ground Engaging Component (GEC)	$0.91/hr	$0.75/hr	-17.6%
Tire	$5.71/hr	-	-
Electrical/Fuel	$27.42/hr	$8.38/hr	-69.4%
Lube	$5.33/hr	-	-
Total Operating Ownership Cost:	**$58.63/hr**	**$25.03/hr**	**-57.3%**

User Defined Adjustments: Annual Field Repair Parts Cost ($8,409.97 -> $0.97) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$48.97/hr	$37.64/hr	-23.1%
Hourly Operating Costs	$58.63/hr	$25.03/hr	-57.3%
Total Hourly Cost	**$107.60**	**$62.67/hr**	**-41.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$32.59/hr	$29.22/hr	-10.3%
Idle	$76.39/hr	$46.02/hr	-39.8%

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Adjustments for 3A 966H Loader in All Saved Models

January 16, 2019

Caterpillar 966H (disc. 2015)
4-Wd Articulated Wheel Loaders

Size Class:
250 - 274 HP
Weight:
52,254 lbs.



Configuration for 966H (disc. 2015)

Bucket Capacity - Heaped	**5.5 cu yd**	Net Horsepower	**262 hp**

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	$9,375.00	$3,179.00	$1,050.00
Adjustments			
Region (New Mexico: 106%)	$562.50	$190.74	$63.00
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$9,937.50**	**$3,369.74**	**$1,113.00**

Date Last Updated: Oct 01, 2018

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Adjustments for 3A 980H Loader in All Saved Models

January 16, 2019

Caterpillar 980H (disc. 2013)
4-Wd Articulated Wheel Loaders

Size Class:
275 - 349 HP
Weight:
67,294 lbs.



Configuration for 980H (disc. 2013)

Power Mode	**Diesel**	Net Horsepower	**315 hp**
Operator Protection	**EROPS**	Bucket Capacity - Heaped	**7.5 cu yd**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$27.41/hr	$25.55/hr	-6.8%
Cost of Facilities Capital (CFC)	$8.69/hr	$7.27/hr	-16.3%
Overhead	$6.72/hr	$5.55/hr	-17.4%
Overhaul Labor	$10.18/hr	$3.30/hr	-67.6%
Overhaul Parts	$8.35/hr	$6.89/hr	-17.5%
Total Hourly Ownership Cost:	**$61.35/hr**	**$48.56/hr**	**-20.8%**

User Defined Adjustments: Annual Use Hours (1,445hrs -> 1,751hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.42/hr	$4.02/hr	-67.6%
Field Parts	$9.21/hr	$1.13/hr	-87.7%
Ground Engaging Component (GEC)	$1.20/hr	$1.03/hr	-14.2%
Tire	$7.69/hr	-	-
Electrical/Fuel	$32.96/hr	$10.08/hr	-69.4%
Lube	$6.70/hr	-	-
Total Operating Ownership Cost:	**$70.18/hr**	**$30.65/hr**	**-56.3%**

User Defined Adjustments: Annual Field Repair Parts Cost ($11,328.38 -> $0.38) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$61.35/hr	$48.56/hr	-20.8%
Hourly Operating Costs	$70.18/hr	$30.65/hr	-56.3%
Total Hourly Cost	**$131.53**	**$79.21/hr**	**-39.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$42.82/hr	$38.37/hr	-10.4%
Idle	$94.31/hr	$58.64/hr	-37.8%

Revised Date: 1st Half 2019

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Adjustments for 3A 980H Loader in All Saved Models

January 16, 2019

Caterpillar 980H (disc. 2013)
4-Wd Articulated Wheel Loaders

Size Class:
275 - 349 HP
Weight:
67,294 lbs.



Configuration for 980H (disc. 2013)

Bucket Capacity - Heaped	**7.5 cu yd**	Net Horsepower	**315 hp**

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	$9,463.00	$3,721.00	$1,141.00
Adjustments			
Region (New Mexico: 106%)	$567.78	$223.26	$68.46
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$10,030.78**	**$3,944.26**	**$1,209.46**

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Adjustments for 3A 988H Loader in All Saved Models

January 16, 2019

Caterpillar 988H (disc. 2014)
4-Wd Articulated Wheel Loaders

Size Class:
350 - 499 HP
Weight:
109,230 lbs.



Configuration for 988H (disc. 2014)

Power Mode	**Diesel**	Net Horsepower	**475 hp**
Operator Protection	**EROPS**	Bucket Capacity - Heaped	**8.33 cu yd**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$51.99/hr	$48.49/hr	-6.7%
Cost of Facilities Capital (CFC)	$16.42/hr	$13.74/hr	-16.3%
Overhead	$14.96/hr	$12.35/hr	-17.4%
Overhaul Labor	$10.18/hr	$3.30/hr	-67.6%
Overhaul Parts	$15.56/hr	$12.84/hr	-17.5%
Total Hourly Ownership Cost:	**$109.11/hr**	**$90.72/hr**	**-16.9%**

User Defined Adjustments: Annual Use Hours (1,445hrs -> 1,751hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.42/hr	$4.02/hr	-67.6%
Field Parts	$17.17/hr	$2.11/hr	-87.7%
Ground Engaging Component (GEC)	$2.26/hr	$1.93/hr	-14.6%
Tire	$16.85/hr	-	-
Electrical/Fuel	$49.70/hr	$15.20/hr	-69.4%
Lube	$11.40/hr	-	-
Total Operating Ownership Cost:	**$109.80/hr**	**$51.51/hr**	**-53.1%**

User Defined Adjustments: Annual Field Repair Parts Cost ($21,117.92 -> $0.92) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$109.11/hr	$90.72/hr	-16.9%
Hourly Operating Costs	$109.80/hr	$51.51/hr	-53.1%
Total Hourly Cost	**$218.91**	**$142.23/hr**	**-35%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$83.37/hr	$74.58/hr	-10.5%
Idle	$158.81/hr	$105.92/hr	-33.3%

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Adjustments for 3A 988H Loader in All Saved Models

January 16, 2019

Caterpillar 988H (disc. 2014)
4-Wd Articulated Wheel Loaders

Size Class:
350 - 499 HP
Weight:
109,230 lbs.



Configuration for 988H (disc. 2014)

Bucket Capacity - Heaped	**8.33 cu yd**	Net Horsepower	**475 hp**

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	$15,351.00	$5,261.00	$1,790.00
Adjustments			
Region (New Mexico: 106%)	$921.06	$315.66	$107.40
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$16,272.06**	**$5,576.66**	**$1,897.40**

Date Last Updated: Oct 01, 2018

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All prices shown in US$

Adjustments for Loader 992K 3A in All Saved Models

January 16, 2019

Caterpillar 992K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
214,948 lbs.



Configuration for 992K

Power Mode	**Diesel**	Net Horsepower	**801 hp**
Operator Protection	**EROPS**	Bucket Capacity - Heaped	**14 cu yd**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$120.33/hr	$112.37/hr	-6.6%
Cost of Facilities Capital (CFC)	$35.65/hr	$29.84/hr	-16.3%
Overhead	$62.12/hr	$51.27/hr	-17.5%
Overhaul Labor	$10.18/hr	$3.30/hr	-67.6%
Overhaul Parts	$32.68/hr	$26.97/hr	-17.5%
Total Hourly Ownership Cost:	**$260.96/hr**	**$223.75/hr**	**-14.3%**

User Defined Adjustments: Annual Use Hours (1,445hrs -> 1,751hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.42/hr	$4.02/hr	-67.6%
Field Parts	$36.06/hr	$4.43/hr	-87.7%
Ground Engaging Component (GEC)	$4.91/hr	$4.99/hr	+1.6%
Tire	$35.39/hr	-	-
Electrical/Fuel	$83.82/hr	$25.63/hr	-69.4%
Lube	$22.35/hr	-	-
Total Operating Ownership Cost:	**$194.95/hr**	**$96.81/hr**	**-50.3%**

User Defined Adjustments: Annual Field Repair Parts Cost ($44,343.18 -> $0.18) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$260.96/hr	$223.75/hr	-14.3%
Hourly Operating Costs	$194.95/hr	$96.81/hr	-50.3%
Total Hourly Cost	**$455.91**	**$320.56/hr**	**-29.7%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$218.10/hr	$193.48/hr	-11.3%
Idle	$344.78/hr	$249.38/hr	-27.7%

Revised Date: 1st Half 2019

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All prices shown in US$

Adjustments for Loader 992K 3A in All Saved Models

January 16, 2019

Caterpillar 992K
4-Wd Articulated Wheel Loaders

Size Class:
500 - 999 HP
Weight:
214,948 lbs.



Configuration for 992K

Bucket Capacity - Heaped	**14 cu yd**	Net Horsepower	**801 hp**

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	$24,083.00	$7,750.00	$2,506.00
Adjustments			
Region (New Mexico: 106%)	$1,444.98	$465.00	$150.36
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$25,527.98**	**$8,215.00**	**$2,656.36**

Date Last Updated: Oct 01, 2018

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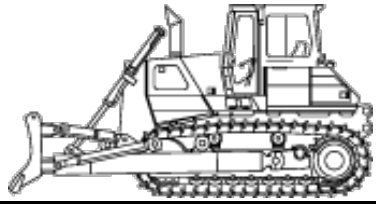
All prices shown in US$

Custom Cost Evaluator

January 16, 2019

Caterpillar D11T
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
208,885 lbs.



Configuration for D11T

Dozer Type	**U Blade**	Power Mode	**Diesel**
Net Horsepower	**850 hp**	Operator Protection	**EROPS**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$116.51/hr	$109.64/hr	-5.9%
Cost of Facilities Capital (CFC)	$34.88/hr	$29.42/hr	-15.7%
Overhead	$66.43/hr	$55.39/hr	-16.6%
Overhaul Labor	$17.23/hr	$5.64/hr	-67.3%
Overhaul Parts	$102.61/hr	$85.56/hr	-16.6%
Total Hourly Ownership Cost:	**$337.66/hr**	**$285.65/hr**	**-15.4%**

User Defined Adjustments: Annual Use Hours (1,400hrs -> 1,679hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$20.17/hr	$6.60/hr	-67.3%
Field Parts	$99.94/hr	$13.89/hr	-86.1%
Ground Engaging Component (GEC)	$16.66/hr	$12.22/hr	-26.7%
Tire	$0.00/hr	-	-
Electrical/Fuel	$97.28/hr	$29.75/hr	-69.4%
Lube	$26.23/hr	-	-
Total Operating Ownership Cost:	**$260.28/hr**	**$88.69/hr**	**-65.9%**

User Defined Adjustments: Annual Field Repair Parts Cost ($116,600.00 -> $0.50) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$337.66/hr	$285.65/hr	-15.4%
Hourly Operating Costs	$260.28/hr	$88.69/hr	-65.9%
Total Hourly Cost	**$597.94**	**$374.34/hr**	**-37.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$217.82/hr	$194.45/hr	-10.7%
Idle	$434.94/hr	$315.40/hr	-27.5%

Revised Date: 1st Half 2019

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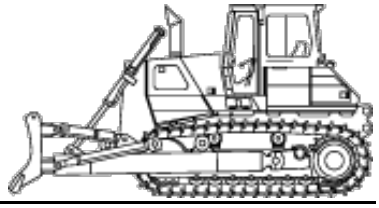
All prices shown in US$

Adjustments for MANDYLILLA5 in All Saved Models

January 16, 2019

Caterpillar D11T
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
208,885 lbs.



Configuration for D11T

Dozer Type	**U Blade**	Net Horsepower	**850 hp**

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	$30,423.00	$10,403.00	$3,509.00
Adjustments			
Region (New Mexico: 113%)	$3,985.41	$1,362.79	$459.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$34,408.41**	**$11,765.79**	**$3,968.68**

Date Last Updated: Oct 01, 2018

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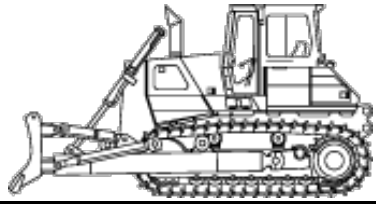
All prices shown in US$

AED Green Book®

January 29, 2019

Caterpillar D11T CD
Standard Crawler Dozers

Size Class:
520 HP & Over
Weight:
220,524 lbs.



Configuration for D11T CD

Dozer Type	**U Blade**	Net Horsepower	**850 hp**

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	$30,423.00	$10,403.00	$3,509.00
Adjustments			
Region (New Mexico: 113%)	$3,985.41	$1,362.79	$459.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$34,408.41**	**$11,765.79**	**$3,968.68**

Date Last Updated: Oct 01, 2018

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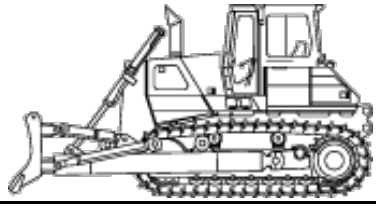
Adjustments for MANDYLILLA6 in All Saved Models

January 16, 2019

Caterpillar D6T
Standard Crawler Dozers

Size Class:
160 - 189 HP
Weight:
40,550 lbs.



Configuration for D6T

Dozer Type	**Semi-U**	Power Mode	**Diesel**
Net Horsepower	**185 hp**	Operator Protection	**EROPS**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$21.97/hr	$20.45/hr	-6.9%
Cost of Facilities Capital (CFC)	$7.33/hr	$5.97/hr	-18.6%
Overhead	$15.71/hr	$12.64/hr	-19.5%
Overhaul Labor	$9.84/hr	$3.11/hr	-68.4%
Overhaul Parts	$16.15/hr	$12.99/hr	-19.6%
Total Hourly Ownership Cost:	**$71.00/hr**	**$55.16/hr**	**-22.3%**

User Defined Adjustments: Annual Use Hours (1,285hrs -> 1,597hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.13/hr	$3.83/hr	-68.4%
Field Parts	$15.65/hr	$2.10/hr	-86.6%
Ground Engaging Component (GEC)	$2.61/hr	$2.10/hr	-19.5%
Tire	$0.00/hr	-	-
Electrical/Fuel	$23.59/hr	$7.22/hr	-69.4%
Lube	$4.83/hr	-	-
Total Operating Ownership Cost:	**$58.81/hr**	**$20.08/hr**	**-65.9%**

User Defined Adjustments: Annual Field Repair Parts Cost ($16,758.98 -> $0.98) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$71.00/hr	$55.16/hr	-22.3%
Hourly Operating Costs	$58.81/hr	$20.08/hr	-65.9%
Total Hourly Cost	**$129.81**	**$75.24/hr**	**-42%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$45.01/hr	$39.06/hr	-13.2%
Idle	$94.59/hr	$62.38/hr	-34.1%

Revised Date: 1st Half 2019

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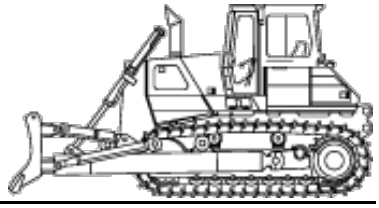
All prices shown in US$

Adjustments for MANDYLILLA6 in All Saved Models

January 16, 2019

Caterpillar D6T
Standard Crawler Dozers

Size Class:
160 - 189 HP
Weight:
40,550 lbs.



Configuration for D6T

Dozer Type	**Semi-U**	Net Horsepower	**185 hp**

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	$7,904.00	$2,778.00	$925.00
Adjustments			
Region (New Mexico: 113%)	$1,035.42	$363.92	$121.18
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$8,939.42**	**$3,141.92**	**$1,046.18**

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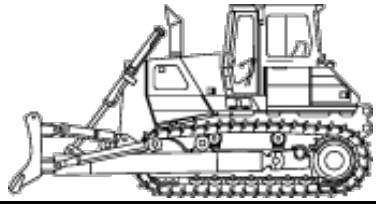
All prices shown in US$

Adjustments for 3A D6TXL in All Saved Models

January 16, 2019

Caterpillar D6T XL
Standard Crawler Dozers

Size Class:
190 - 259 HP
Weight:
44,420 lbs.



Configuration for D6T XL

Dozer Type	**Semi-U**	Power Mode	**Diesel**
Net Horsepower	**200 hp**	Operator Protection	**EROPS**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$26.11/hr	$24.43/hr	-6.4%
Cost of Facilities Capital (CFC)	$7.85/hr	$6.41/hr	-18.3%
Overhead	$15.49/hr	$12.47/hr	-19.5%
Overhaul Labor	$9.84/hr	$3.11/hr	-68.4%
Overhaul Parts	$17.88/hr	$14.39/hr	-19.5%
Total Hourly Ownership Cost:	**$77.17/hr**	**$60.81/hr**	**-21.2%**

User Defined Adjustments: Annual Use Hours (1,285hrs -> 1,597hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$12.13/hr	$3.83/hr	-68.4%
Field Parts	$17.33/hr	$2.32/hr	-86.6%
Ground Engaging Component (GEC)	$2.89/hr	$2.36/hr	-18.3%
Tire	$0.00/hr	-	-
Electrical/Fuel	$25.51/hr	$7.80/hr	-69.4%
Lube	$5.28/hr	-	-
Total Operating Ownership Cost:	**$63.14/hr**	**$21.59/hr**	**-65.8%**

User Defined Adjustments: Annual Field Repair Parts Cost ($18,555.77 -> $0.77) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$77.17/hr	$60.81/hr	-21.2%
Hourly Operating Costs	$63.14/hr	$21.59/hr	-65.8%
Total Hourly Cost	**$140.31**	**$82.40/hr**	**-41.3%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$49.45/hr	$43.31/hr	-12.4%
Idle	$102.68/hr	$68.61/hr	-33.2%

Revised Date: 1st Half 2019

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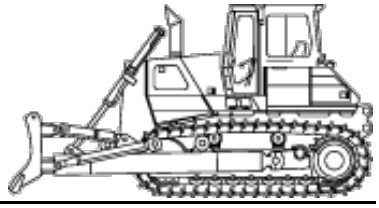
All prices shown in US$

Adjustments for 3A D6TXL in All Saved Models

January 16, 2019

Caterpillar D6T XL
Standard Crawler Dozers

Size Class:
190 - 259 HP
Weight:
44,420 lbs.



Configuration for D6T XL

Dozer Type	**Semi-U**	Net Horsepower	**200 hp**

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	$8,050.00	$3,554.00	$1,196.00
Adjustments			
Region (New Mexico: 113%)	$1,054.55	$465.57	$156.68
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$9,104.55**	**$4,019.57**	**$1,352.68**

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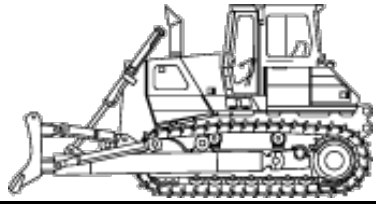
Adjustments for MANDYLILLA4 in All Saved Models

January 16, 2019

Caterpillar D9T
Standard Crawler Dozers

Size Class:
360 - 519 HP
Weight:
105,600 lbs.



Configuration for D9T

Dozer Type	**Semi-U**	Power Mode	**Diesel**
Net Horsepower	**410 hp**	Operator Protection	**ROPS/FOPS**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$45.49/hr	$42.80/hr	-5.9%
Cost of Facilities Capital (CFC)	$13.80/hr	$11.64/hr	-15.7%
Overhead	$37.97/hr	$31.66/hr	-16.6%
Overhaul Labor	$17.23/hr	$5.64/hr	-67.3%
Overhaul Parts	$40.59/hr	$33.84/hr	-16.6%
Total Hourly Ownership Cost:	**$155.08/hr**	**$125.58/hr**	**-19%**

User Defined Adjustments: Annual Use Hours (1,400hrs -> 1,679hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$20.17/hr	$6.60/hr	-67.3%
Field Parts	$39.53/hr	$5.49/hr	-86.1%
Ground Engaging Component (GEC)	$6.59/hr	$3.98/hr	-39.6%
Tire	$0.00/hr	-	-
Electrical/Fuel	$46.92/hr	$14.35/hr	-69.4%
Lube	$11.22/hr	-	-
Total Operating Ownership Cost:	**$124.43/hr**	**$41.64/hr**	**-66.5%**

User Defined Adjustments: Annual Field Repair Parts Cost ($46,119.12 -> $0.12) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$155.08/hr	$125.58/hr	-19%
Hourly Operating Costs	$124.43/hr	$41.64/hr	-66.5%
Total Hourly Cost	**$279.51**	**$167.22/hr**	**-40.2%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$97.26/hr	$86.10/hr	-11.5%
Idle	$202.00/hr	$139.93/hr	-30.7%

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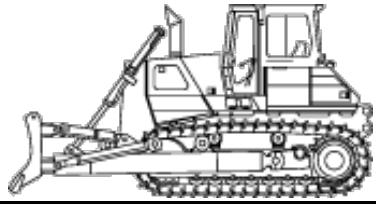
All prices shown in US$

Adjustments for MANDYLILLA4 in All Saved Models

January 16, 2019

Caterpillar D9T
Standard Crawler Dozers

Size Class:
360 - 519 HP
Weight:
105,600 lbs.



Configuration for D9T

Dozer Type	**Semi-U**	Net Horsepower	**410 hp**

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	$26,622.00	$9,141.00	$3,118.00
Adjustments			
Region (New Mexico: 113%)	$3,487.48	$1,197.47	$408.46
User Defined			
Rental Rates (100%)	-	-	-
Total:	**$30,109.48**	**$10,338.47**	**$3,526.46**

Date Last Updated: Oct 01, 2018

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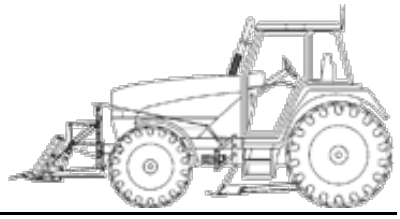
All prices shown in US$

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

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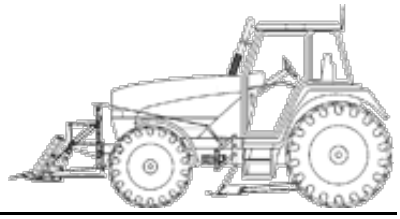
All prices shown in US$

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

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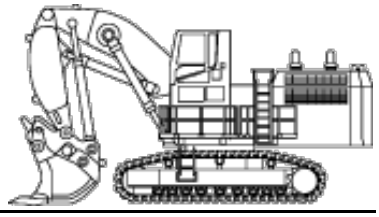
All prices shown in US$

Adjustments for MANDYLILLA15 in All Saved Models

January 17, 2019

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
772,000 lbs.



Configuration for EX3600-5 (disc. 2009)

Operating Weight	**350 mt**	Bucket Capacity - Heaped	**27.4 cu yd**
Net Horsepower	**1880 hp**	Power Mode	**Diesel**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$157.54/hr	$148.69/hr	-5.6%
Cost of Facilities Capital (CFC)	$46.64/hr	$42.62/hr	-8.6%
Overhead	$72.89/hr	$66.17/hr	-9.2%
Overhaul Labor	$30.53/hr	$10.88/hr	-64.4%
Overhaul Parts	$121.97/hr	$110.72/hr	-9.2%
Total Hourly Ownership Cost:	**$429.57/hr**	**$379.08/hr**	**-11.8%**

User Defined Adjustments: Annual Use Hours (1,850hrs -> 2,038hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$40.55/hr	$14.45/hr	-64.4%
Field Parts	$133.55/hr	$24.25/hr	-81.8%
Ground Engaging Component (GEC)	$19.91/hr	$16.56/hr	-16.8%
Tire	$0.00/hr	-	-
Electrical/Fuel	$270.49/hr	$82.72/hr	-69.4%
Lube	$59.15/hr	-	-
Total Operating Ownership Cost:	**$523.65/hr**	**$197.13/hr**	**-62.4%**

User Defined Adjustments: Annual Field Repair Parts Cost ($197,654.88 -> $0.47) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$429.57/hr	$379.08/hr	-11.8%
Hourly Operating Costs	$523.65/hr	$197.13/hr	-62.4%
Total Hourly Cost	**$953.22**	**$576.21/hr**	**-39.6%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$277.07/hr	$257.48/hr	-7.1%
Idle	$700.06/hr	$461.80/hr	-34%

Revised Date: 1st Half 2019

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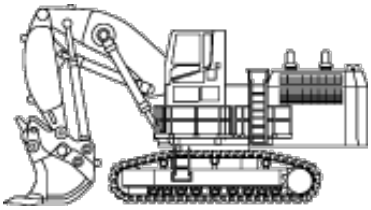
Adjustments for MANDYLILLA15 in All Saved Models

January 16, 2019

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
772,000 lbs.



Configuration for EX3600-5 (disc. 2009)

Operating Weight	**350 mt**	Bucket Capacity - Heaped	**27.4 cu yd**
Net Horsepower	**1880 hp**	Power Mode	**Diesel**

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	$76,625.00	$21,455.00	$5,365.00	$805.00	$530.00	$965.37
Adjustments						
Region (Las Cruces, New Mexico: 90.4%)	($7,356.00)	($2,059.68)	($515.04)	($77.28)		
Model Year (2009: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$69,269.00**	**$19,395.32**	**$4,849.96**	**$727.72**	**$530.00**	**$923.57**

Non-Active Use Rates

	Hourly
Standby Rate	$196.79
Idling Rate	$664.06

Rate Element Allocation

Element	**Percentage**	**Value**
Depreciation (ownership)	32%	$24,520.00/mo
Overhaul (ownership)	50%	$38,312.50/mo
CFC (ownership)	9%	$6,896.25/mo
Indirect (ownership)	9%	$6,896.25/mo
Fuel (operating) @ 3.27	51%	$270.49/hr

Revised Date: 1st Half 2019

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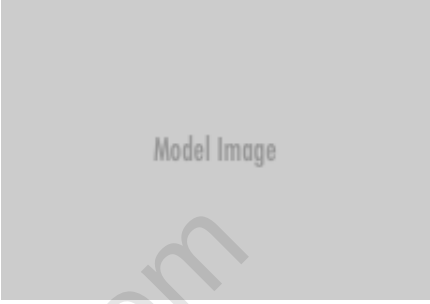
Adjustments for MANDYLILLA12 in All Saved Models

January 16, 2019

Miscellaneous MSR-359H
Crawler Tractor Multi-Shank Rippers

Size Class:
260 HP & Over
Weight:
N/A



Configuration for MSR-359H

Engine Horsepower	**260 - 359**	Number of Shanks	**3**
Ripper Type	**Parallelogram**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$7.23/hr	$6.86/hr	-5.1%
Cost of Facilities Capital (CFC)	$0.97/hr	$0.79/hr	-18.6%
Overhead	$1.68/hr	$1.33/hr	-20.8%
Overhaul Labor	$2.75/hr	$0.85/hr	-69.1%
Overhaul Parts	$2.35/hr	$1.86/hr	-20.9%
Total Hourly Ownership Cost:	**$14.98/hr**	**$11.69/hr**	**-22%**

User Defined Adjustments: Annual Use Hours (1,285hrs -> 1,623hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$5.04/hr	$1.56/hr	-69%
Field Parts	$2.37/hr	$0.31/hr	-86.9%
Ground Engaging Component (GEC)	$1.97/hr	$1.56/hr	-20.8%
Tire	$0.00/hr	-	-
Electrical/Fuel	$0.00/hr	-	-
Lube	$0.37/hr	-	-
Total Operating Ownership Cost:	**$9.75/hr**	**$3.80/hr**	**-61%**

User Defined Adjustments: Annual Field Repair Parts Cost ($2,534.87 -> $0.87) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$14.98/hr	$11.69/hr	-22%
Hourly Operating Costs	$9.75/hr	$3.80/hr	-61%
Total Hourly Cost	**$24.73**	**$15.49/hr**	**-37.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$9.88/hr	$8.98/hr	-9.1%
Idle	$14.98/hr	$11.69/hr	-22%

Revised Date: 1st Half 2019

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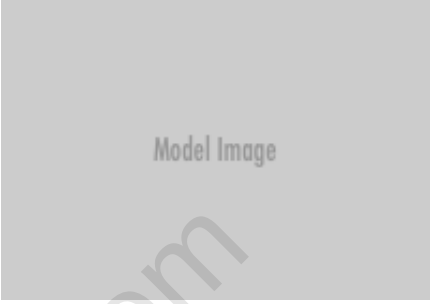
All prices shown in US$

Adjustments for MANDYLILLA12 in All Saved Models

January 16, 2019

Miscellaneous MSR-359H
Crawler Tractor Multi-Shank Rippers

Size Class:
260 HP & Over
Weight:
N/A



Configuration for MSR-359H

Engine Horsepower	**260 - 359**	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	$2,635.00	$740.00	$185.00	$28.00	$9.75	$24.72
Adjustments						
Region (Las Cruces, New Mexico: 89%)	($289.85)	($81.40)	($20.35)	($3.08)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$2,345.15**	**$658.60**	**$164.65**	**$24.92**	**$9.75**	**$23.07**

Non-Active Use Rates

	Hourly
Standby Rate	$9.19
Idling Rate	$13.32

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	50%	$1,317.50/mo
Overhaul (ownership)	31%	$816.85/mo
CFC (ownership)	7%	$184.45/mo
Indirect (ownership)	12%	$316.20/mo

Fuel cost data is not available for these rates.

Revised Date: 1st Half 2019

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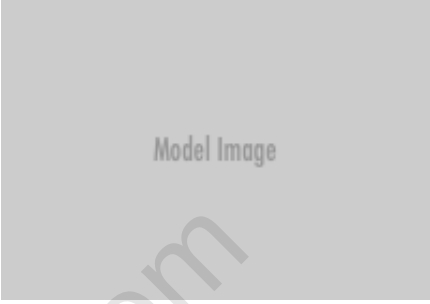
All prices shown in US$

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%

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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.



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

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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

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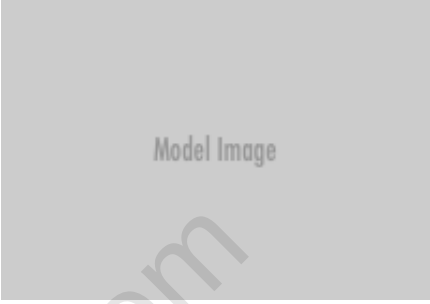
Rental Rate Blue Book®

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**

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

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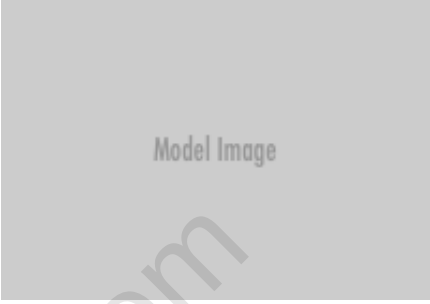
All prices shown in US$

Adjustments for MANDYLILLA21 in All Saved Models

January 17, 2019

Miscellaneous 6000 330
Off-Highway Water Tanker Trucks

Size Class:
300 - 399 HP
Weight:
54,400 lbs.



Configuration for 6000 330

Power Mode	**Diesel**	Horsepower	**330**
Tank Capacity	**6000 gal**		

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$22.90/hr	$21.43/hr	-6.4%
Cost of Facilities Capital (CFC)	$5.88/hr	$4.96/hr	-15.6%
Overhead	$7.31/hr	$6.06/hr	-17.1%
Overhaul Labor	$9.02/hr	$2.94/hr	-67.4%
Overhaul Parts	$5.85/hr	$4.85/hr	-17.1%
Total Hourly Ownership Cost:	**$50.96/hr**	**$40.24/hr**	**-21%**

User Defined Adjustments: Annual Use Hours (1,500hrs -> 1,809hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$22.16/hr	$7.21/hr	-67.5%
Field Parts	$10.69/hr	$1.48/hr	-86.2%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$6.42/hr	-	-
Electrical/Fuel	$36.80/hr	$11.25/hr	-69.4%
Lube	$6.15/hr	-	-
Total Operating Ownership Cost:	**$82.22/hr**	**$32.51/hr**	**-60.5%**

User Defined Adjustments: Annual Field Repair Parts Cost ($13,358.68 -> $0.68) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$50.96/hr	$40.24/hr	-21%
Hourly Operating Costs	$82.22/hr	$32.51/hr	-60.5%
Total Hourly Cost	**$133.18**	**$72.75/hr**	**-45.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$36.09/hr	$32.45/hr	-10.1%
Idle	$87.76/hr	$51.49/hr	-41.3%

Revised Date: 1st Half 2019

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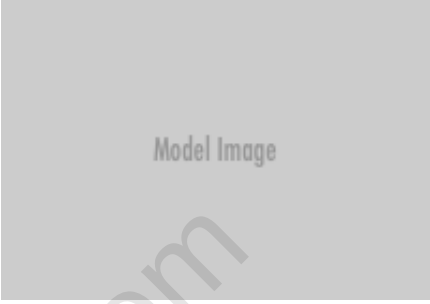
All prices shown in US$

Adjustments for MANDYLILLA21 in All Saved Models

January 16, 2019

Miscellaneous 6000 330
Off-Highway Water Tanker Trucks

Size Class:
300 - 399 HP
Weight:
54,400 lbs.



Configuration for 6000 330

Power Mode	**Diesel**	Horsepower	**330**
Tank Capacity	**6000 gal**		

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	$8,970.00	$2,510.00	$630.00	$95.00	$82.20	$133.17
Adjustments						
Region (Las Cruces, New Mexico: 91.1%)	($798.33)	($223.39)	($56.07)	($8.45)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$8,171.67**	**$2,286.61**	**$573.93**	**$86.55**	**$82.20**	**$128.63**

Non-Active Use Rates

	Hourly
Standby Rate	$32.50
Idling Rate	$83.23

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	45%	$4,036.50/mo
Overhaul (ownership)	30%	$2,691.00/mo
CFC (ownership)	11%	$986.70/mo
Indirect (ownership)	14%	$1,255.80/mo
Fuel (operating) @ 3.27	45%	$36.80/hr

Revised Date: 1st Half 2019

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Adjustments for MANDYLILLA25 in All Saved Models

January 17, 2019

Miscellaneous 48" X 60' - 516
Single Deck Portable Screening Plants

Size Class:
37" & Over
Weight:
23,300 lbs.



Configuration for 48" X 60' - 516

Screen Size	**5' X 16'**	Power Mode	**Diesel**
Horsepower	**110**	Conveyor Size	**48" X 60'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$10.30/hr	$9.74/hr	-5.4%
Cost of Facilities Capital (CFC)	$2.11/hr	$1.74/hr	-17.5%
Overhead	$3.48/hr	$2.80/hr	-19.5%
Overhaul Labor	$12.47/hr	$3.94/hr	-68.4%
Overhaul Parts	$7.59/hr	$6.11/hr	-19.5%
Total Hourly Ownership Cost:	**$35.95/hr**	**$24.33/hr**	**-32.3%**

User Defined Adjustments: Annual Use Hours (1,250hrs -> 1,553hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$14.12/hr	$4.46/hr	-68.4%
Field Parts	$7.05/hr	$1.14/hr	-83.8%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$0.39/hr	-	-
Electrical/Fuel	$15.86/hr	$4.85/hr	-69.4%
Lube	$2.37/hr	-	-
Total Operating Ownership Cost:	**$39.79/hr**	**$13.21/hr**	**-66.8%**

User Defined Adjustments: Annual Field Repair Parts Cost ($7,054.61 -> $0.61) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$35.95/hr	$24.33/hr	-32.3%
Hourly Operating Costs	$39.79/hr	$13.21/hr	-66.8%
Total Hourly Cost	**$75.74**	**$37.54/hr**	**-50.4%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$15.89/hr	$14.28/hr	-10.1%
Idle	$51.81/hr	$29.18/hr	-43.7%

Revised Date: 1st Half 2019

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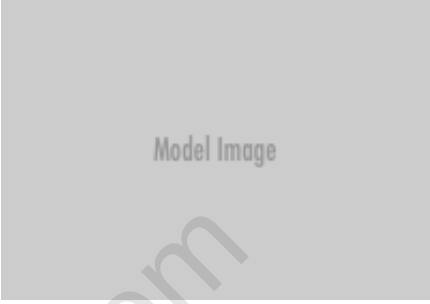
Adjustments for MANDYLILLA25 in All Saved Models

January 17, 2019

Miscellaneous 48" X 60' - 516
Single Deck Portable Screening Plants

Size Class:
37" & Over
Weight:
23,300 lbs.



Configuration for 48" X 60' - 516

Screen Size	**5' X 16'**	Power Mode	**Diesel**
Horsepower	**110**	Conveyor Size	**48" X 60'**

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	$6,330.00	$1,770.00	$445.00	$67.00	$39.80	$75.77
Adjustments						
Region (Las Cruces, New Mexico: 89.6%)	($658.32)	($184.08)	($46.28)	($6.97)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$5,671.68**	**$1,585.92**	**$398.72**	**$60.03**	**$39.80**	**$72.03**

Non-Active Use Rates

	Hourly
Standby Rate	$13.21
Idling Rate	$48.09

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	27%	$1,709.10/mo
Overhaul (ownership)	59%	$3,734.70/mo
CFC (ownership)	5%	$316.50/mo
Indirect (ownership)	9%	$569.70/mo
Fuel (operating) @ 3.27	40%	$15.86/hr

Revised Date: 1st Half 2019

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Adjustments for MANDYLILLA24 in All Saved Models

January 17, 2019

Miscellaneous 42" X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37" & Over
Weight:
26,300 lbs.



Configuration for 42" X 60' - 516

Screen Size	**5' X 16'**	Power Mode	**Diesel**
Horsepower	**110**	Conveyor Size	**42" X 60'**

Hourly Ownership Costs

	Standard Value	User Adjusted Value	Variance
Depreciation	$10.18/hr	$9.62/hr	-5.5%
Cost of Facilities Capital (CFC)	$2.13/hr	$1.75/hr	-17.8%
Overhead	$3.52/hr	$2.84/hr	-19.3%
Overhaul Labor	$13.04/hr	$4.12/hr	-68.4%
Overhaul Parts	$7.56/hr	$6.09/hr	-19.4%
Total Hourly Ownership Cost:	**$36.43/hr**	**$24.42/hr**	**-33%**

User Defined Adjustments: Annual Use Hours (1,250hrs -> 1,551hrs) Sales Tax (5.1% -> 0%)

Hourly Operating Costs

	Standard Value	User Adjusted Value	Variance
Field Labor	$14.59/hr	$4.62/hr	-68.3%
Field Parts	$7.23/hr	$1.16/hr	-84%
Ground Engaging Component (GEC)	$0.00/hr	-	-
Tire	$0.37/hr	-	-
Electrical/Fuel	$15.86/hr	$4.85/hr	-69.4%
Lube	$2.38/hr	-	-
Total Operating Ownership Cost:	**$40.43/hr**	**$13.38/hr**	**-66.9%**

User Defined Adjustments: Annual Field Repair Parts Cost ($7,225.13 -> $0.45) Diesel Cost (3.27 -> 1) Mechanics Wage ($58.84 -> $23.09)

Total

	Standard Value	User Adjusted Value	Variance
Hourly Ownership Costs	$36.43/hr	$24.42/hr	-33%
Hourly Operating Costs	$40.43/hr	$13.38/hr	-66.9%
Total Hourly Cost	**$76.86**	**$37.80/hr**	**-50.8%**

Non-active use rates

	Standard Value	User Adjusted Value	Variance
Standby	$15.83/hr	$14.21/hr	-10.2%
Idle	$52.29/hr	$29.27/hr	-44%

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Adjustments for MANDYLILLA24 in All Saved Models

January 17, 2019

Miscellaneous 42" X 60' - 516
Triple Deck Portable Screening Plants

Size Class:
37" & Over
Weight:
26,300 lbs.



Configuration for 42" X 60' - 516

Screen Size	**5' X 16'**	Power Mode	**Diesel**
Horsepower	**110**	Conveyor Size	**42" X 60'**

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	$6,410.00	$1,795.00	$450.00	$68.00	$40.45	$76.87
Adjustments						
Region (Las Cruces, New Mexico: 89.6%)	($666.64)	($186.68)	($46.80)	($7.07)		
Model Year (2019: 100%)	-	-	-	-		
Adjusted Hourly Ownership Cost (100%)	-	-	-	-		
Hourly Operating Cost (100%)					-	
Total:	**$5,743.36**	**$1,608.32**	**$403.20**	**$60.93**	**$40.45**	**$73.08**

Non-Active Use Rates

	Hourly
Standby Rate	$13.38
Idling Rate	$48.49

Rate Element Allocation

Element	Percentage	Value
Depreciation (ownership)	26%	$1,666.60/mo
Overhaul (ownership)	59%	$3,781.90/mo
CFC (ownership)	6%	$384.60/mo
Indirect (ownership)	9%	$576.90/mo
Fuel (operating) @ 3.27	39%	$15.86/hr

Revised Date: 1st Half 2019

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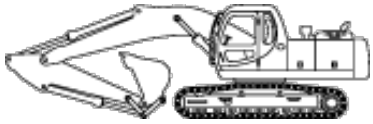
Spec Finder

December 8, 2018

Caterpillar 319D L (disc. 2012)
Crawler Mounted Hydraulic Excavators



Size Class:
19.1 - 21.0 MTons
Weight:
43,872 lbs.

Specifications

BOOM, STICK & BUCKET	
Stick Length	126 in
Bucket Capacity Range	.59 cu yd - 1.4 cu yd
Boom Type	1-Piece
Boom Length	209 in
Bucket Capacity - Heaped	1 cu yd
Bucket Type	Heavy Duty
Bucket Digging Force-Standard	18142 lbs
Bucket Width	36 in
ENGINE	
Engine	C4.2
Engine Manufacturer	Caterpillar
Power Mode	Diesel
Net Horsepower	125 hp
Displacement (cu. in)	259
Gross Horsepower	131 hp
FLUID CAPACITIES	
Hydraulic Tank Capacity	28 gal
Fuel Tank Capacity	79.3 gal
HYDRAULICS	
Standard Relief Pressure	5076 psi
Main Pump - Maximum Flow	100.1 gal/min
PERFORMANCE	
Side Lift Capy @ 20' G.L.	6700 lbs
Maximum Drawbar Pull	46466 lbs
Travel Speed - High	3 mph
Maximum Swing Speed	11.1 rpm
Stick Digging Force - Standard	18142 lbs
Front Lift Capy @ 20' G.L.	13000 lbs
UNDERCARRIAGE	
Ground Pressure	5.1 psi
No. of Upper/Carrier Rollers	2
Track Gauge	87 in
Track Shoe Width	28 in
Track Length	175 in
No. of Lower/Track Rollers	7
WEIGHTS & DIMENSIONS	
Undercarriage Ground Clearance	17 in
Tail Swing Radius	98 in
Overall Track Width--Retracted	114 in
Maximum Digging Depth	271 in
Maximum Dumping Height	269 in
Overall Length	345 in
Overall Height	139 in
Overall Width	114 in
Digging Depth (8' Flat Bottom)	265 in
Maximum Reach at Ground Level	380 in
Operating Weight	19.9 mt

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Vertical Straight Wall Depth	225 in

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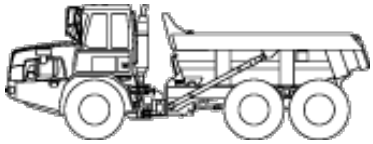
Spec Finder

February 17, 2019

Caterpillar 725 (disc. 2014)
Articulated Rear Dumps



Size Class:
20 - 25 MTons
Weight:
49,075 lbs.

Specifications

AXLES & TIRES	
Axle Configuration	6 X 6
Front Tire_Size	23.5 R25
Rear Tire Size	23.5 R25
DUMP BODY	
Body Capacity (Struck--Heaped)	14.3 cu yd - 18.8 cu yd
Dump Cycle (Hoist/Raise)	10 "
Dump Cycle (Power Down)	8 "
Dump Angle	70 °
Body Sidewall Thickness	.47 in
Body Front-Plate Thickness	.31 in
Body Floor-Plate Thickness	.55 in
ENGINE	
Engine	C11 ACERT
Engine Manufacturer	Caterpillar
Power Mode	Diesel
Emissions Tier	Tier 3
Net Horsepower	301 hp
Cylinders	6
Displacement (cu. in)	680
FLUID CAPACITIES	
Fuel Tank Capacity	94 gal
Hydraulic System Capacity	49 gal
STEERING	
Steering Angle	45 °
TRANSMISSION	
Maximum Speed	35 mph
Transmission Manufacturer	Caterpillar
Number of Speeds	6F/1R
Transmission Type	Autoshift
WEIGHTS & DIMENSIONS	
Overall Machine Length	389 in
Overall Machine Width	109 in
Ground Clearance	18 in
Wheelbase	215 in
Rated Payload	23.6 mt
Rear Axle Weight (GVW)	33510 lbs
Front Axle Weight (GVW)	33135 lbs
Center Axle Weight (GVW)	34440 lbs
Inside Turning Radius	146 in
Load Over Height	108 in
Net Weight	49075 lbs
Overall Machine Height	135 in
Gross Weight	101085 lbs
Outside Turning Radius	286 in

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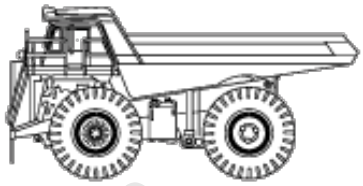
Spec Finder

January 31, 2019

Komatsu 730E
Electric Drive Rear Dumps

Size Class:
170 - 199 MTons
Weight:
309,950 lbs.



Specifications

AXLES & TIRES	
Front Tire_Size	37.00R57
Rear Tire Size	37.00R57
BRAKES	
Elec. Dynamic Retarding (Max.)	3700 hp
Parking Brake	SAHR
Service Brakes - Front	Wheel Spd Disc
Service Brakes - Rear	Dual Disc
DUMP BODY	
Body Capacity (Struck--Heaped)	101 cu yd - 145 cu yd
Dump Cycle (Power Down)	15 "
Body Sidewall Thickness	.35 in
Body Front-Plate Thickness	.47 in
Body Floor-Plate Thickness	.75 in
Dump Angle	45 °
Dump Cycle (Hoist/Raise)	21 "
ELECTRIC DRIVE	
Wheel Motor Planetary Ratio	26.825:1
Alternator/Generator Model	GTA-22
Alternator/Generator Mfr	General Electric
System Current	AC/DC
Maximum Travel Speed	34.6
Wheel Motor Model	GE788
Wheel Motor Manufacturer	General Electric
ENGINE	
Rated RPM	1900
Engine	SSA16V159
Engine Manufacturer	Komatsu
Power Mode	Diesel
Net Horsepower	1860 hp
Gross Horsepower	2000 hp
Cylinders	16
FLUID CAPACITIES	
Fuel Tank Capacity	850 gal
Hydraulic System Capacity	193 gal
WEIGHTS & DIMENSIONS	
Gross Weight	715000 lbs
Height of Rear Body (Empty)	221 in
Net Weight	309950 lbs
Rated Payload	183.7 mt
Maximum Payload	186 mt
Height to Cab Guard - Loading	246 in
Clearance Circle	1104 in
Overall Machine Length	505 in
Overall Machine Width	297 in

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Ground Clearance	45 in
Wheelbase	232 in

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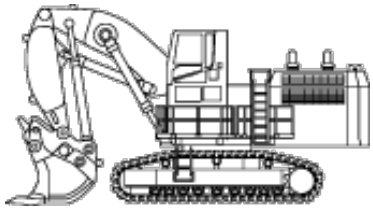
Spec Finder

January 31, 2019

Hitachi EX3600-5 (disc. 2009)
Hydraulic Shovels

Size Class:
150.1 MTons & Over
Weight:
772,000 lbs.



Specifications

BOOM & BUCKET	
Bucket Type	Bottom Dump
Bucket Digging Force-Standard	254000 lbs
Bucket Width	155 in
Bucket Capacity - Heaped	27.4 cu yd
Boom Length	311 in
ENGINE	
Cylinders	16
Displacement (cu. in)	3990
Rated RPM	1600
Gross Horsepower	1880 hp
Engine	S16R-TAA
Engine Manufacturer	Hitachi
Power Mode	Diesel
Net Horsepower	1880 hp
FLUID CAPACITIES	
Fuel Tank Capacity	1900 gal
HYDRAULICS	
Hydraulic Pumps - Type	Piston
Main Pump - Maximum Flow	1056 gal/min
Standard Relief Pressure	4270 psi
PERFORMANCE	
Stick Digging Force - Standard	269000 lbs
Travel Speed - High	1.4 mph
Maximum Drawbar Pull	395700 lbs
Maximum Swing Speed	3.2 rpm
UNDERCARRIAGE	
Track Gauge	217 in
Track Shoe Width	50 in
Ground Pressure	26.3 psi
WEIGHTS & DIMENSIONS	
Upperstructure Width	355 in
Tail Swing Radius	262 in
Operating Weight	350 mt
Overall Track Width--Retracted	267 in
Component Weight-Counterweight	88600 lbs
Maximum Dumping Height	433 in
Length of Track on Ground	262 in
Track Length	342 in
Height to Top of Cab	305 in
Maximum Reach at Ground Level	599 in
Undercarriage Ground Clearance	36 in
Maximum Digging Depth	154 in

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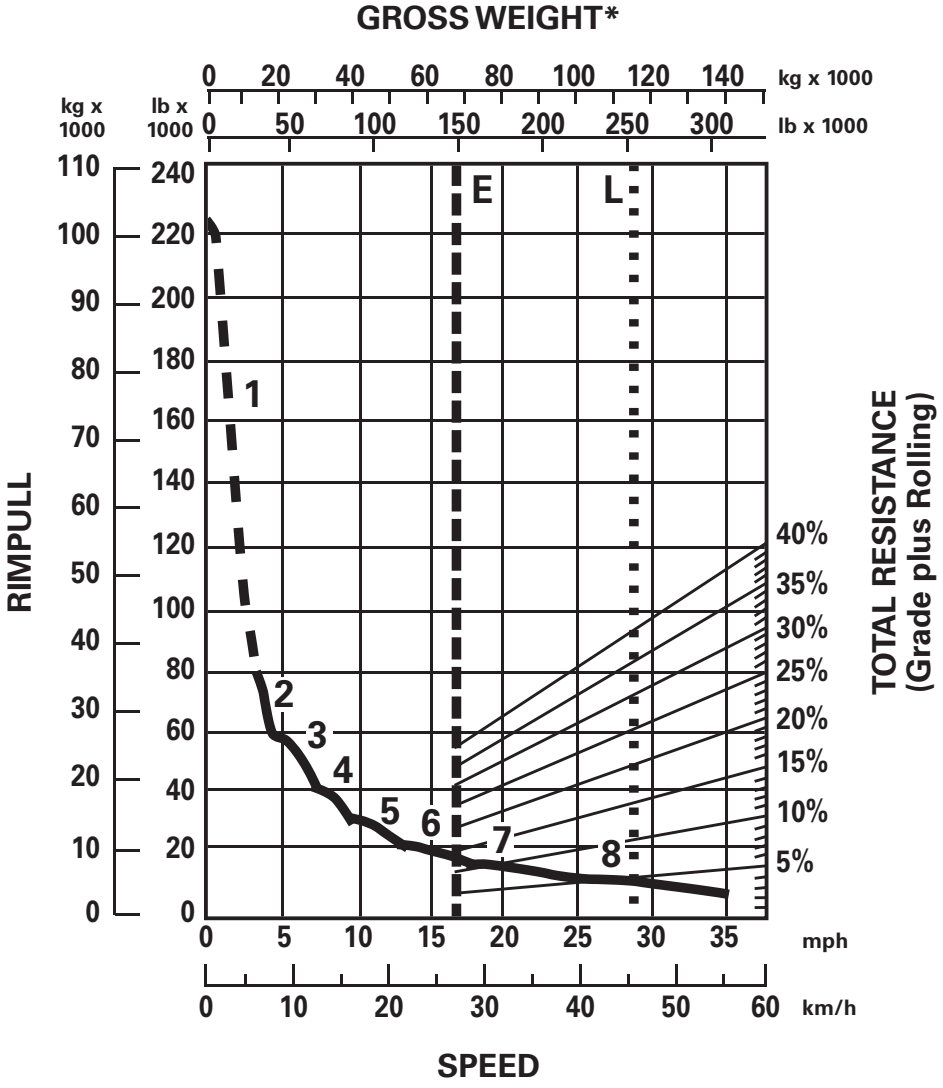
Appendix B.3

Equipment Productivity Curve Fits



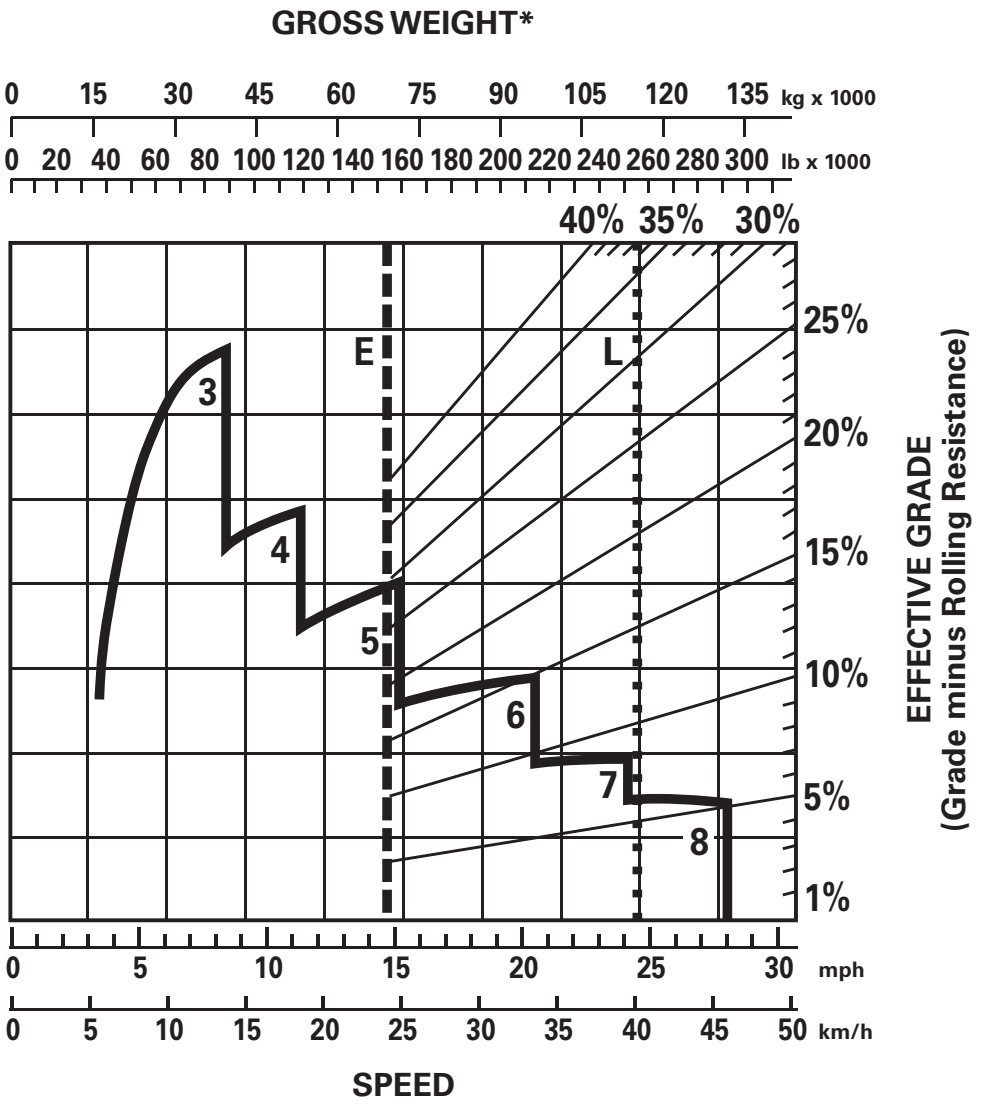
*at sea level

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)



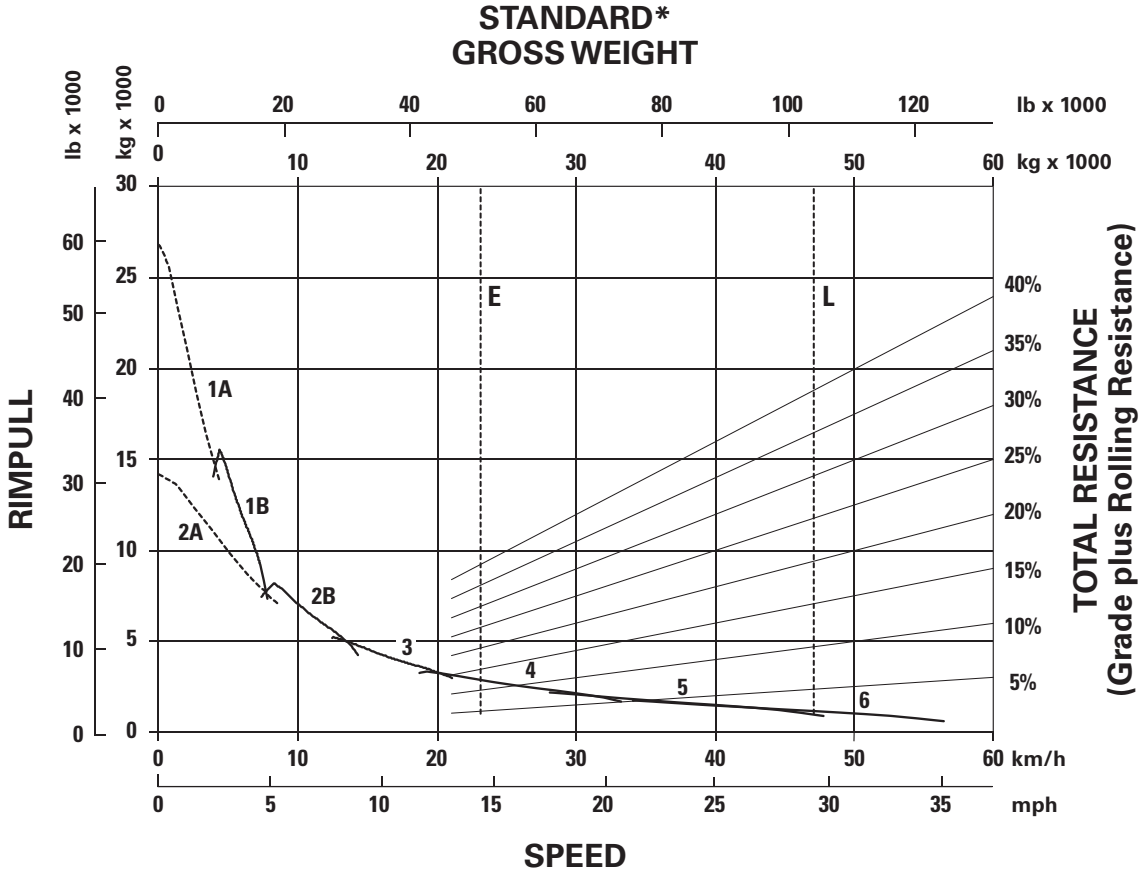
*at sea level

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

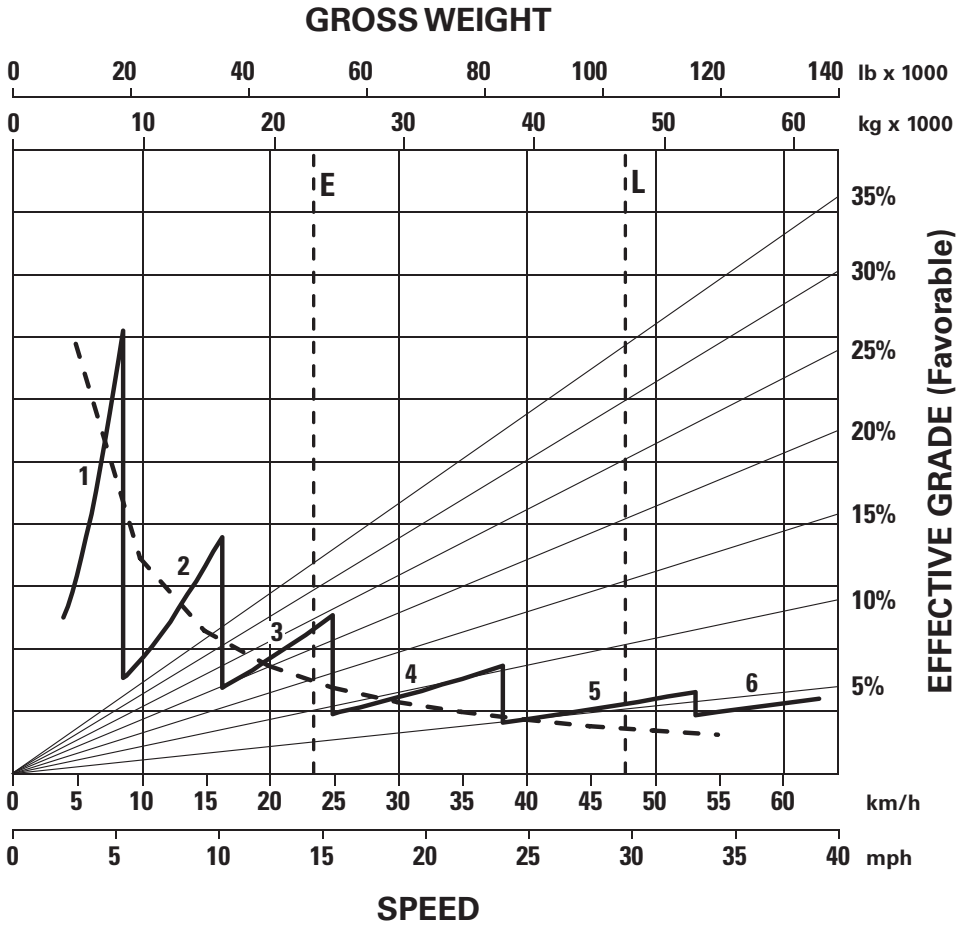
1A — 1st Gear (Converter Drive)
1B — 1st Gear (Direct Drive)
2A — 2nd Gear (Converter Drive
2B — 2nd Gear (Direct Drive)
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear

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)

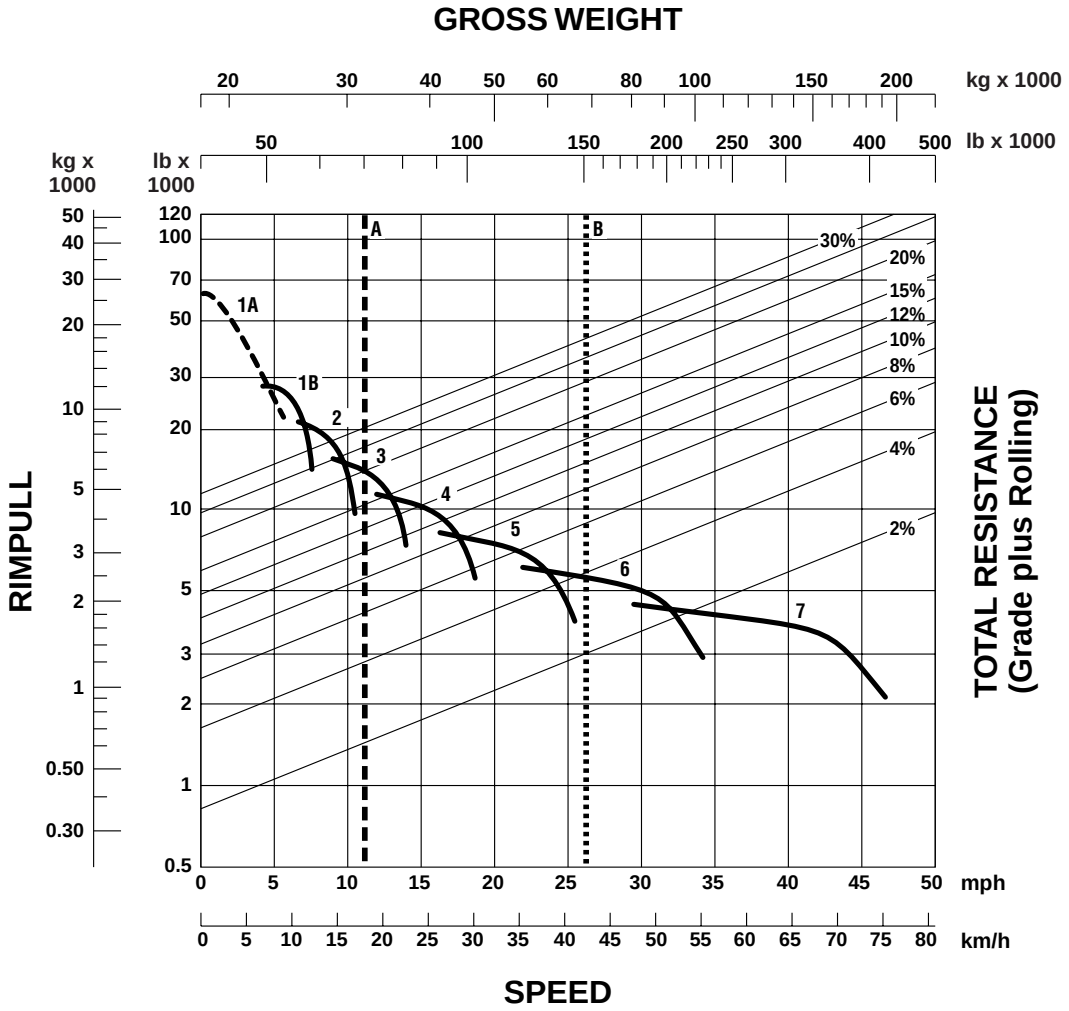


KEY

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)



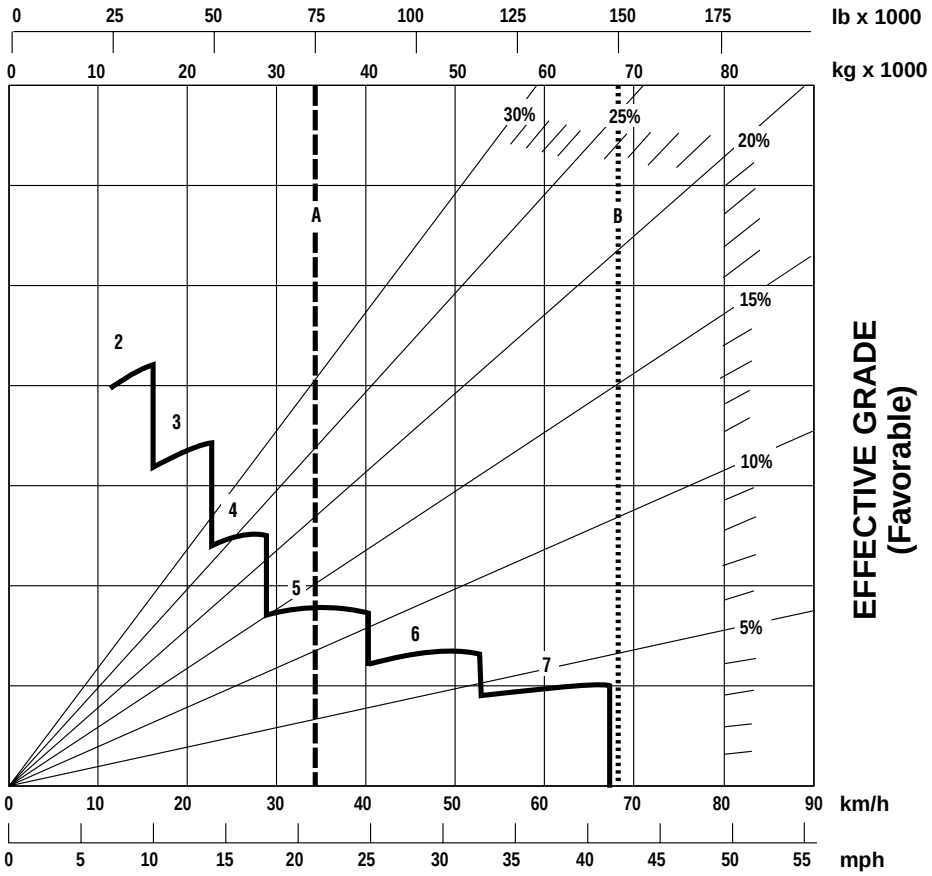
KEY

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)

GROSS WEIGHT



SPEED

CONTINUOUS GRADE LENGTH

KEY

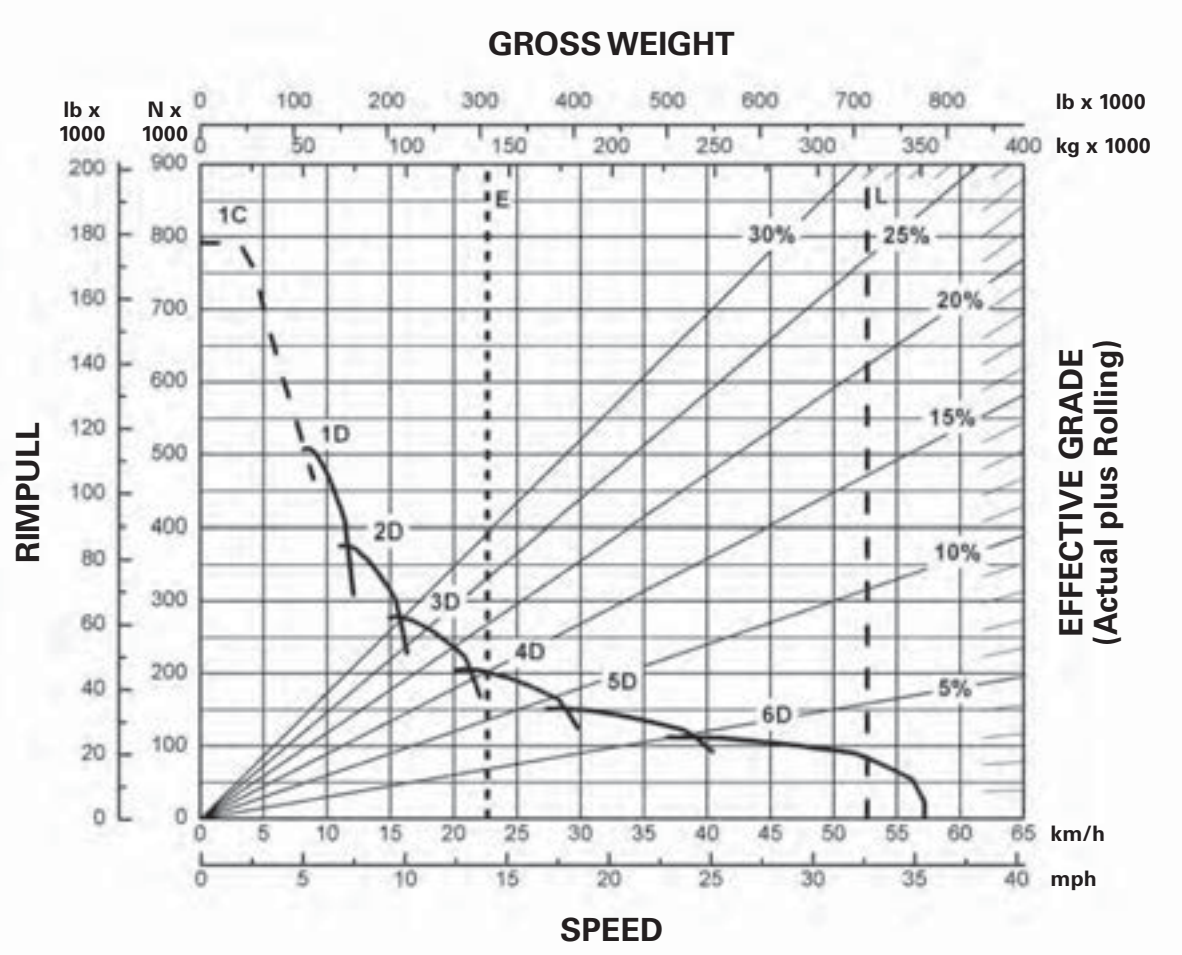
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear
7 — 7th Gear

KEY

A — Empty 31 250 kg (68,900 lb)
B — Max GMW 68 182 kg (150,000 lb)

9

789D 2100 HP Rimpull-Speed-Gradeability
- 37.00R57 Tires**
- 1593 mm **(5'2.7")** Tire Radius



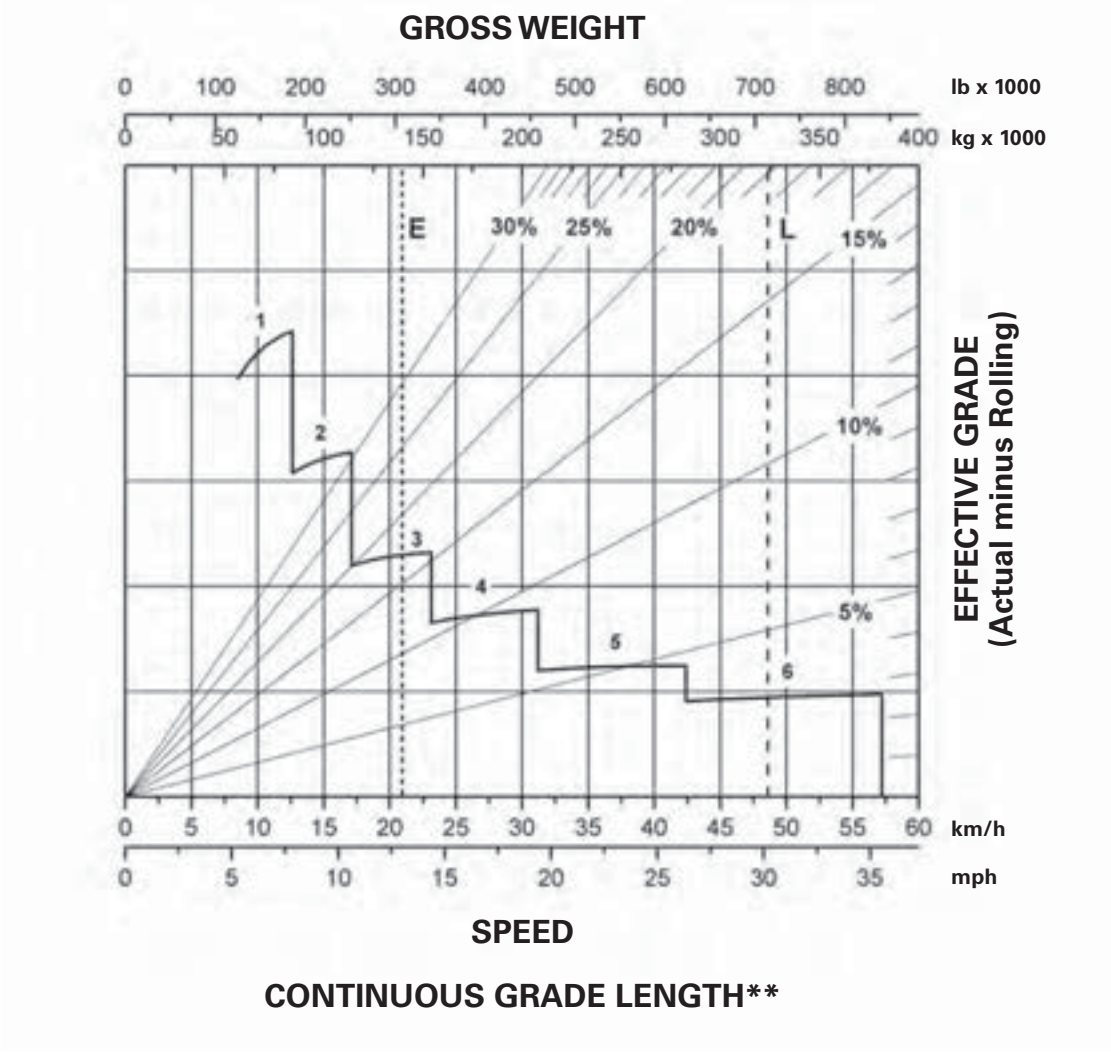
KEY

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

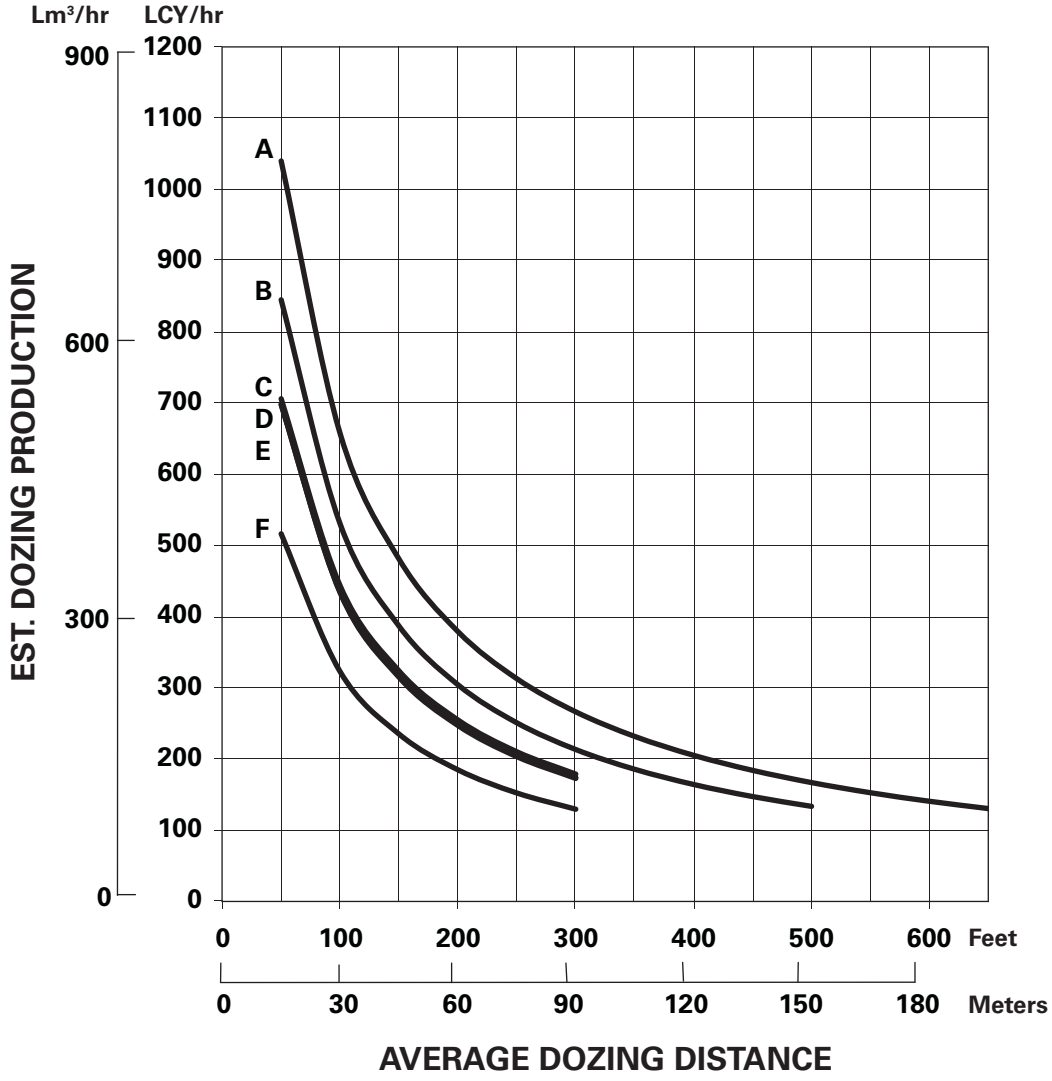
1 — 1st Gear
2 — 2nd Gear
3 — 3rd Gear
4 — 4th Gear
5 — 5th Gear
6 — 6th Gear

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

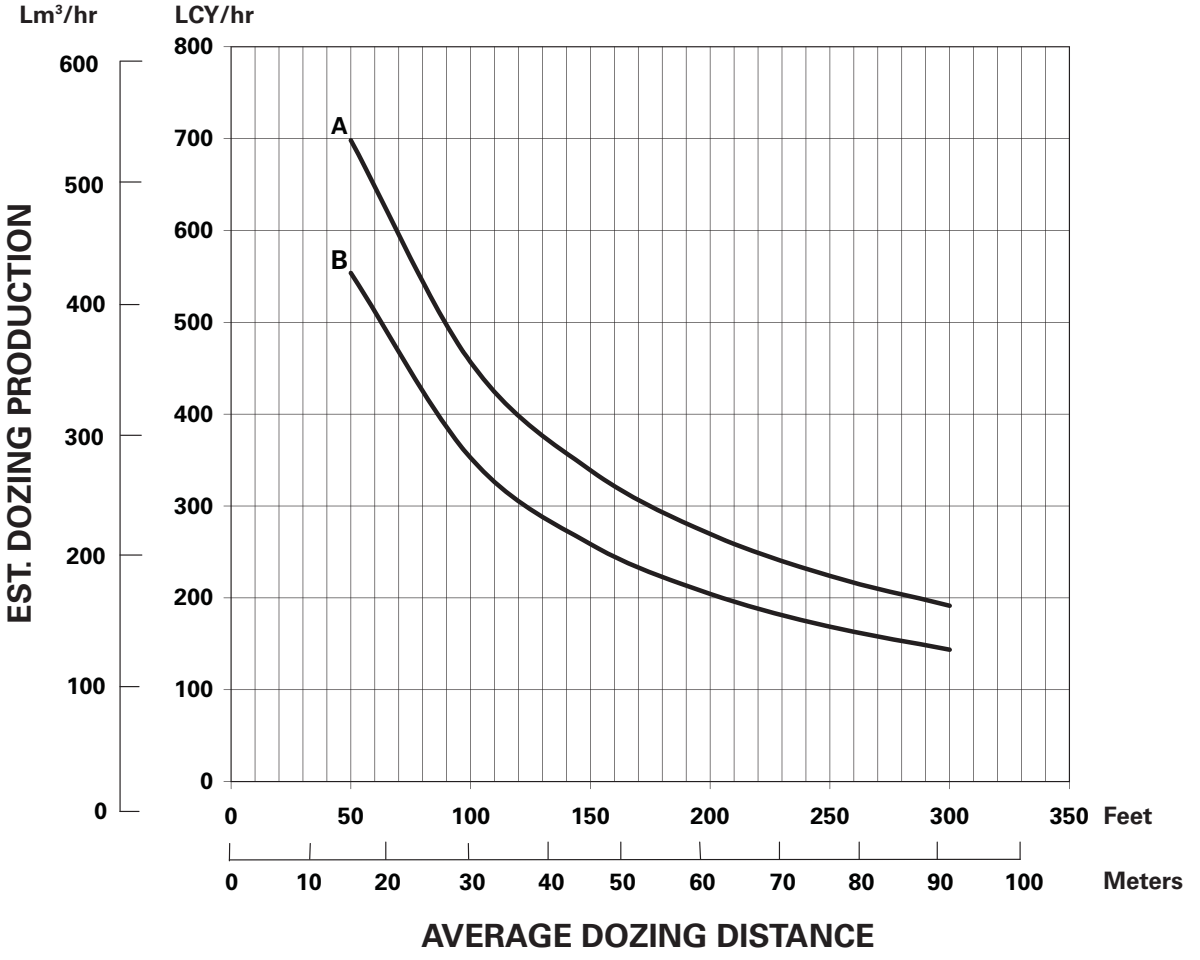


KEY

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

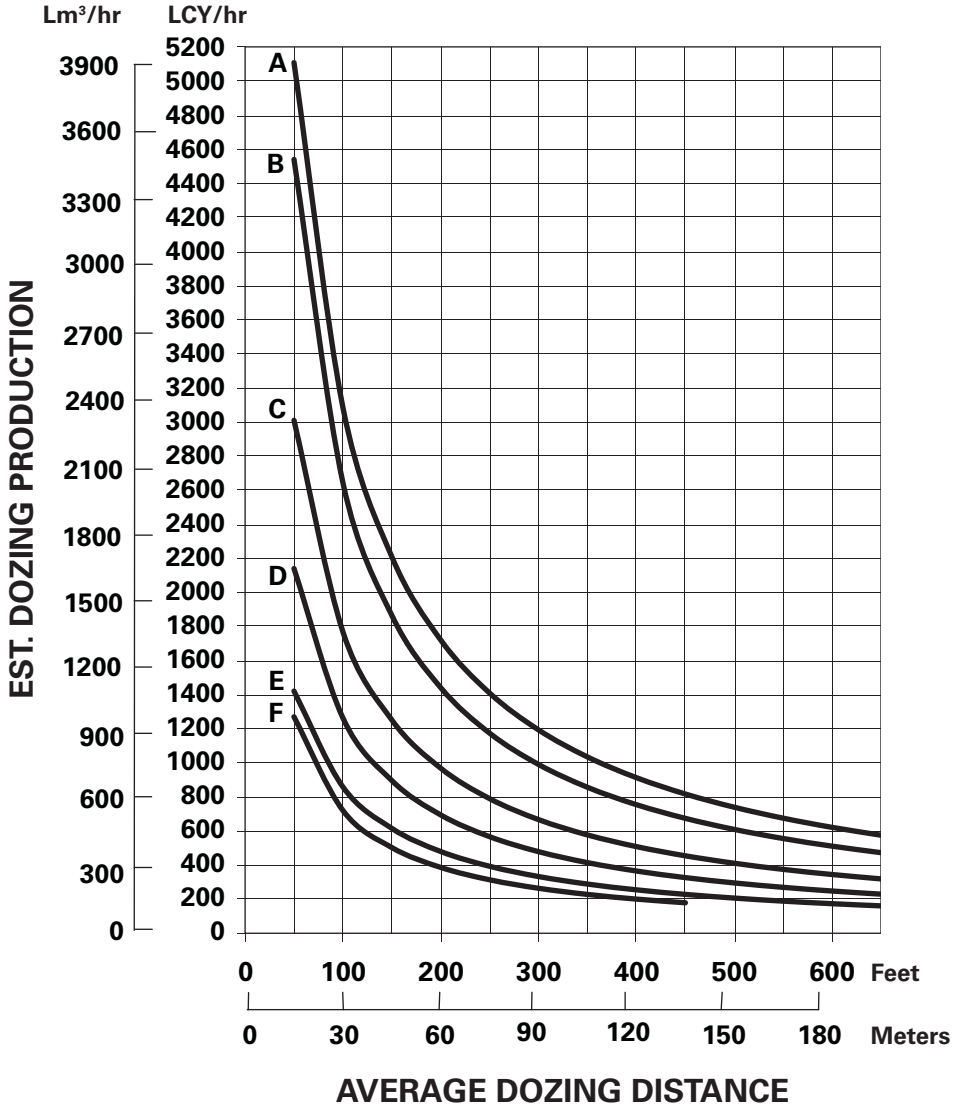


KEY

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.

ESTIMATED DOZING PRODUCTION ● Universal Blades ● D7E through D11T CD

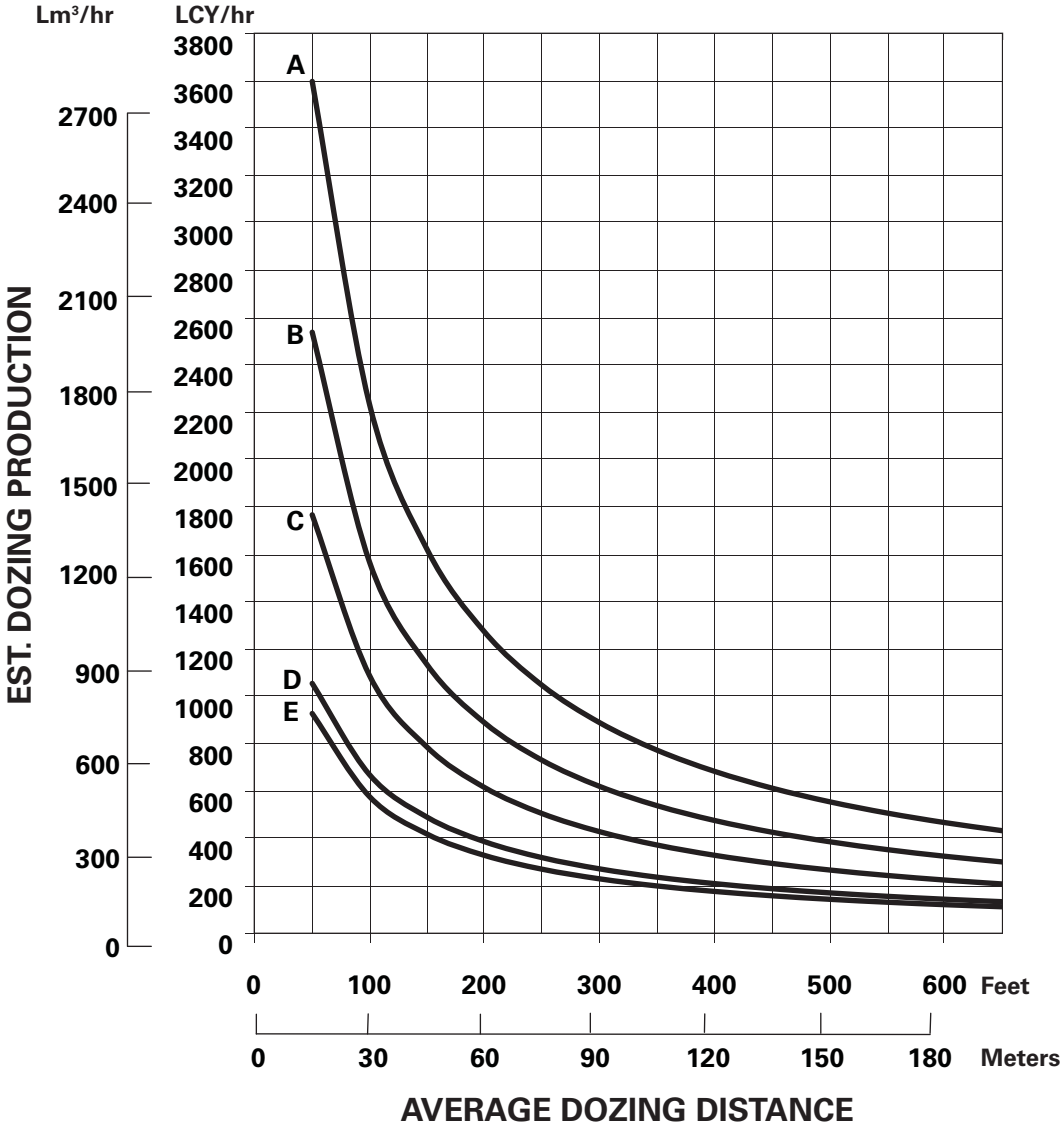


KEY

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

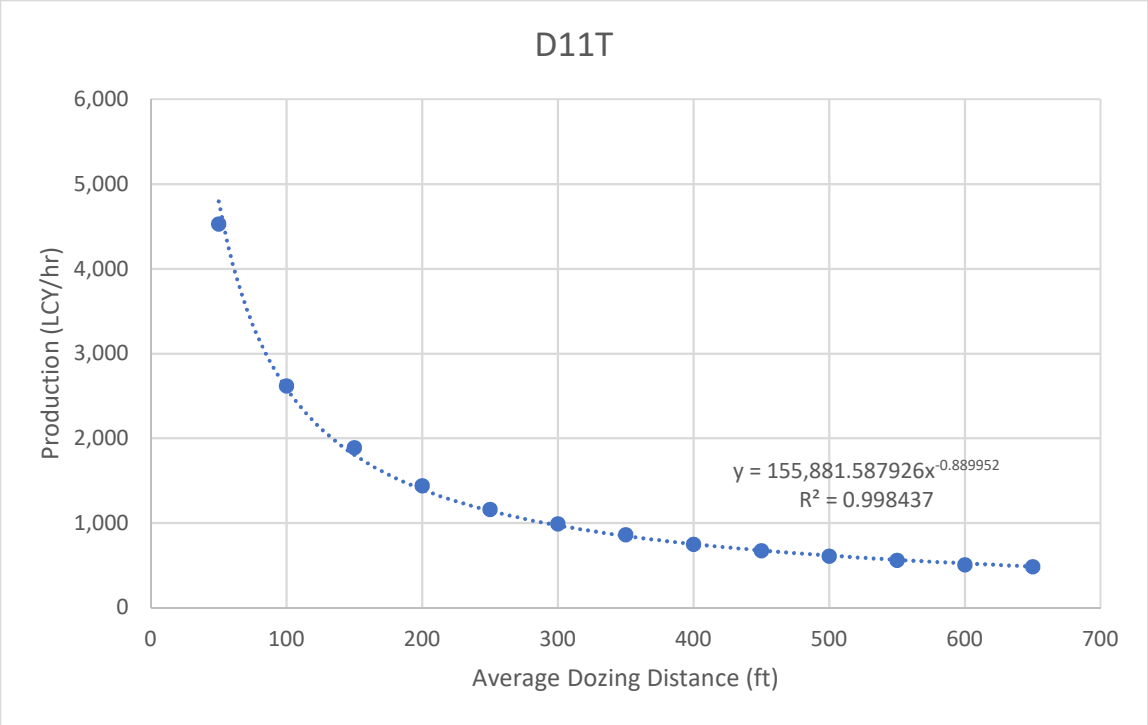


KEY

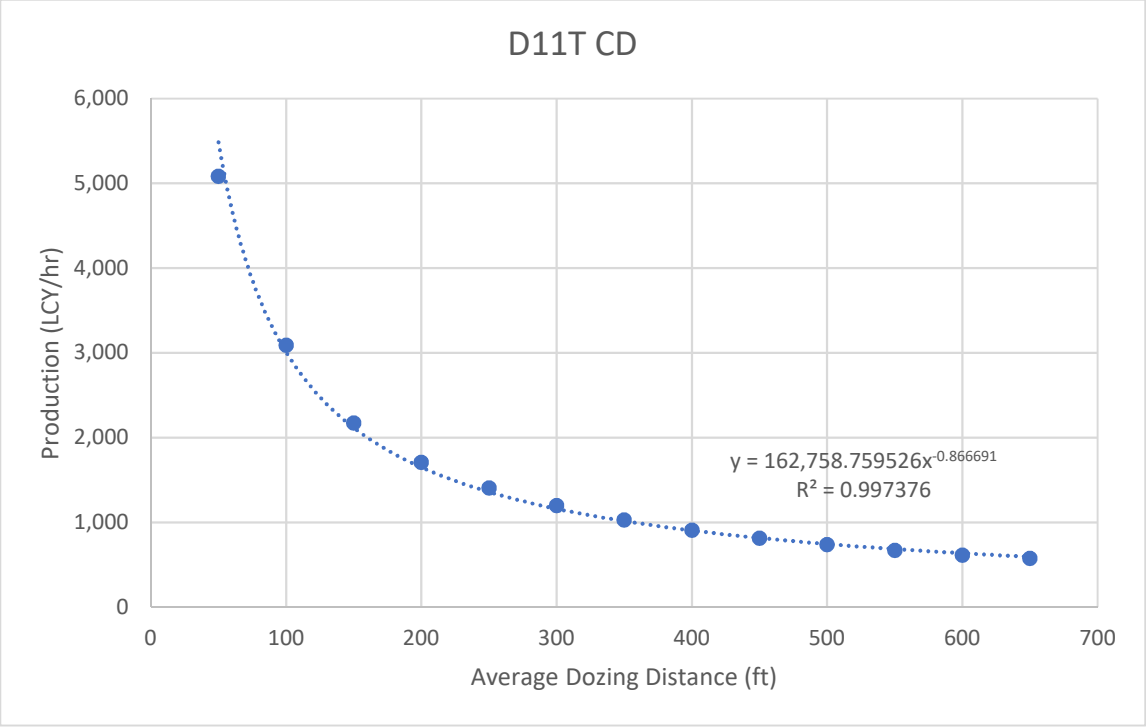
A — D11T
B — D10T2
C — D9T
D — D8T
E — D7E

NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

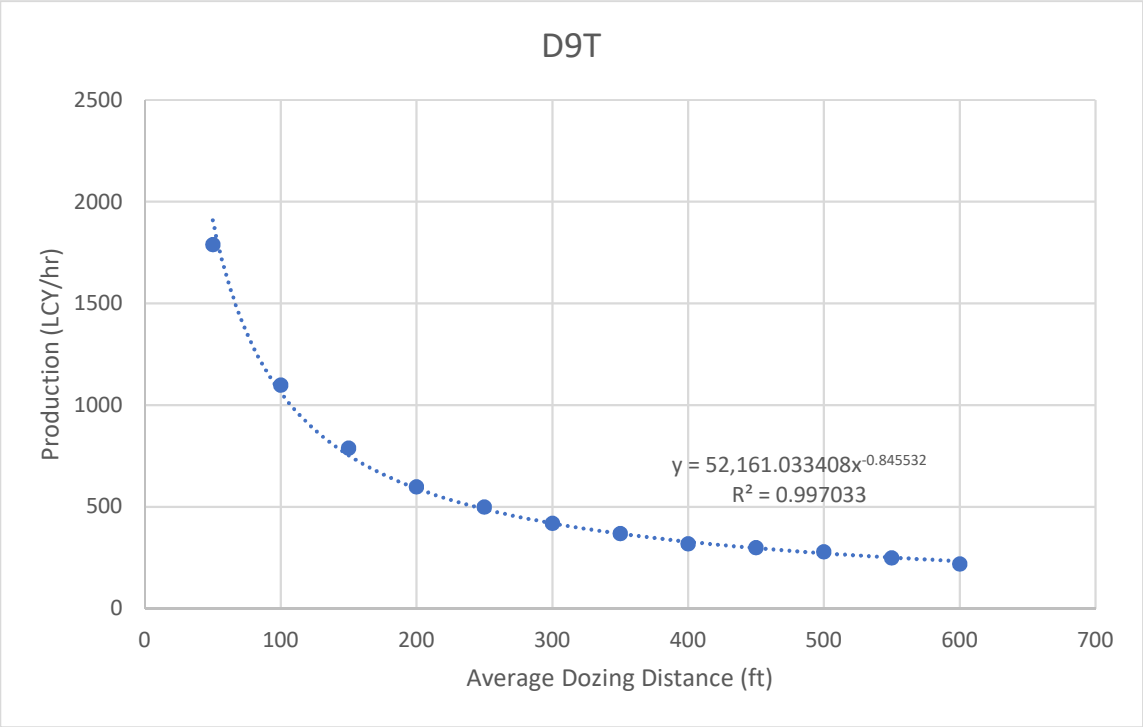
Dozing Production



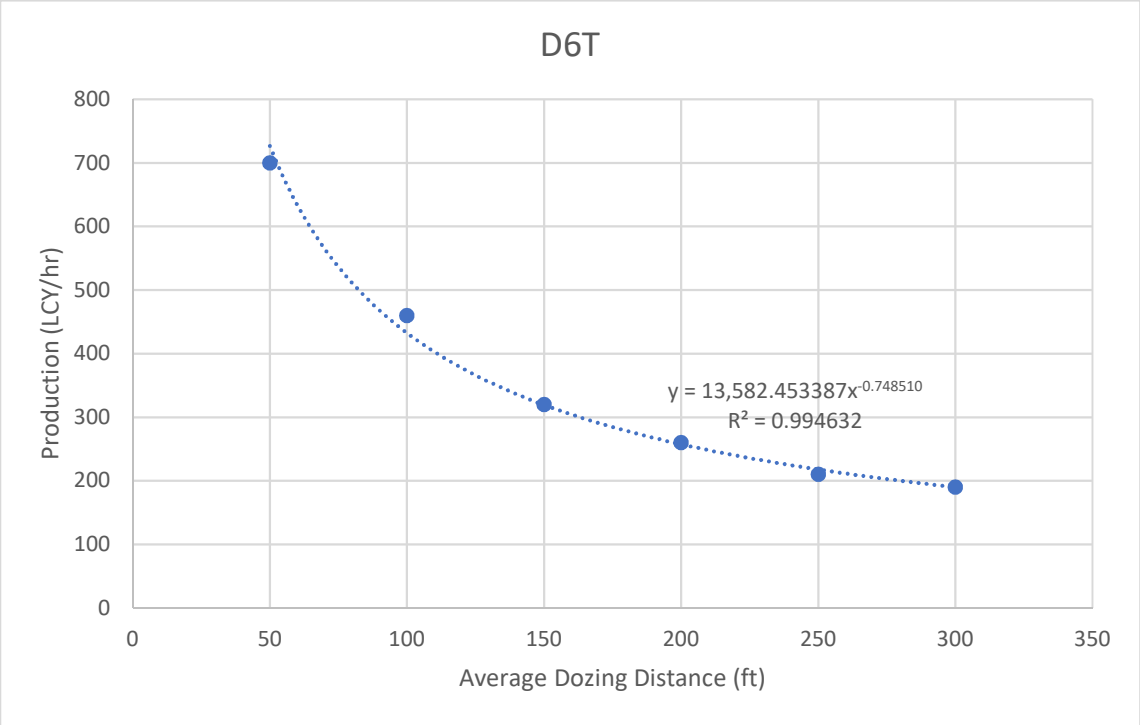
Caterpillar Performance Handbook Edition 47, 19-51



Caterpillar Performance Handbook Edition 47, 19-51



Caterpillar Performance Handbook Edition 47, 19-52



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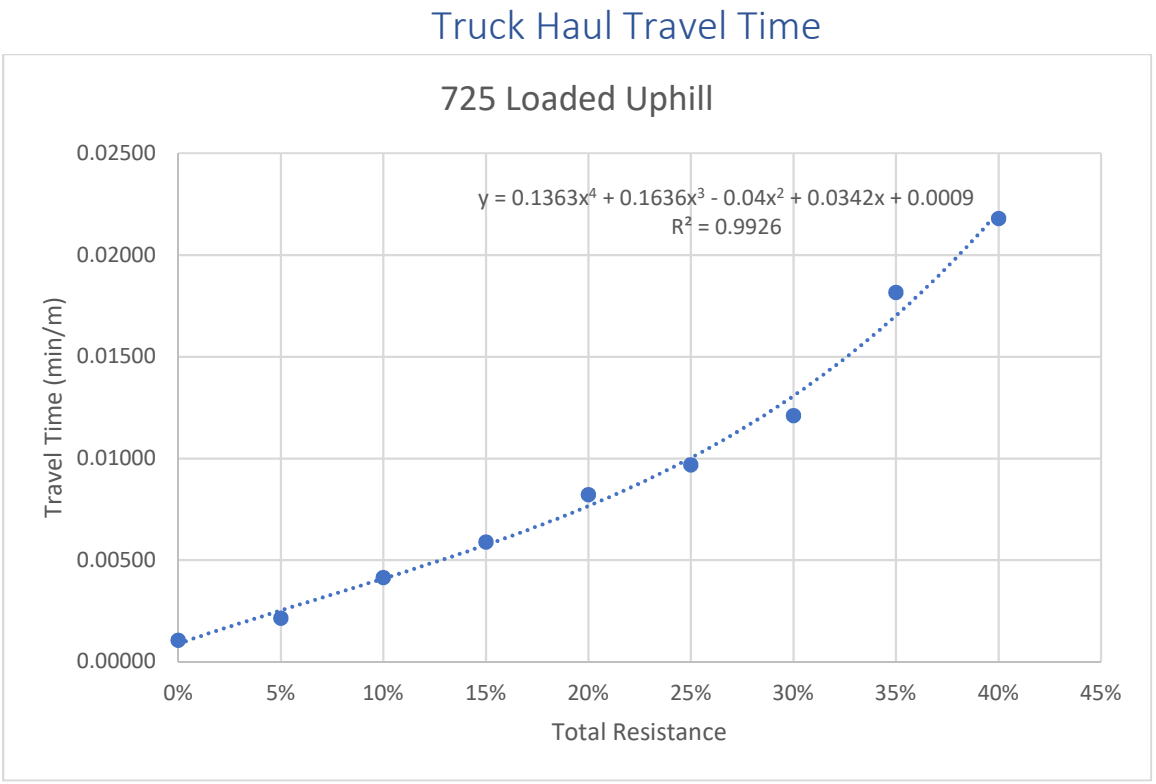
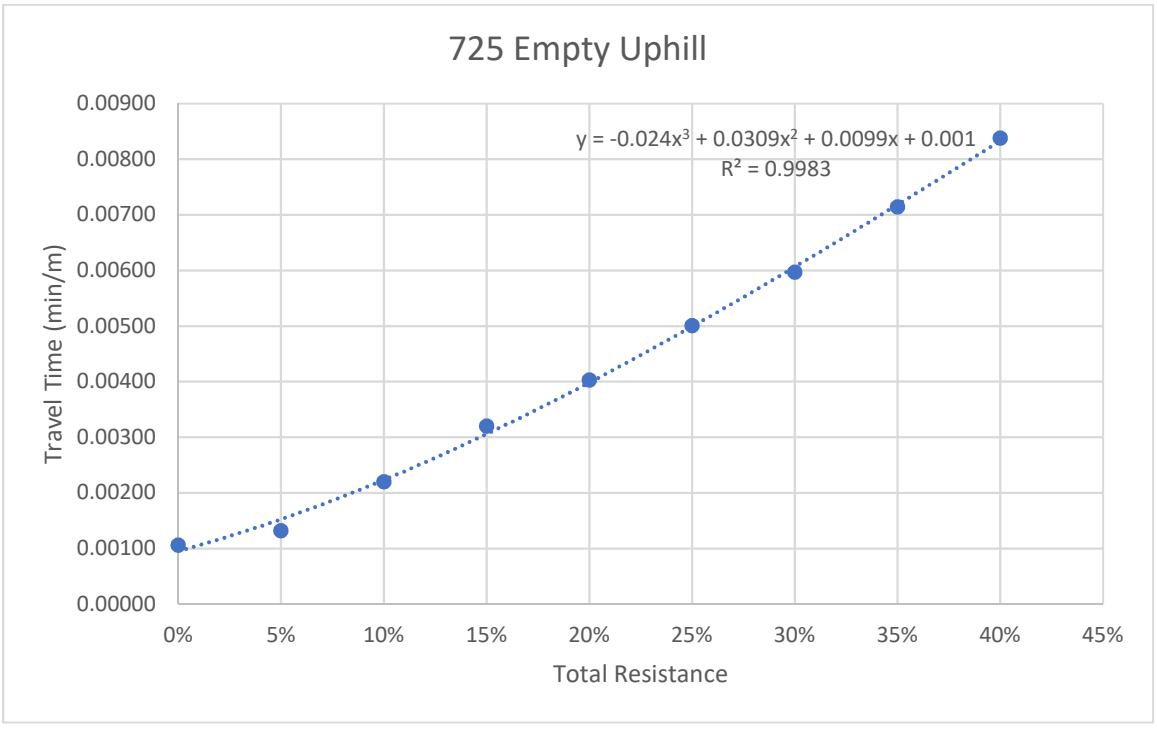
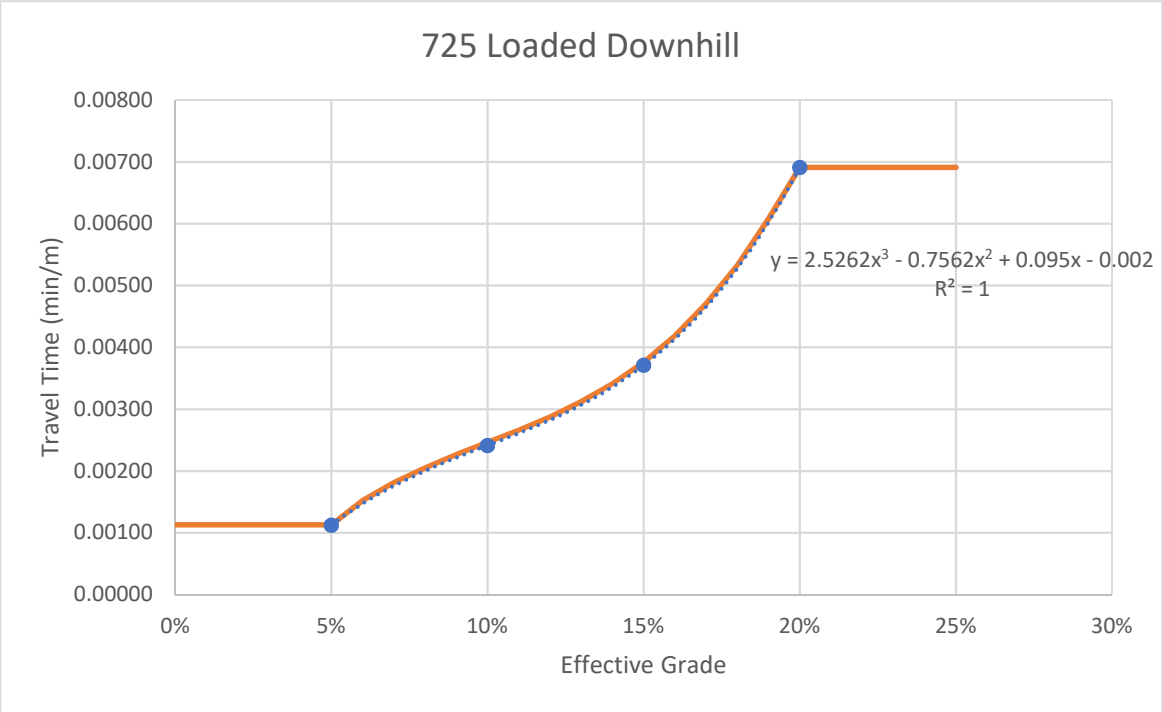


Caterpillar Performance Handbook Edition 47, 1-9



Caterpillar Performance Handbook Edition 47, 1-9



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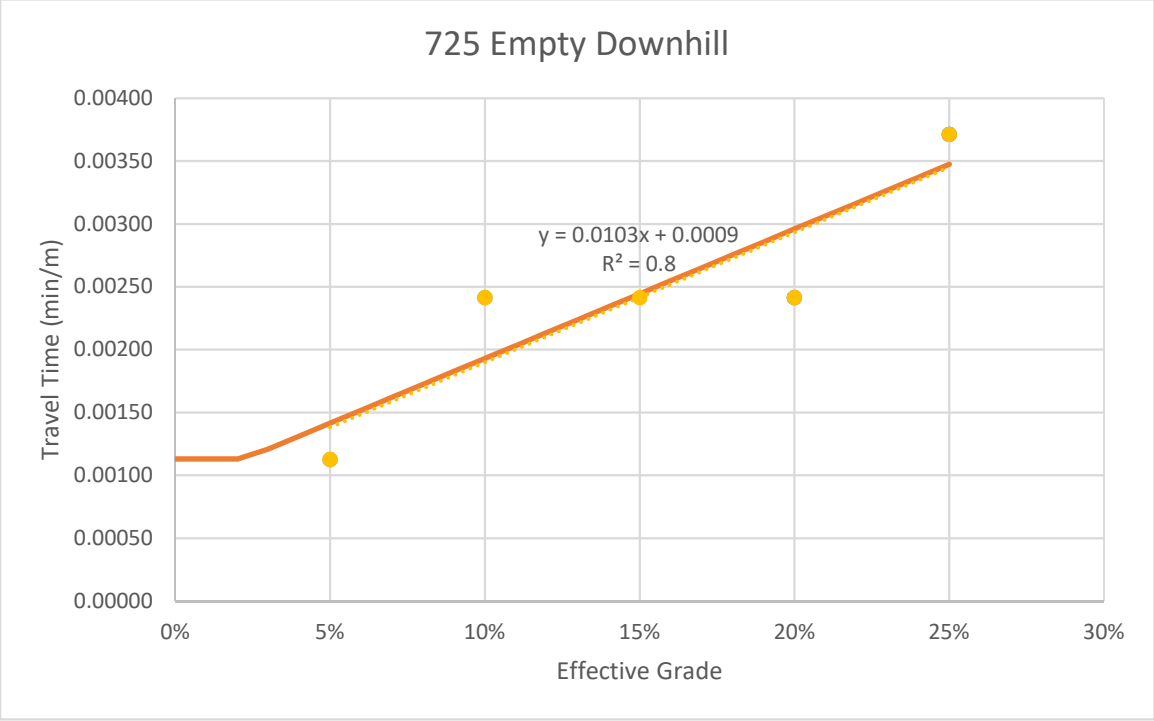
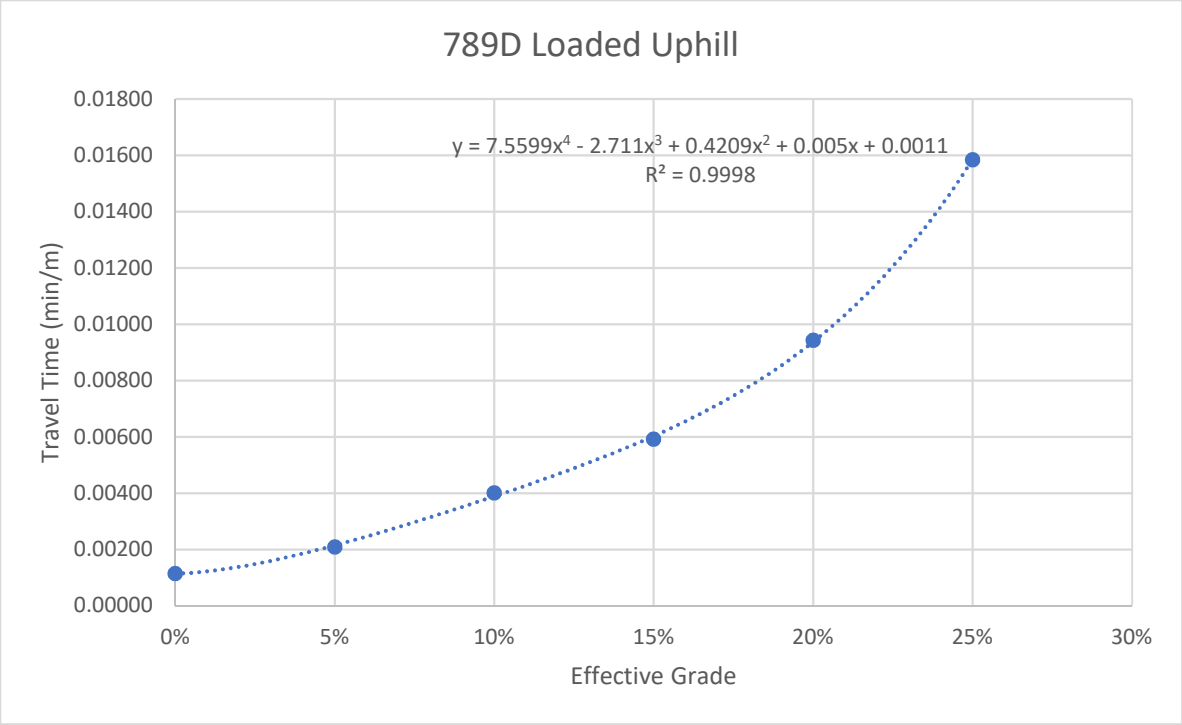


Caterpillar Performance Handbook Edition 47, 1-10



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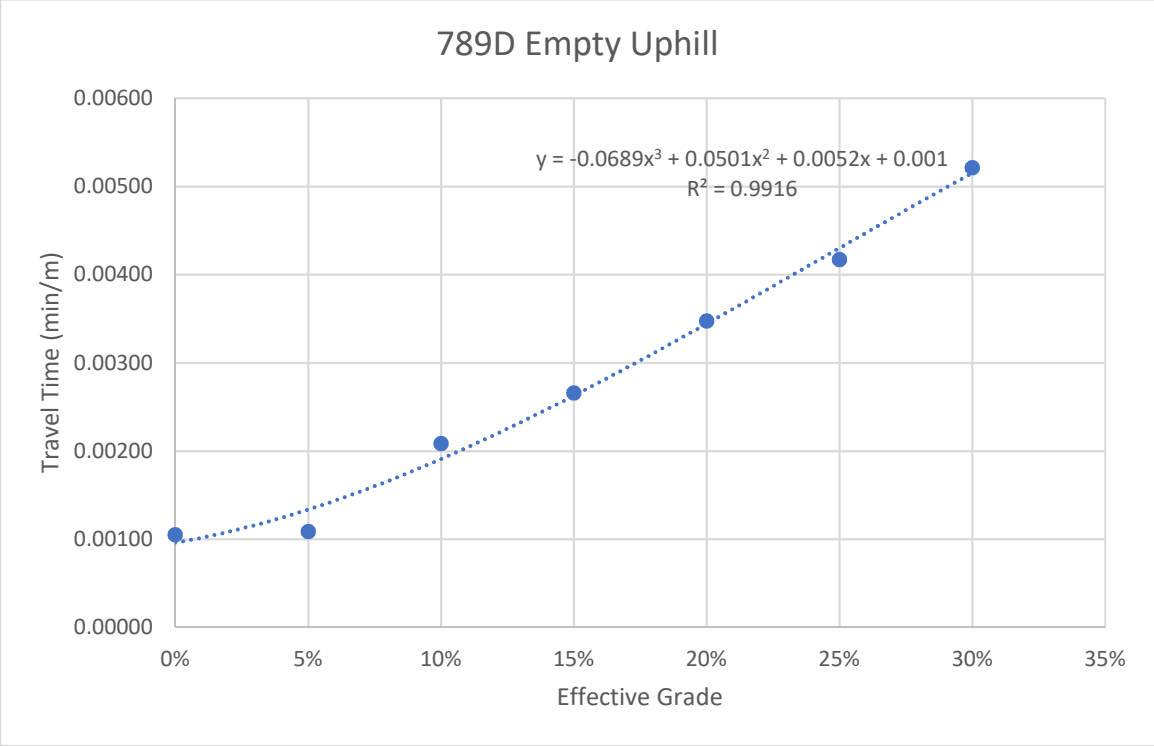
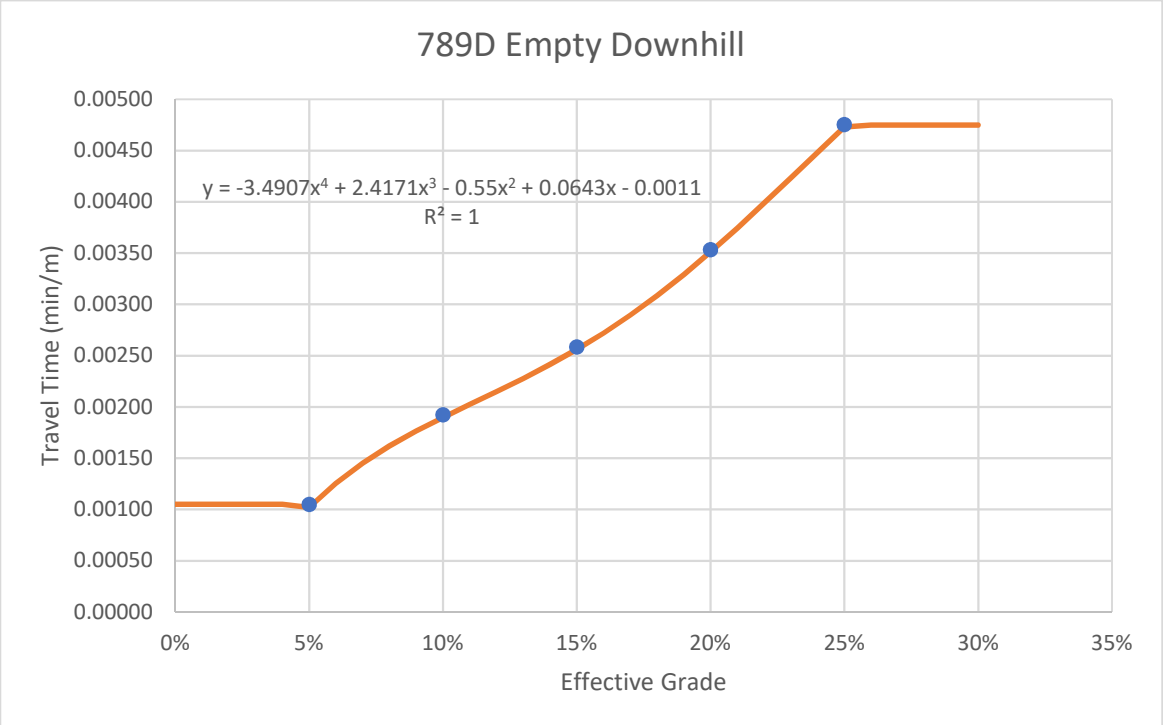


Caterpillar Performance Handbook Edition 47, 10-64



Caterpillar Performance Handbook Edition 47, 10-65



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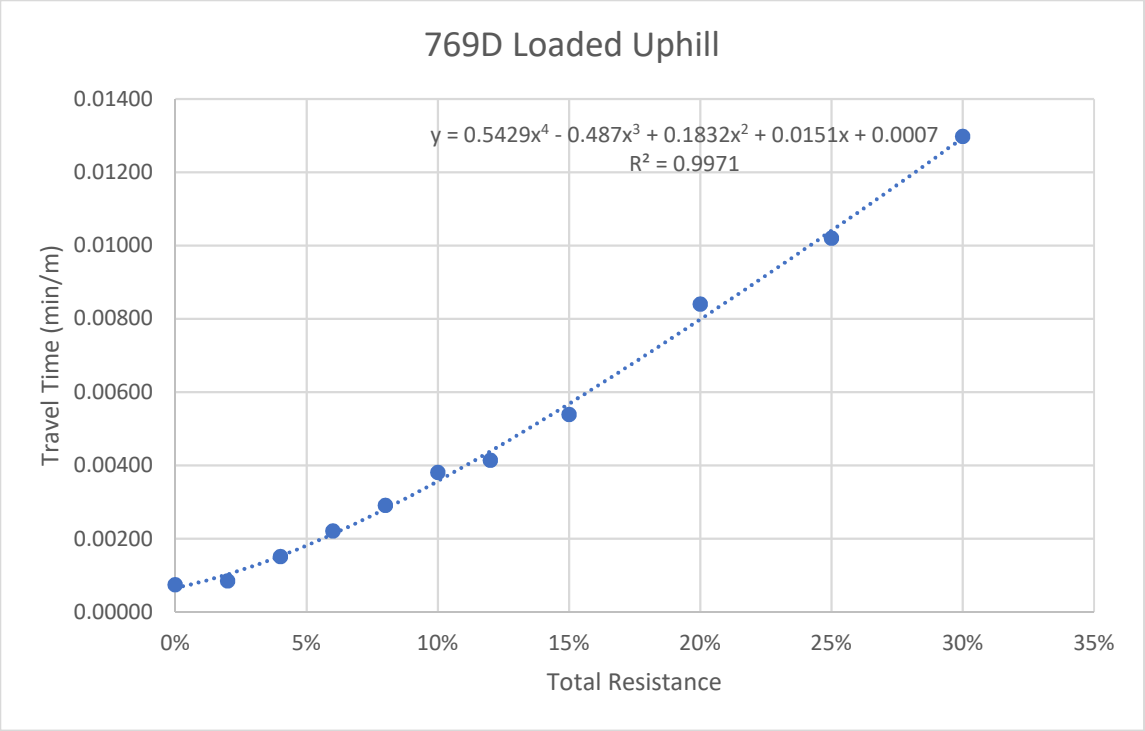
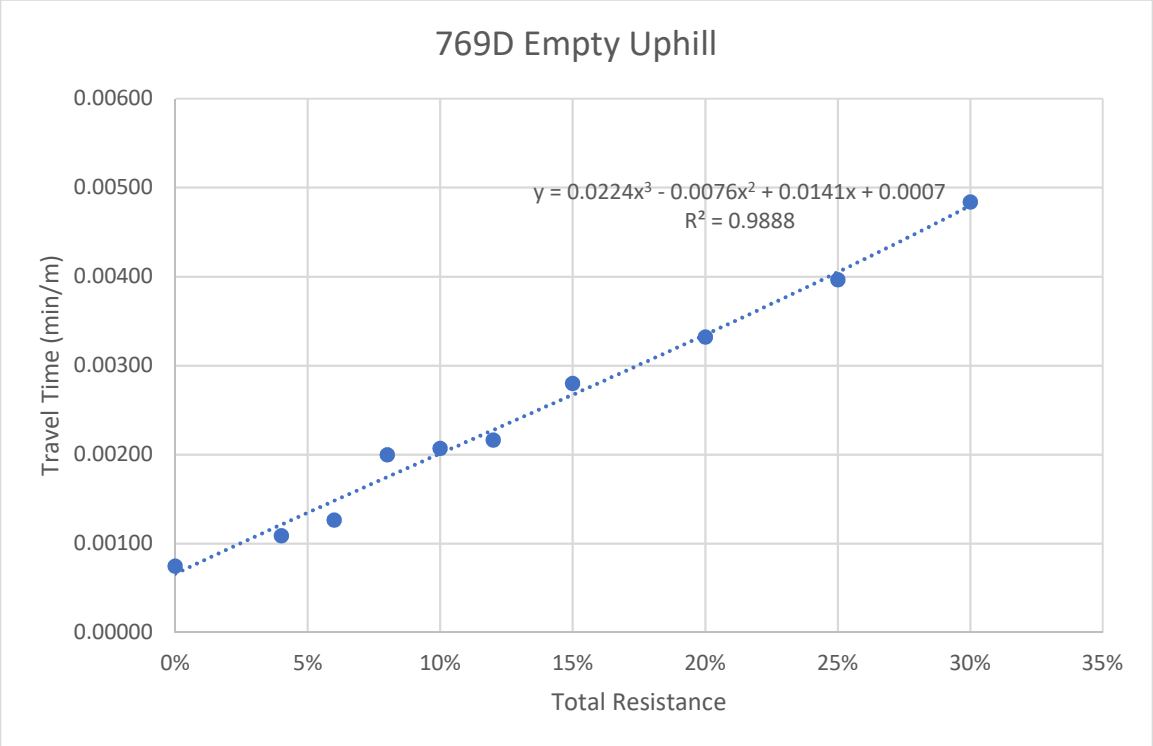


Caterpillar Performance Handbook Edition 29, 9-10



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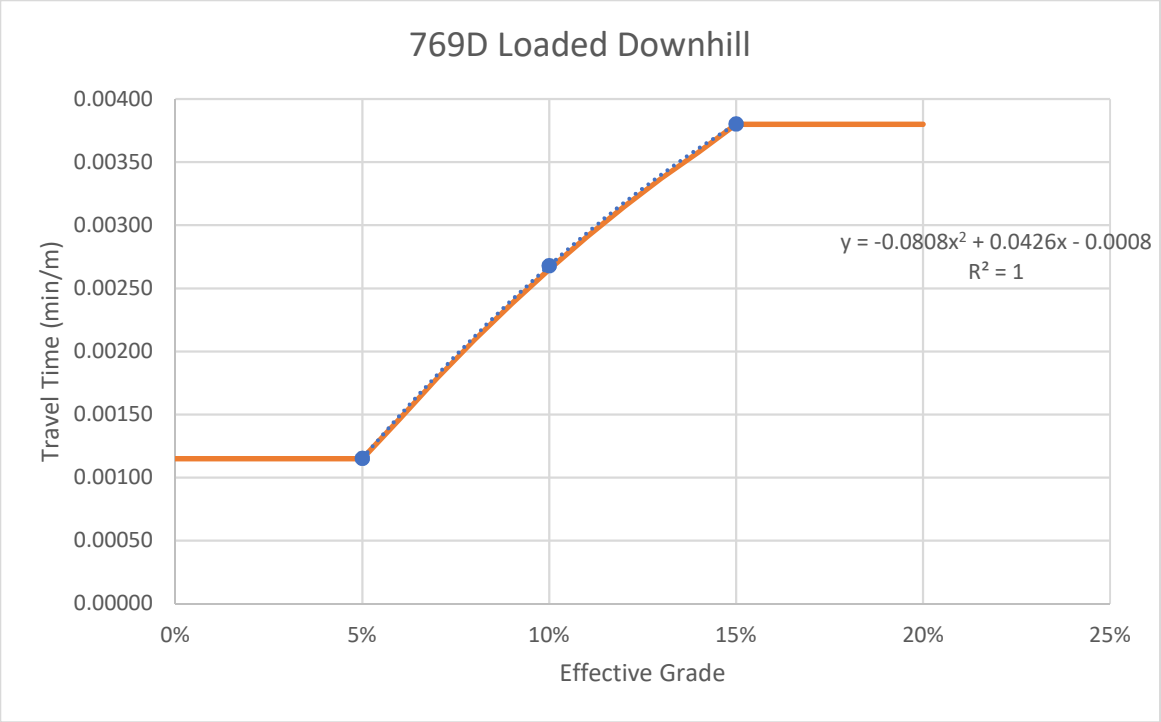
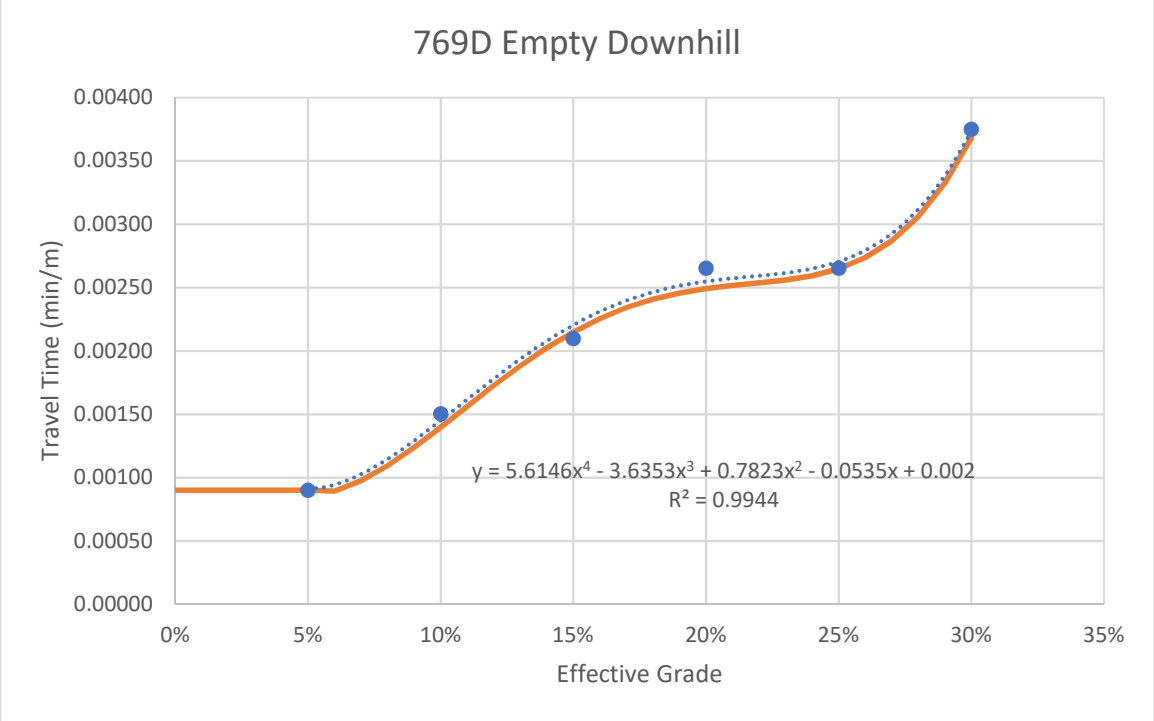


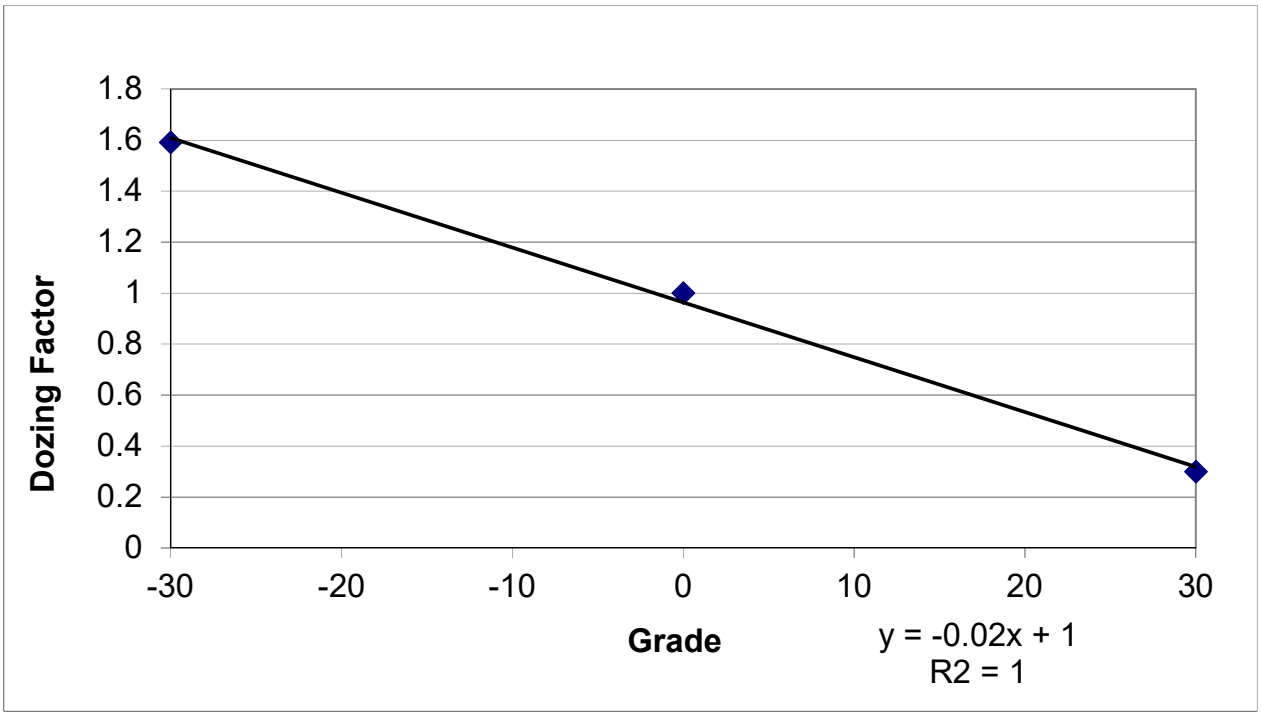
Caterpillar Performance Handbook Edition 29, 9-11



Caterpillar Performance Handbook Edition 29, 9-11

Grade vs. Dozing Factor

Grade %	Dozing Factor
0	1
-30	1.59
30	0.3



Appendix B.4

R.S. Means Data

Tyrone Unit Costs from RS Means Online (accessed February-April 2019)

Use in RCE	Line Number	Description	Unit	Material	Labor	Equipment	Total	Data Release	CCI Location
Demolition									
Steel tank	130505750530	Steel tank, single wall, above ground, 5,000 thru 10,000 gallon, selective demolition, excluding foundation, pumps or piping	Ea.	$ -	$ 553.42	$ 452.55	$ 1,005.97	Year 2019	NEW MEXICO / LAS CRUCES (880)
Steel tank	130505750540	Steel tank, single wall, above ground, 15,000 thru 30,000 gallon, selective demolition, excluding foundation, pumps or piping	Ea.	$ -	$ 768.18	$ 1,400.75	$ 2,168.93	Year 2019	NEW MEXICO / LAS CRUCES (880)
Pipeline cleanout	026510300320	Removal of underground storage tanks, petroleum storage tanks, non-leaking, remove sludge, water and remaining product from tank bottom of tank with vacuum truck, 9,000 - 12,000 gallon tank	Ea.	$ -	$ 98.95	$ 207.74	$ 306.69	Year 2019	NEW MEXICO / LAS CRUCES (880)
Building structure	024116130100	Building demolition, large urban projects, mixture of types, excludes foundation demolition, dump fees	C.F.	$ -	$ 0.12	$ 0.13	$ 0.25	Year 2019	NEW MEXICO / LAS CRUCES (880)
Building foundation	024116170400	Buillding footings and foundations demolition, floors, concrete slab on grade, plain concrete, 6" thick, excludes disposal costs and dump fees	S.F.	$ -	$ 0.19	$ 0.43	$ 0.62	Year 2019	NEW MEXICO / LAS CRUCES (880)
Electrical	024113800200	Selective demolition, utility poles & cross arms, utility poles, wood, 35'-45' high	Ea.	$ -	$ 193.83	$ 22.41	$ 216.24	Year 2019	NEW MEXICO / LAS CRUCES (880)
Electrical	260505100370	Non metallic sheathed cable, (Romex), #14, 3 wire, electrical demolition, remove	L.F.	$ -	$ 0.63	$ -	$ 0.63	Year 2019	NEW MEXICO / LAS CRUCES (880)
Substation	260505101570	Transformer, dry type, primary, 3 phase, to 600 V, 750 kVA, electrical demolition, remove, including removal of supports, wire & conduit terminations	Ea.	$ -	$ 922.35	$ 101.72	$ 1,024.07	Year 2019	NEW MEXICO / LAS CRUCES (880)
Substation	015433406300	Rent steam cleaner 100 gph, Incl. Hourly Oper. Cost.	Week	$ -	$ -	$ 322.48	$ 322.48	Year 2019	NEW MEXICO / LAS CRUCES (880)
Steel trestle	024116330200	Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide	S.F.	$ -	$ 4.06	$ 3.55	$ 7.61	Year 2019	NEW MEXICO / LAS CRUCES (880)
Steel trestle	024119180200	Selective demolition, disposal only, urban buildings with salvage value allowed, steel frame, includes loading and 5 mile haul to dump	C.Y.	$ -	$ 4.14	$ 4.70	$ 8.84	Year 2019	NEW MEXICO / LAS CRUCES (880)
Fire hydrant	024113230900	Utility removal, hydrants, fire, remove only, excludes hauling	Ea.	$ -	$ 332.51	$ 64.22	$ 396.73	Year 2019	NEW MEXICO / LAS CRUCES (880)
Culvert	024113400190	Selective demolition, metal drainage piping, CMP, steel, 48"-60", diameter, excludes excavation	L.F.	$ -	$ 10.18	$ 2.51	$ 12.69	Year 2019	NEW MEXICO / LAS CRUCES (880)
Wastes requiring special handling									
Pickup (minimum)	028120101120	Hazardous waste cleanup/pickup/disposal, solid pickup, bulk material, minimum	Ton	$ -	$ -	$ -	$ 162.26	Year 2019	NEW MEXICO / LAS CRUCES (880)
Pickup (maximum)	028120101130	Hazardous waste cleanup/pickup/disposal, solid pickup, bulk material, maximum	Ton	$ -	$ -	$ -	$ 508.13	Year 2019	NEW MEXICO / LAS CRUCES (880)
Transport to disposal (minimum)	028120101260	Hazardous waste cleanup/pickup/disposal, transportation to disposal site, truckload = 80 drums or 25 C.Y. or 18 tons, minimum	Mile	$ -	$ -	$ -	$ 3.37	Year 2019	NEW MEXICO / LAS CRUCES (880)
Transport to disposal (maximum)	028120101270	Hazardous waste cleanup/pickup/disposal, transportation to disposal site, truckload = 80 drums or 25 C.Y. or 18 tons, maximum	Mile	$ -	$ -	$ -	$ 6.19	Year 2019	NEW MEXICO / LAS CRUCES (880)
Miscellaneous									
Grade control wall (launder line drainages)	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.	$ 124.41	$ 40.85	$ 0.33	$ 165.59	Year 2019	NEW MEXICO / LAS CRUCES (880)
Cutoff wall (dissipater)	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.	$ 147.68	$ 95.95	$ 11.34	$ 254.97	Year 2019	NEW MEXICO / LAS CRUCES (880)
Revegetation	015433201500	Rent disc harrow attchment for tractor, Excl. Hourly Oper. Cost.	Month	$ -	$ -	$ 616.33	$ 616.33	Year 2019	NEW MEXICO / LAS CRUCES (880)
Vehicle gates	323113205070	Fence, chain link industrial, double swing gates, 6' high, 20' opening, includes excavation, posts & hardware in concrete	Opng.	$ 618.45	$ 317.19	$ 67.24	$ 1,002.88	Year 2019	NEW MEXICO / LAS CRUCES (880)
Signs	101453200600	Signs, guide and directional signs, reflectorized, 12" x 18", excludes posts	Ea.	$ 40.50	$ 16.93	$ 7.76	$ 65.19	Year 2019	NEW MEXICO / LAS CRUCES (880)
Fence	323113200800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	L.F.	$ 19.07	$ 3.28	$ 0.70	$ 23.05	Year 2019	NEW MEXICO / LAS CRUCES (880)

Crews - Standard

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-12B	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, 1.5 C.Y.		908.70		999.57	56.79	62.47
16 L.H., Daily Totals		$1696.70		$2186.37	$106.04	$136.65
Crew B-12C	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, 2 C.Y.		1078.00		1185.80	67.38	74.11
16 L.H., Daily Totals		$1866.00		$2372.60	$116.63	$148.29
Crew B-12D	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, 3.5 C.Y.		2256.00		2481.60	141.00	155.10
16 L.H., Daily Totals		$3044.00		$3668.40	$190.25	$229.28
Crew B-12E	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, .5 C.Y.		443.75		488.13	27.73	30.51
16 L.H., Daily Totals		$1231.75		$1674.93	$76.98	$104.68
Crew B-12F	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, .75 C.Y.		681.25		749.38	42.58	46.84
16 L.H., Daily Totals		$1469.25		$1936.18	$91.83	$121.01
Crew B-12G	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 15 Ton		866.60		953.26		
1 Clamshell Bucket, .5 C.Y.		42.55		46.81	56.82	62.50
16 L.H., Daily Totals		$1697.15		$2186.86	$106.07	$136.68
Crew B-12H	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 25 Ton		1386.00		1524.60		
1 Clamshell Bucket, 1 C.Y.		51.20		56.32	89.83	98.81
16 L.H., Daily Totals		$2225.20		$2767.72	$139.07	$172.98
Crew B-12I	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 20 Ton		1130.00		1243.00		
1 Dragline Bucket, .75 C.Y.		21.85		24.04	71.99	79.19
16 L.H., Daily Totals		$1939.85		$2453.84	$121.24	$153.36
Crew B-12J	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Gradall, 5/8 C.Y.		862.55		948.80	53.91	59.30
16 L.H., Daily Totals		$1650.55		$2135.61	$103.16	$133.48

Crew No.	Bare Costs		Incl. Subs O&P		Cost Per Labor-Hour	
Crew B-12K	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Gradall, 3 Ton, 1 C.Y.		1185.00		1303.50	74.06	81.47
16 L.H., Daily Totals		$1973.00		$2490.30	$123.31	$155.64
Crew B-12L	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 15 Ton		866.60		953.26		
1 F.E. Attachment, .5 C.Y.		63.95		70.34	58.16	63.98
16 L.H., Daily Totals		$1718.55		$2210.41	$107.41	$138.15
Crew B-12M	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 20 Ton		1130.00		1243.00		
1 F.E. Attachment, .75 C.Y.		68.90		75.79	74.93	82.42
16 L.H., Daily Totals		$1986.90		$2505.59	$124.18	$156.60
Crew B-12N	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 25 Ton		1386.00		1524.60		
1 F.E. Attachment, 1 C.Y.		74.85		82.33	91.30	100.43
16 L.H., Daily Totals		$2248.85		$2793.74	$140.55	$174.61
Crew B-12O	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 40 Ton		1392.00		1531.20		
1 F.E. Attachment, 1.5 C.Y.		85.65		94.22	92.35	101.59
16 L.H., Daily Totals		$2265.65		$2812.22	$141.60	$175.76
Crew B-12P	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 40 Ton		1392.00		1531.20		
1 Dragline Bucket, 1.5 C.Y.		35.10		38.61	89.19	98.11
16 L.H., Daily Totals		$2215.10		$2756.61	$138.44	$172.29
Crew B-12Q	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, 5/8 C.Y.		587.30		646.03	36.71	40.38
16 L.H., Daily Totals		$1375.30		$1832.83	$85.96	$114.55
Crew B-12S	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Hyd. Excavator, 2.5 C.Y.		1441.00		1585.10	90.06	99.07
16 L.H., Daily Totals		$2229.00		$2771.90	$139.31	$173.24
Crew B-12T	**Hr.**	**Daily**	**Hr.**	**Daily**	**Bare Costs**	**Incl. O&P**
1 Equip. Oper. (crane)	$57.45	$459.60	$86.25	$690.00	$49.25	$74.17
1 Laborer	41.05	328.40	62.10	496.80		
1 Crawler Crane, 75 Ton		1734.00		1907.40		
1 F.E. Attachment, 3 C.Y.		111.50		122.65	115.34	126.88
16 L.H., Daily Totals		$2633.50		$3216.85	$164.59	$201.05

Appendix B.4 (continued)

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Caterpillar Performance Handbook

Edition 29

CATERPILLAR®

CONSTRUCTION & MINING TRUCKS
CONSTRUCTION & MINING TRACTORS

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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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NOTE: Always refer to the appropriate Operation and Maintenance Manual for specific product information.

Materials and specifications are subject to change without notice.

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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 in³**	15.2 L	**928 in³**	18.1 L	**1104.5 in³**	27.1 L	**1666 in³**
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

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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 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.

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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.

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.

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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
	yd³	**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
	yd³	**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

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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

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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 in³**	12.5 L	**763 in³**
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.

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:

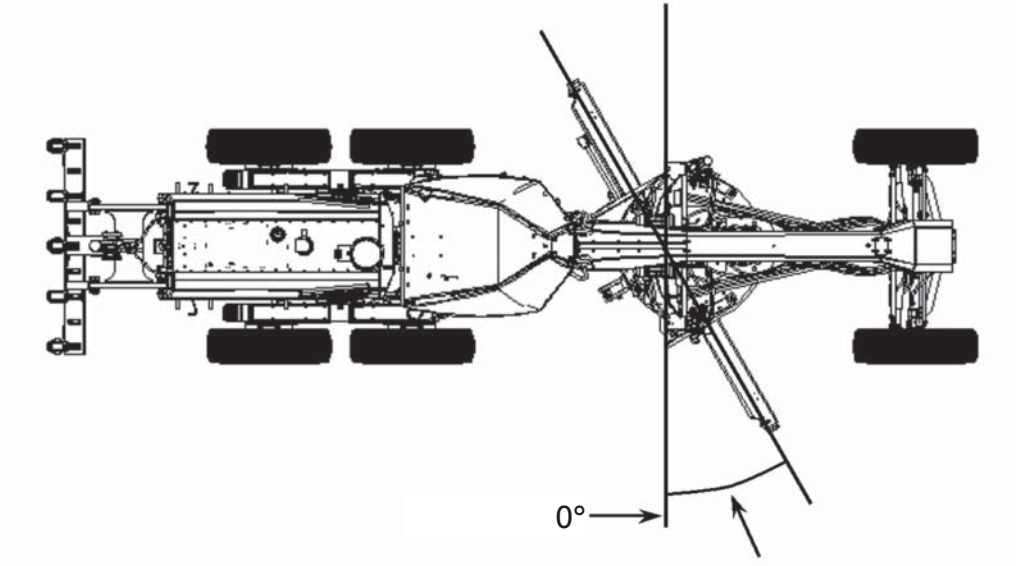
Typical operating speeds by application

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.



Moldboard Angle

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")

Wr × 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

10 501 × 0.65 = 6825.65

English

RW = 23,151 lb

T = 0.65

23,151 × 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

$$\frac{\mathbf{WB}}{\mathbf{(WB - BA)}} \times \mathbf{FW = BD}$$

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 = ?

$$\frac{\mathbf{6086}}{\mathbf{(6086 - 2565)}} \times \mathbf{4223 = 7299\ kg}$$

English

BA = 101 in FW = 9310 lb

WB = 240 in BD = ?

$$\frac{\mathbf{240}}{\mathbf{(240 - 101)}} \times \mathbf{9310 = 16{,}075\ lb}$$

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')	
		m	ft	m	ft	m	ft	m	ft
Angle°	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

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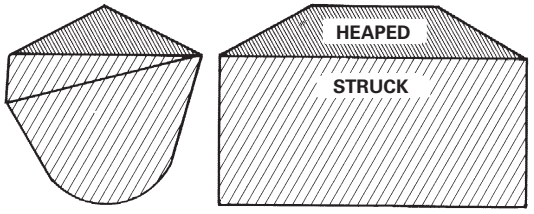
Features common to all D Series models (953D-963D-973D):

- **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.

$$\textit{Cycles per hour at 100\% Efficiency} = \frac{60\ \textit{Min}}{\textit{Total Cycle Time in Minutes}}$$

Job efficiency is an important factor in machine selection. Efficiency is the actual number of minutes worked during an hour. Job efficiency accounts for 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

	GENERAL PURPOSE BUCKET SIZE		MAXIMUM OPERATING CAPACITY	
MODEL	m^3	yd^3	kg	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 —

$$\frac{60 \text{ min/hr}}{0.80 \text{ min/cycle}} = 75 \text{ cycles per hour @ } 100\% \text{ efficiency}$$

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

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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 in³**	8.8 L	**537 in³**
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 m²	**4531 in²**	3.15 m²	**4878 in²**
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 in³**	9.3 L	**567 in³**	9.3 L	**567 in³**
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 m²	**5489 in²**	4.81 m²	**7449 in²**	6.53 m²	**10,122 in²**
VPAT	3.54 m²	**5489 in²**	5.10 m²	**7909 in²**	5.60 m²	**8684 in²**
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

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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

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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.

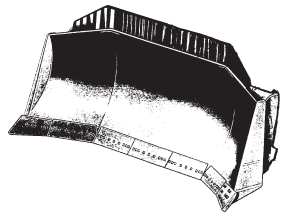
The effect of freezing depends on the moisture content. When frozen, the material's bond strengthens as moisture content increases and temperature decreases. However, freezing a completely dry material does not change its characteristics.

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.

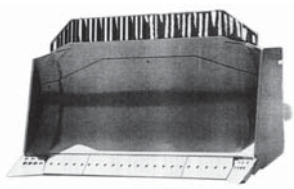
Tractor Limitations

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.

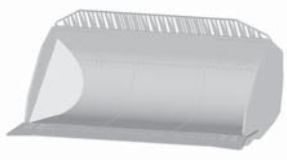
Production Dozing Tools



"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.

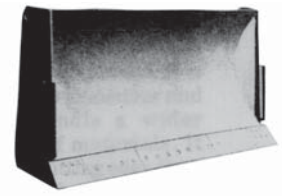


"SU" — The Semi-U blade combines the desirable characteristics of S and U-blades into one package. It has increased capacity by the addition of short wings which include only the dozer end bits. The wings provide improved load retention capabilities while maintaining the blade's ability to penetrate 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 CarryDozer 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 carryback 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.



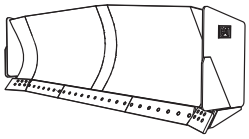
Power Angle and Tilt Blade — Versatility is its key feature with its ability to perform a variety of site development to general dozing work as well as heavy-duty applications. Angle and tilt control is with 2 levers on some machines, 1 lever on others.

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.

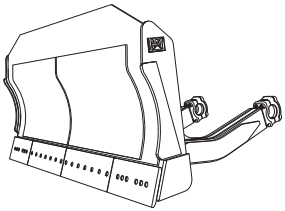
They provide the aggressive cutting action needed for digging, while having the material retention characteristics needed for moving high volumes over a distance. This is accomplished through a moldboard which varies in radius from the edge to the center. This creates a rolling action in the material 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 sidecasting, 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.

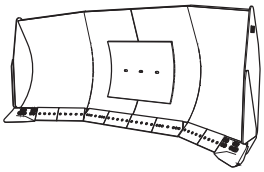
Cushion Dozers



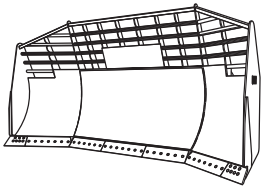
Cushion Dozers are designed to push-load wheel-tractor scrapers, or track-type tractors. The heavy-duty design includes reinforcement to transfer machine power without damaging the blade or the tractor. Blade cylinders are pinned to the C-frame, and the blade height is such that the blade lift cylinders 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.

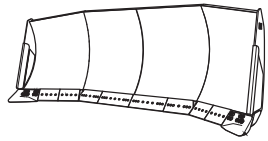
When not push-loading, the dozer can be used for cut maintenance and other general dozing jobs.



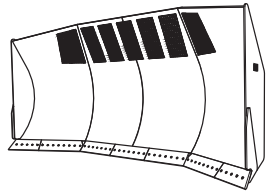
Coal U-Blades are designed specifically to move large volumes of coal in coal piles, at powerplants and transshipment points. The wing angle of thirty degrees crowds material to the center of the blade, maximizing capacity by minimizing side spill. The moldboard is much higher and wider than standard, 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.

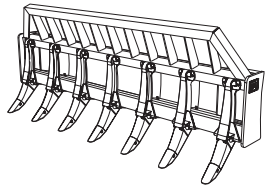


Reclamation U-Blades — are purpose-built for reclamation of mine spoil piles. The blade has a larger capacity than a standard U-blade. The wing angle of 28 degrees provides a good balance between load retention and shearing action, keeping the optimal load in front of the blade, but cutting cleanly through the material when necessary.



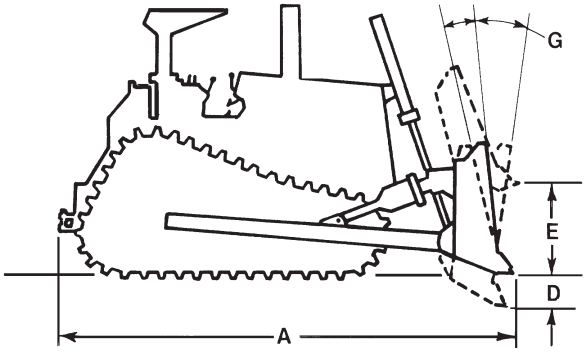
The width of **Woodchip U-Blades** gives operators maximum control and greater confidence, even in steep chip piles. Deep curvature of the moldboard keeps material flowing to liven dead chips and optimize production on long pushes. Blade height and wings angled at thirty degrees combine for excellent material retention – giving better production with every pass. An operator visibility window in the top section is standard.

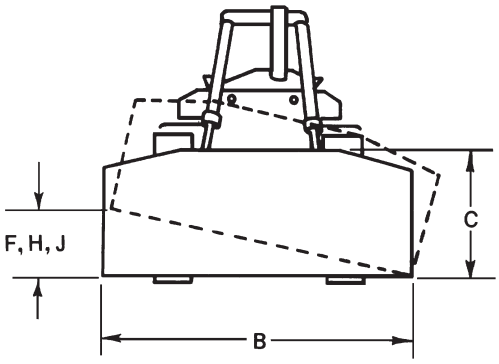
Multi-Application/Rock and Root Rakes



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%.

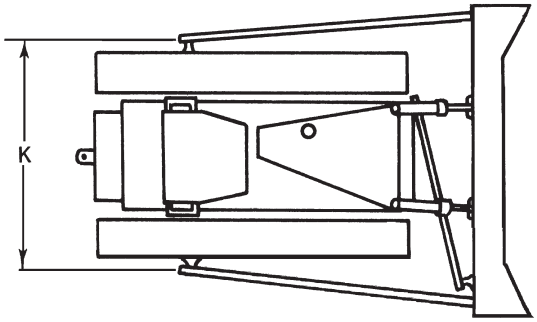
Rake is a direct replacement for existing blade, and utilizes existing push arms and C-frames.





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:

$Vs = 0.8\ WH^2$.

$Vu = ZH\ (W\text{-}Z)\ \tan X$.

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.

MODEL	D6T 6A XL		D6T 6SU XL		D6T 6VPAT XL		D6T 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"**

MODEL	D6T 6SU XW		D6T 6A LGP		D6T 6S LGP		D6T 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 m^3	**35.5 yd^3**	34.4 m^3	**45.0 yd^3**	43.6 m^3	**57.0 yd^3**
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°** or		**+7.5° to 7.6°** 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:

$$\text{Production } (Lm^3/hr) \text{ (LCY/hr)} = \text{Maximum production} \times \text{Correction factors}$$

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.

$$\text{Production } Bm^3/hr \text{ (BCY/h)} = Lm^3/hr \text{ (LCY/h)} \times LF$$

*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).

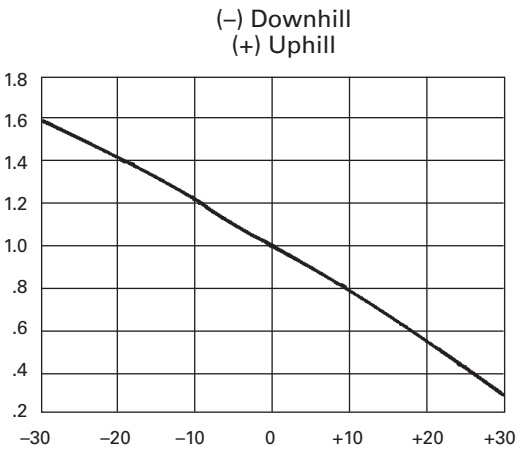
**This gear sequence is based on level to downhill terrain, light to medium density material, and no blade extensions such as spill plates, rock guards, etc. Exceeding these conditions may require carry in 1F, but productivity should equal or exceed "standard conditions" due to the larger loads that 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



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/Lm³ (2650 lb/LCY). Operator is average. Job efficiency is estimated at 50 min/hr.

Uncorrected Maximum Production — 458 Lm³/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 Lm³.

= 458 Lm³/h × Factors
= 309.6 Lm³/h

RIPPERS

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Features:

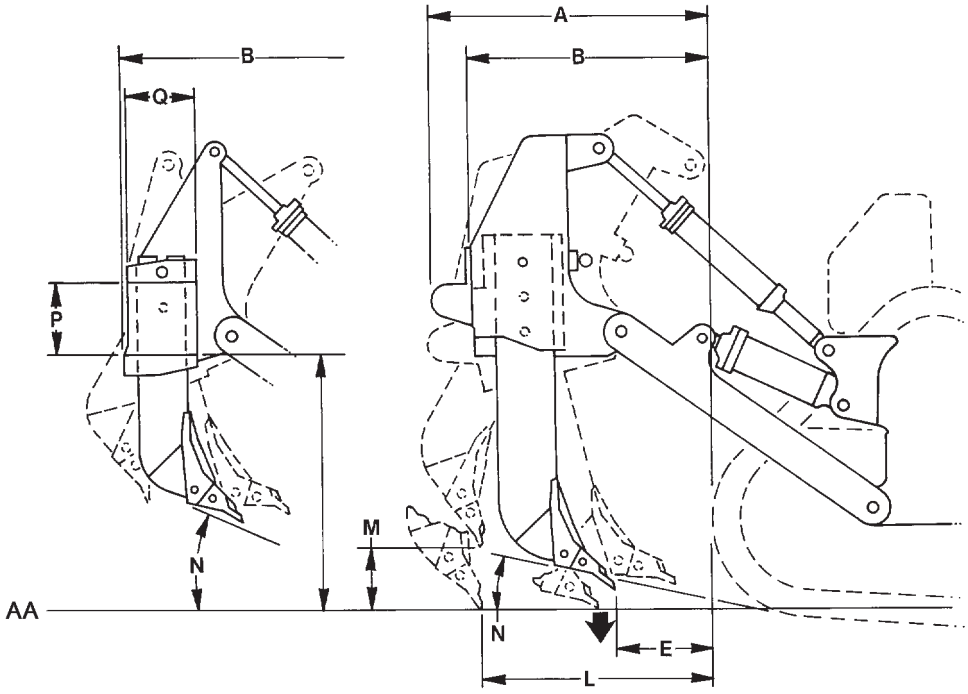
- **Parallelogram linkage with hydraulically variable pitch** on D7E, D7R, D8R/D8T, D9R/D9T, D10T2 and D11T. Operator can adjust angle of ripper tip to the material for penetration at all ripping depths to increase production.
- **Fixed Parallelogram linkage design** used on D3K2, D4K2, D5K2, D6K2, D6N, 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

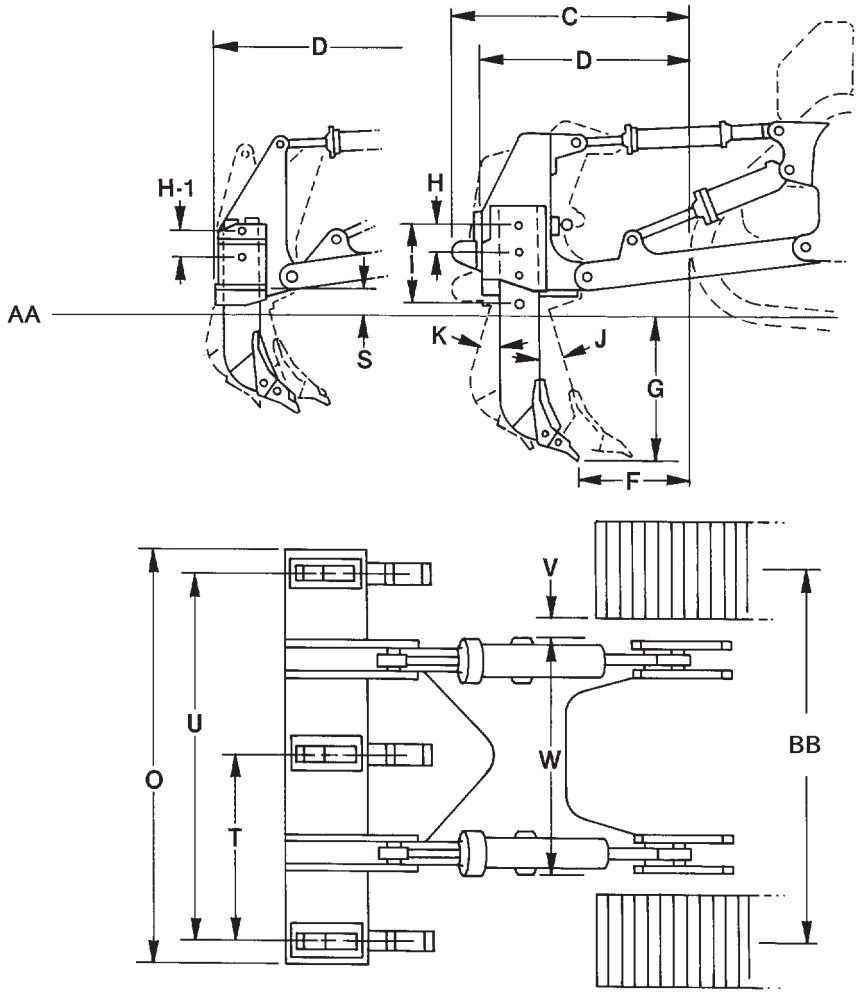


NOTE: Letters correspond to ripper specifications on pages that follow.

KEY

AA — Ground Line

Adjustable Parallelogram Ripper



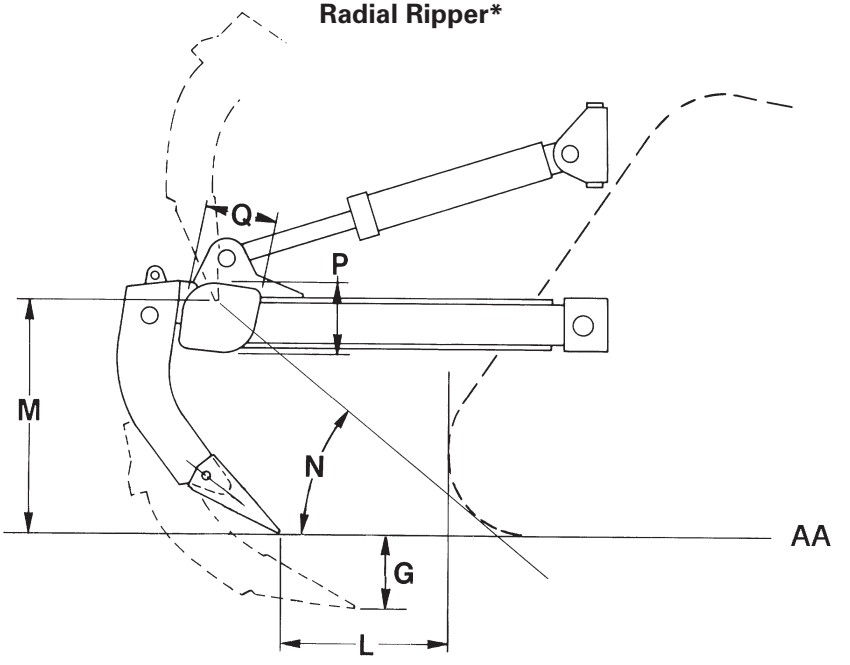
NOTE: Letters correspond to ripper specifications on pages that follow.

KEY

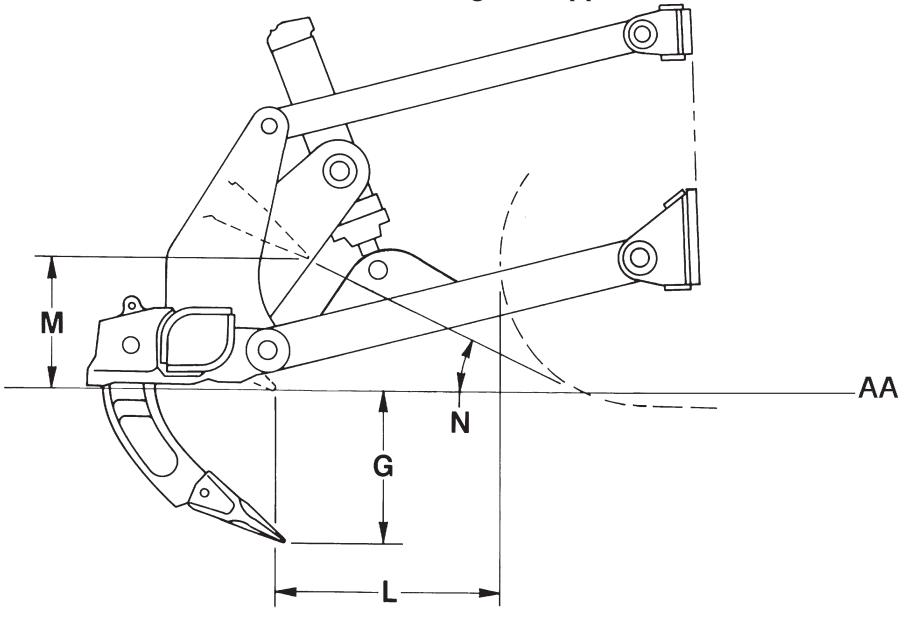
AA — Ground Line
BB — Track Gauge

Specification Diagrams
- Radial Ripper
- Fixed Parallelogram Ripper

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.

●●●

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

●●●

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

●●●

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. $$\text{Production per cycle} = \frac{300 \times 3 \times 2}{27} = 66.7 \text{ BCY/cycle}$$

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.

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INTEGRATED TOOLCARRIERS

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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 in^3**	7.2 L	**439 in^3**	11.1 L	**677 in^3**
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.

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	m^3	3.80	3.80	4.00	4.00	4.20	4.20	4.60	4.60	—
	yd^3	**4.97**	**4.97**	**5.23**	**5.23**	**5.49**	**5.49**	**6.02**	**6.02**	**—**
Capacity — 110%	m^3	4.18	4.18	4.40	4.40	4.62	4.62	5.06	5.06	—
	yd^3	**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						
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	5.40	5.40	5.70	5.70	6.00	6.00	—
	yd^3	**7.06**	**7.06**	**7.46**	**7.46**	**7.85**	**7.85**	**—**
Capacity — 110%	m^3	5.94	5.94	6.27	6.27	6.60	6.60	—
	yd^3	**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	m^3	5.70	5.70	4.40	4.40	8.20	5.70	5.70	—
	yd^3	**7.46**	**7.46**	**5.75**	**5.75**	**10.73**	**7.46**	**7.46**	**—**
Capacity — 110%	m^3	6.27	6.27	4.84	4.84	9.02	6.27	6.27	—
	yd^3	**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	m^3	4.48	4.31	5.66	5.38	5.38	5.41	—
	yd^3	**5.86**	**5.64**	**7.40**	**7.03**	**7.03**	**7.07**	**—**
Capacity — 110%	m^3	4.93	4.75	6.22	5.91	5.91	5.95	—
	yd^3	**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.

Bucket Type			Standard 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 (§)		m^3	10.7	11.5	12.3	10.7	11.5	10.7	10.7
		yd^3	**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 (§)		m^3	8.9	9.5	10.2	8.9	9.5	8.9	8.9
		yd^3	**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 (§)	m^3	10.7	11.5	12.3	10.7	11.5	10.7	10.7
	yd^3	**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 (§)	m^3	8.9	9.5	10.2	8.9	9.5	8.9	8.9
	yd^3	**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

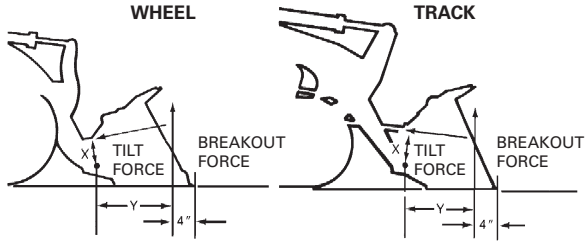
a. "Raise Time" — Time in seconds required to raise the bucket from level position on the ground.
b. "Lower Time" — Time in seconds required to lower the empty bucket from the full height to a level position on the ground.
c. "Dump Time" — Time in seconds required to move the bucket at maximum height 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.

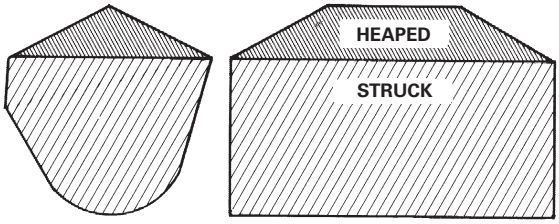
The following are illustrations used (according to provisions of SAE J732 JUN92) to measure Cat Loader breakout forces.



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.

$$\textit{Cycles per hour at 100\% Efficiency} = \frac{60\ \text{min}}{\textit{Total Cycle Time in Minutes}}$$

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.

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 × 3 m^3 = 2.75 Loose m^3 delivered per cycle.
0.90 × 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: $\frac{450 \text{ tons/hr}}{1.66 \text{ tons/m}^3} = 271 \text{ m}^3\text{/hr}$

English: $\frac{496 \text{ tons/hr}}{1.4 \text{ tons/yd}^3} = 354 \text{ yd}^3\text{/hr}$

Volume Required per Cycle

Metric: $\frac{271 \text{ m}^3\text{/hr}}{100 \text{ cycles/hr}} = 2.71 \text{ m}^3\text{/cycle}$

English: $\frac{354 \text{ yd}^3\text{/hr}}{100 \text{ cycles/hr}} = 3.54 \text{ yd}^3\text{/cycle}$

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)

$\frac{2.71 \text{ m}^3\text{/cycle}}{0.95 \text{ fill factor}} = 2.85 \text{ m}^3$

$\frac{3.54 \text{ yd}^3\text{/cycle}}{0.95 \text{ fill factor}} = 3.73 \text{ yd}^3$

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 $m^3 \times 1660 \text{ kg/m}^3 = 4814$ kg
(3.75 $yd^3 \times 2800$ lb/$yd^3 = 10{,}500$ 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.

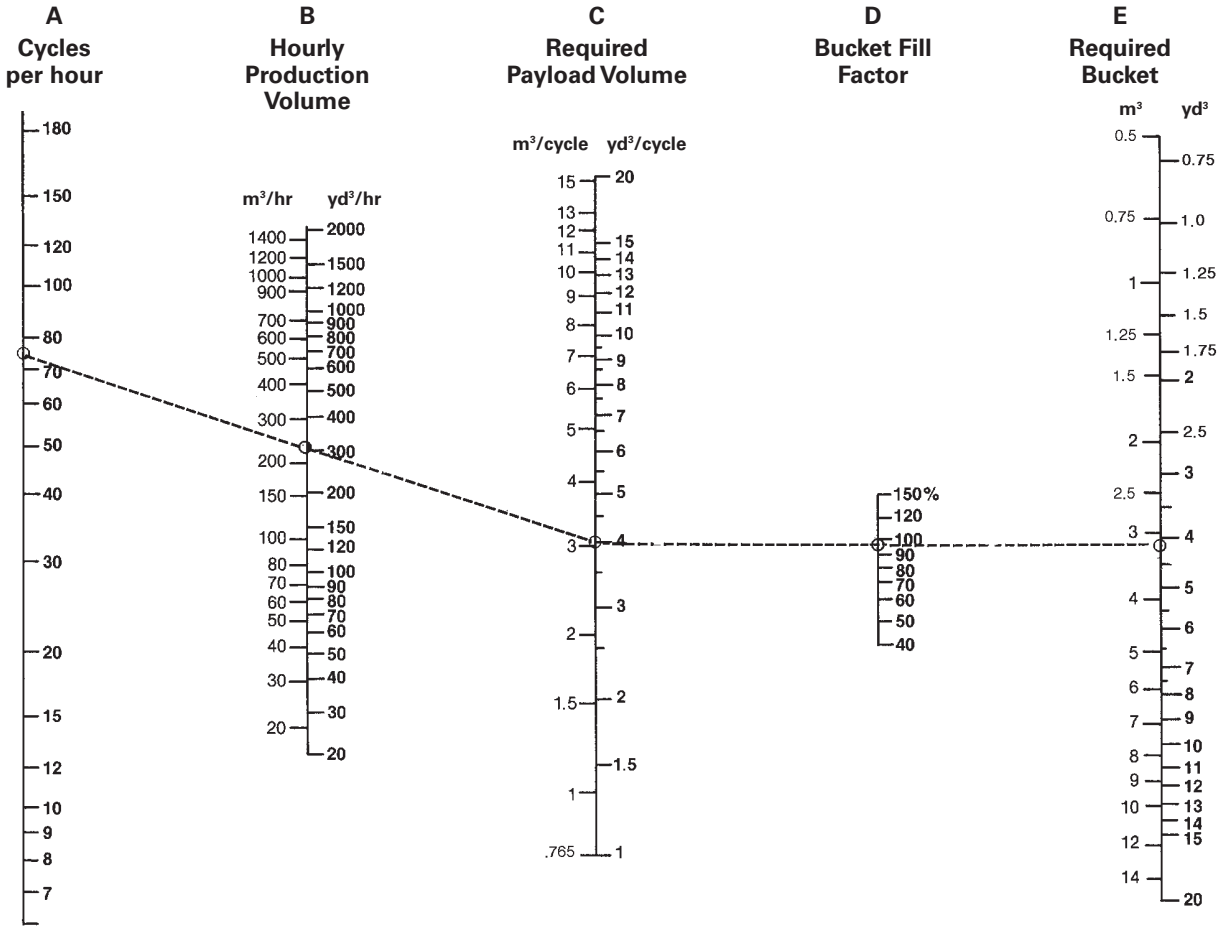
Solution:

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

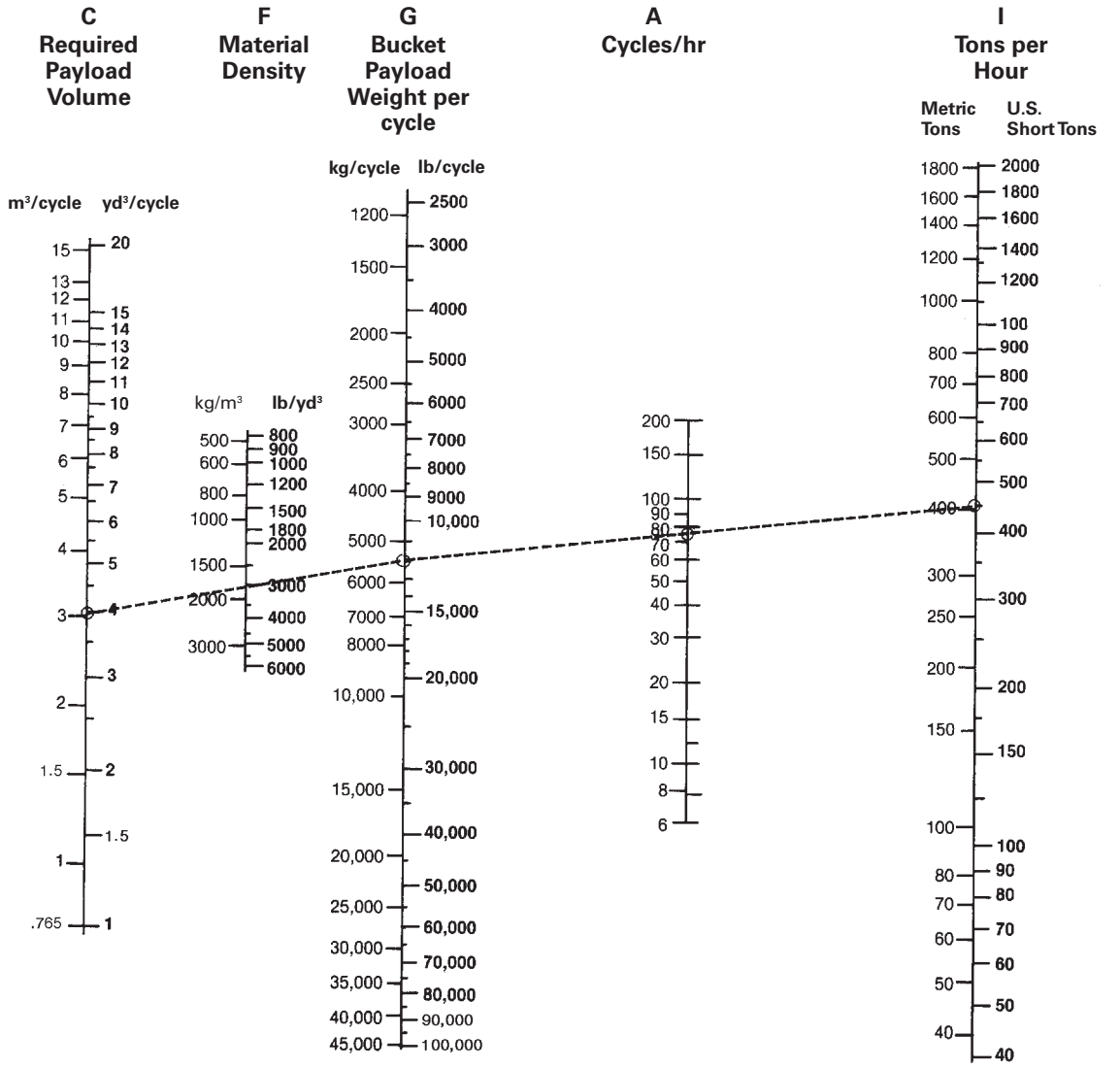
1. Enter required hourly production on Scale B 230 m^3/hr (300 yd^3/hr).
2. Enter cycles per hour on Scale A (60 ÷ .6 = 100 × .75 = 75 cycles/hr).
3. Connect A through B to C. This shows a required payload of 3 m^3 (4 yd^3) per cycle.
4. Enter estimated bucket fill factor on Scale D (0.95).
5. Connect 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	m^3	yd^3	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**

MINING AND EARTHMOVING

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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)?

Loose = Bank × (1 + Swell) =
1000 BCM × (1 + 0.2) = 1200 LCM
1308 BCY × (1 + 0.2) = 1570 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%.

Bank = Loose ÷ (1 + Swell) =
1000 LCM ÷ (1 + 0.25) = 800 BCM
1308 LCY ÷ (1 + 0.25) = 1046 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. $\text{Load} = \dfrac{\text{Weight of load}}{\text{Bank density}}$

$$= \frac{42{,}000 \text{ lb}}{3125 \text{ lb/BCY}} = 13.4 \text{ BCY}$$

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. $\text{Load} = \dfrac{\text{Weight of load}}{\text{Bank density}}$

$$= \frac{19\,050 \text{ kg}}{1854 \text{ kg/BCM}} = 10.3 \text{ BCM}$$

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.

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.

$$\frac{\text{4.6 m (rise)}}{\text{53.3 m (horizontal distance)}} = 8.6\%\ \text{grade}$$

$$\frac{\text{15 ft (rise)}}{\text{175 ft (horizontal distance)}} = 8.6\%\ \text{grade}$$

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.

● ● ●

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.

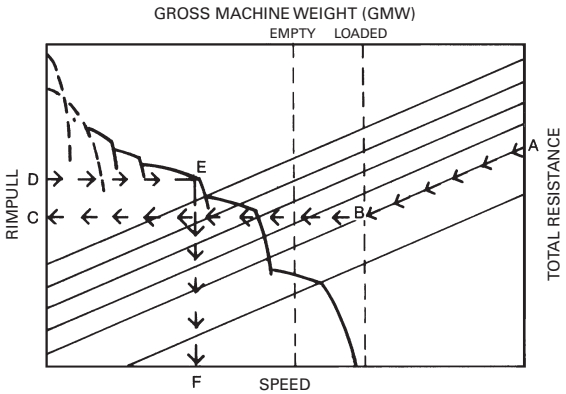
The Tables Section gives the altitude deration in percent of flywheel horsepower for current machines. It should be noted that some turbocharged engines can operate up to 4570 m (15,000 ft) before they require derating. Most machines are engineered to operate up to 1500-2290 m (5000-7500 ft) before they 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.

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?

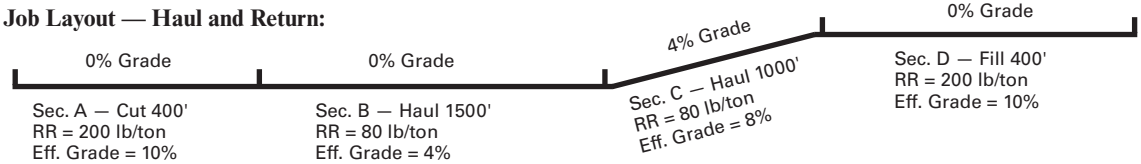
Equipment:

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

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 (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%
D9T — 100%
12H — 83%
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 = 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.

●●●

Example problem (Metric)

A contractor is planning to put the following spread on a dam job. What is the estimated production?

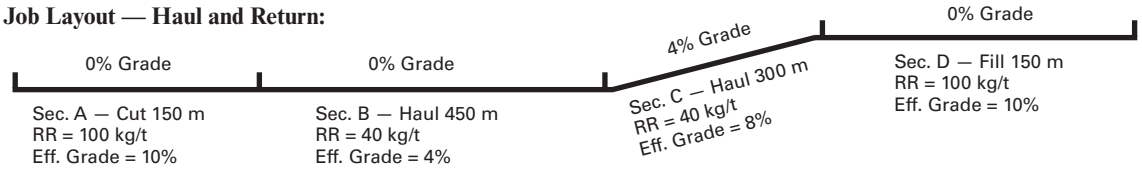
Equipment:

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 time*, 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.

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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

$$\textit{Load Factor (L.F.)} = \frac{100\%}{100\% + \%\ \text{swell}}$$

Load (bank measure) = Loose cubic meters (LCM) × L.F.

= Loose cubic yards (LCY) × L.F.

$$\textit{Shrinkage Factor (S.F.)} = \frac{\text{Compacted cubic meters (or yards)}}{\text{Bank cubic meters (or yards)}}$$

Density = Weight/Unit Volume

$$\textit{Load (bank measure)} = \frac{\text{Weight of load}}{\text{Bank density}}$$

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

$$\textit{Travel Time} = \frac{\text{Distance (m)}}{\text{Speed (m/min)}}$$

$$= \frac{\text{Distance (ft)}}{\text{Speed (fpm)}}$$

$$\textit{Cycles per hour} = \frac{60\ \text{min/hr}}{\text{Total cycle time (min/cycle)}}$$

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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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.

Appendix B.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 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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(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.

Layne Christensen Company
12030 E. Riggs Road
Chandler, Arizona 85249
Office: 480.895.9336
Fax: 480.895.9336

Estimate

Company:	**Freeport McMoRan Tyrone**	**Date:**	**July 31, 2018**
Contact:	**David Princehouse**	**Project:**	**Tyrone Hole Abandonment**
Address:	**Box 571 Hwy 90 South**	**Location:**	**Tyrone Mine**
City:	**Tyrone**	**Estimated By:**	**Joel Campbell**
State:	**NM**	**Proposal Number:**	**18-000-RC**
Postal Code:	**88065**	**Estimated Footage:**	**1,500 feet**
Phone:	**575 912 5752**	**Number of Holes:**	**1**
Cell:	**575 654 5246**	**Max. Depth:**	**1,500 feet**
Email:	dprinceh@fmi.com	**Average Depths:**	**1,500 feet**

HAMMER DRILLING	RATE PER HOUR	
FOOTAGE RANGE	**Hole Size**	**Hourly**
0-1,500 Feet	5.5-inch	$375.00

MOB / DEMOB	LUMP SUM	HOURLY
*MOBILIZATION	$5,000.00	
DEMOBILIZATION	$5,000.00	

ADDITIONAL EQUIPMEN	PER MONTH	PER HOUR
FORKLIFT RENTAL		N/A
AUX. AIR OP RATE	N/A	$20.00

PER DIEM CHARGE	PER MAN/PER DAY
3 MAN CREW	$85.00

FUEL	RATE
SUPPLIED BY TYRONE	COST

CREW TRAVEL TIME	RATE
Included in Footage Rate	N/C

OPERATING HOURLY RIG RATE ACTIVITIES	PER HOUR
DRILL HOLE ABANDONMENT	$375.00

STANDBY HOURLY RIG RATE ACTIVITIES	PER HOUR
CLIENT DIRECTED STANDBY WITH CREW	$300.00
WEATHER DELAY- NON OPERATING RATE	$300.00

SUPPLIES	RATE
CEMENT 47lb BAG EACH	$7.61
ABANTONITE 50lb BAG EACH	$16.00
LOST TOOLING / DRILL STEEL	Cost
DRILLING FLUID ADDITIVES	Cost plus 10%
OTHER MATERIALS / SUPPLIES AS NEEDED	Cost plus 10%

PROPOSED LAYNE SUPPLIED RC DRILLING EQUIPMENT:

One (1) Schramm 450 Track Rotary rig complete with 1,500 ft. of drill pipe, conventional downhole hammer, bit and tool subs, lubricants, wet rotary splitter, and tools necessary
One (1) 4 X 4 water truck with 1,600 gallon capacity.
One (1) 4 X 4 pipe truck
CREW: One (1) Driller; Two (2) Helpers
One (1) Ford F-250 4 x 4 Crew truck

BID CONDITIONS:
- RIG WILL WORK 1 (ONE) - 12 HOUR SHIFT PER DAY ON A 10 DAYS ON WITH 4 DAYS OFF SCHEDULE OR AS AGREED BY THE PARTIES.
- WATER SUPPLY, ACCESS, DRILL SITES, AND ALL REQUIRED PERMITS ARE THE RESPONSIBILITY OF THE

Layne Christensen Company
12030 E. Riggs Road
Chandler, Arizona 85249
Office: 480.895.9336
Fax: 480.895.9536

Estimate

Company:	**Freeport McMoRan Tyrone**	**Date:**	**July 31, 2018**
Contact:	**David Princehouse**	**Project:**	**Tyrone Hole Abandonment**
Address:	**Box 571 Hwy 90 South**	**Location:**	**Tyrone Mine**
City:	**Tyrone**	**Estimated By:**	**Joel Campbell**
State:	**NM**	**Proposal Number:**	**18-000-RC**
Postal Code:	**88065**	**Estimated Footage:**	**1,500 feet**
Phone:	**575 912 5752**	**Number of Holes:**	**1**
Cell:	**575 654 5246**	**Max. Depth:**	**1,500 feet**
Email:	dprinceh@fmi.com	**Average Depths:**	**1,500 feet**

Description	Quantity	Unit	Cost	Total
Mobilization and Moving				
Move Rig and Equipment	1	LS	$5,000.00	$5,000.00
De -Mobilize Rig and Equipment	1	LS	$5,000.00	$5,000.00
Move between holes 12hrs / move		HR	$375.00	$0.00
			Job Total	**$10,000.00**
Abandon 1 x 5.5-inch Hole to 1,500 Feet				
Mix and Pump Cement Grout Whilst Pulling Rods	6	HR	$375.00	$2,250.00
Cement Materials	454	Bag	$7.61	$3,454.94
Sundry Materials Supplied - cost plus 15%				$0.00
				$0.00
				$0.00
				$0.00
			Total 1 Well	**$5,704.94**

July 31, 2018

To: David Princehouse
Tyrone Mining NM

Re: Abandonment of Exploration Holes

Layne intends to abandon the exploration holes drilled for Tyrone Mining for the RC Exploration program adhering to the following procedures

1. Upon reaching total depth the hole will be backfilled filling from the bottom up through the drill rods with a neat cement grout.

2. Verification of proper sealing is that the volume of sealing material placed in the hole during abandonment operations equals or exceeds the volume of the borehole to be filled and sealed

Regards



Audie Medhurst
General Manager, Mineral Exploration
Mineral Services Western US
LAYNE | water + mineral + energy
12030 E. Riggs Road | Chandler, AZ | 85249
Office: 602-824-0934 | Cell: 602-359-3010
audie.medhurst@layne.com | **layne.com**

August 23, 2011
Revised August 25, 2011

Kurt Stauder
Telesto Solutions, Inc.
2950 E. Harmony Rd. Suite 200
Fort Collins, CO 80528
Phone: (970) 484-7704

Wilcox
PROFESSIONAL SERVICES
CREATING INDUSTRY LEADING RESULTS
1055 S 63rd Avenue
Phoenix, Arizona 85043
t 602.442.0667 | f.602.442.0669

RE: Shramrock Exploration Project
Silver City, New Mexico
Wilcox Proposal No.: 14.00645

Via Email: kstauder@telesto-inc.com

Dear Mr. Stauder:

Wilcox Professional Services, LLC (Wilcox) is pleased to submit this proposal to provide exploratory drilling services in connection with the Shamrock Exploration Project located West of Silver City, New Mexico. Wilcox appreciates this opportunity and looks forward to working with you to make this a successful endeavor for all involved.

This proposal is based upon scope of work and bid sheets dated August 23, 2011 and are subject to negotiations between Wilcox and Hoffman Consulting & NV Gold Corp. (Client), if needed.

Drilling Scope of Work:

- Consists of 10 to 25 exploration holes to an anticipated depth of 300' each
- Reverse Circulation (RC)
- Vertical holes
- Schedule and Crew: One 12 hr. shift per day, drill till complete
- Commence October 2011

It is understood that to facilitate this drilling program the Client will provide the following at no cost to Wilcox:

- A suitable water supply (if required)
- Full time on site Geologist capable of making decisions on program to avoid delays
- Legal access to the site from public roads
- Staging area for unloading and loading equipment
- Drill pad construction and reclamation (if required)
- Road and mud pit construction and reclamation (if required)
- Any bonding and all permitting fees (if required)

The Client will be responsible for reimbursing Wilcox for the following items at suppliers' list price plus 10 percent (10%). Client may provide certain items as mutually agreed.

- Drilling mud and additives
- Cement and cementing services
- Chip boxes and lids, sample bags and marker blocks
- Special tools or drilling accessories, rig well for testing purposes or which may be a lift in the hole upon client request
- All casing shoes
- Down Hole Survey Interment (Reflex EZ-SHOT or equivalent)

- Core drilling bits, reamers and tricones
- Casing lost/left in holes or recovered but damaged
- All materials lost in the hole
- Sump liners/tank, if required
- Sanitary facilities
- Disposal of all liquids and solid waste generated on site
- Other items as negotiated

Wilcox will provide specialized equipment and services for completion of your drilling program, including in Drilling Unit Price:

- 1 RC Drill Rig
- RC Drilling System
- MSHA Certified Drill Crews (2 man)
- Water transport (if required)
- Support equipment (welding, pickup & tools)

General Provisions

a. Lost Materials

In the event that drill rods, casing, or other equipment become lost, broken, or stuck in the hole while drilling at the footage rates, the Client agrees to reimburse the Contractor at field cost rates. These rates will include time and materials expended in recovery attempts. If materials are unrecoverable, the Contractor shall be reimbursed for same at replacement cost.

b. Unsatisfactory Progress In Hole and Hole Abandonment

In the event that excessive water flows, cavities, loose, swelling, caving materials, or hole stability problems are encountered, and they prevent the completion or satisfactory progress of a hole the Contractor does not guarantee to drill to a predetermined depth. If it becomes necessary to abandon the hole the Contractor shall charge the Client for the holes abandoned. Such charges will include the depth of abandonment and the rates specified in our proposal. If the Client requests the Contractor to proceed in the hole, the Contractor has the option to revert to the operating field cost rates plus all materials, supplies, and equipment required at replacement cost plus ten percent (10%). These charges will be subject to the Client's approval.

c. Field Cost Definitions

1. Operating

   It is agreed that the operating rates shall include the labor of a regular three-man crew per shift, and drill and support equipment rental. The cost of rods, casing, below-the-head consumables, and other materials and supplies consumed onsite shall be charged to the Client at cost plus ten percent (10%).

   In the event that extra labor over and above the regular two-man crew per shift is utilized, the Contractor agrees to supply such additional labor at the rates specified in Bid Prices, Section 5.

2. Non-Operating (Standby)

   It is agreed that the non-operating rates shall prevail when work is interrupted due to delays not caused by the Contractor, or delays beyond his control.

Pricing of Services

3000 ft Estimate

Item	Quantity	Unit	Cost	Price
DRILLING COSTS				
Mobilization	1	LS	5,000	$5,000.00
Demobilization	1	LS	5,000	$5,000.00
SURFACE CASING				
Vertical Casing Advancement Drilling	40	HR	150	$6,000.00
DRILLING WITH DOWN HOLE HAMMER				
Vertical DHH Drilling; 5 1/2" Borehole, 0'-Up to 300'	300	FT	32	$96,000.00
RIG TIME OTHER THAN DRILLING - OPERATING				
Plugging	100	HR	150	$15,000.00
RIG TIME OTHER THAN DRILLING - NON-OPERATING				
Move-on, Set-up, Take-down Between Holes	50	HR	150	$7,500.00
MATERIALS				
Portland Cement; 97lb. Sack	700	EA	15	$10,500.00
Bentonite- AquaGuard or e; 50lb. Sack	90	EA	25	$2,250.00
DAILY CHARGES				
Daily Crew Travel and/or Per Diem (Per Shift)	25	EA	300	$7,500.00
Stand-by Time	25	HR	150	$3,750.00
Contingency			10%	$15,000.00
		Total		$173,500

4500 ft Estimate

Item	Quantity	Unit	Cost	Price
DRILLING COSTS				
Mobilization	1	LS	5,000	$5,000.00
Demobilization	1	LS	5,000	$5,000.00
SURFACE CASING				
Vertical Casing Advancement Drilling	50	HR	150	$7,500.00
DRILLING WITH DOWN HOLE HAMMER				
Vertical DHH Drilling; 5 1/2" Borehole, 0'-Up to 300'	4500	FT	30	$135,000.00
RIG TIME OTHER THAN DRILLING - OPERATING				
Plugging	125	HR	150	$18,750.00
RIG TIME OTHER THAN DRILLING - NON-OPERATING				
Move-on, Set-up, Take-down Between Holes	100	HR	150	$15,000.00
MATERIALS				
Portland Cement; 97lb. Sack	1000	EA	15	$15,000.00
Bentonite- AquaGuard or e; 50lb. Sack	100	EA	25	$2,500.00
DAILY CHARGES				
Daily Crew Travel and/or Per Diem (Per Shift)	35	EA	300	$10,500.00
Stand-by Time	35	HR	150	$5,250.00
Contingency			10%	$20,000.00
		Total		$239,500.00

This proposal is not a binding contract. It is a submission for information purposes only and until bound by a contract, is subject to revision by either party.

ASSUMES FULL CHARGE

7500 ft Estimate

Item	Quantity	Unit	Cost	Price
DRILLING COSTS				
Mobilization	1	LS	5,000	$5,000.00
Demobilization	1	LS	5,000	$5,000.00
SURFACE CASING				
Vertical Casing Advancement Drilling	50	HR	125	$6,250.00
DRILLING WITH DOWN HOLE HAMMER				
Vertical DHH Drilling; 5 1/2" Borehole, 0'-Up to 300'	7500	FT	27.5	$206,250.00
RIG TIME OTHER THAN DRILLING - OPERATING				
Plugging	150	HR	125	$18,750.00
RIG TIME OTHER THAN DRILLING - NON-OPERATING				
Move-on, Set-up, Take-down Between Holes	100	HR	125	$12,500.00
MATERIALS				
Portland Cement; 97lb. Sack	1500	EA	15	$22,500.00
Bentonite- AquaGuard or e; 50lb. Sack	125	EA	25	$3,125.00
DAILY CHARGES				
Daily Crew Travel and/or Per Diem (Per Shift)	50	EA	300	$15,000.00
Stand-by Time	50	HR	150	$6,250.00
Contingency			10%	$30,000.00
			Total	$330,625.00

$1.5/ft

$\frac{\$18,750}{7,500\ ft} = 2.5$

$\frac{\$22,500}{7500} = 3$

≈ $1

3 $1

≈ $9/FT

Wilcox Professional Services 2011 Billing Rates

Standard Hourly Rates are set forth in this Exhibit and include salaries and wages paid to Personnel in each billing class plus the cost of customary and statutory benefits, general Administrative overhead, non-project operating costs, and operating margin or profit.

Personnel

Project Director ..... $190.00/per hour

Project Manager / Sr. Professional ..... $150.00/per hour

Project Engineer / Surveyor ..... $130.00/per hour

Sr. Technician / Sr. Designer ..... $110.00/per hour

Technician / CAD Drafter ..... $90.00/per hour

Superintendent..... $150.00/per hour

Survey Crew..... $150.00/per hour

Clerical ..... $60.00/per hour

Outside Consultants (Client Authorized)

Coordination at Personnel Hourly Rates listed above Cost + 10%

This proposal is not a binding contract. It is a submission for information purposes only and until bound by a contract, is subject to revision by either party.

Wilcox will require a deposit amount of $30,000.00 be received upon authorization of the contract to hold the drilling rig, crew and equipment. The deposit will be applied towards the final invoice. A 15 days notice to prepare and transport rig to project site will also be required.

We appreciate your confidence in Wilcox and look forward to working with you on this and other projects. Thanks again for this opportunity to submit out proposal. Wilcox is ready to commence work upon receipt of authorization. If you have questions, please do not hesitate to call me at 602-442-0667.

Sincerely,
WILCOX PROFESSIONAL SERVICES, LLC

Richard D. Wilcox, P.E.
President

Enclosures

CC:

This proposal is not a binding contract. It is a submission for information purposes only and until bound by a contract, is subject to revision by either party.

O'KEEFE DRILLING

P.O. Box 3810 ~ Butte, MT 59702
Office: (406) 494-3310 Fax: (406) 494-3301
Email: info@okeefedrilling.com

Item	Description	Unit	Estimated Quantity	Unit Cost	Total
Drilling					
1	Mobilization/ Demobilization (RC/ Dual Rotary)	LS	1	$ 7,000.00	$ 7,000.00
2	Mobilization-Pump Truck	LS	1	$ 2,500.00	$ 2,500.00
3	Set-up between holes	Each	54	$ 1,500.00	$ 81,000.00
4	Decontamination-Drilling	LS	54	$ 1,000.00	$ 54,000.00
5	Drilling (Pilot Holes-Mud Rotary)*	Ft	3600	$ -	$ -
6	Abandonment-Pilot Holes	Ft	3600	$ -	$ -
7	Drilling (Reverse Circulation)	Ft	4650	$ 34.00	$ 158,100.00
8	Drilling (Dual Rotary)	Ft	4650	$ 40.00	$ 186,000.00
9	4-inch SCH-40 PVC Well - Installed				$ -
	Screen	Ft	1080	$ 65.00	$ 70,200.00
	Sand (5' above screen)	Ft	1350	$ 55.00	$ 74,250.00
	Blank Casing	Ft	8220	$ 12.00	$ 98,640.00
	Grout	Ft	7950	$ 6.00	$ 47,700.00
10	Surface Completion	Each	54	$ 375.00	$ 20,250.00

Well Development and Sampling					
11	Well Development	Hour	400	$ 165.00	$ 66,000.00
12	Decontamination-Development	LS	54	$ 165.00	$ 8,910.00
13	Stand-by Time (Pump Truck)	Hour		$ 115.00	$ -
14	Per diem	Day	113	$ 275.00	$ 31,075.00
15	Stand-by Time (Drill Rig)	Hour		$ 220.00	$ -
16	Interm Travel	Per Hour	96	$ 100.00	$ 9,600.00
				Total	$ 915,225.00

Note: The Mud Rotary Drilling will be drilled by others

$59300

$100/ft

Appendix B.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

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

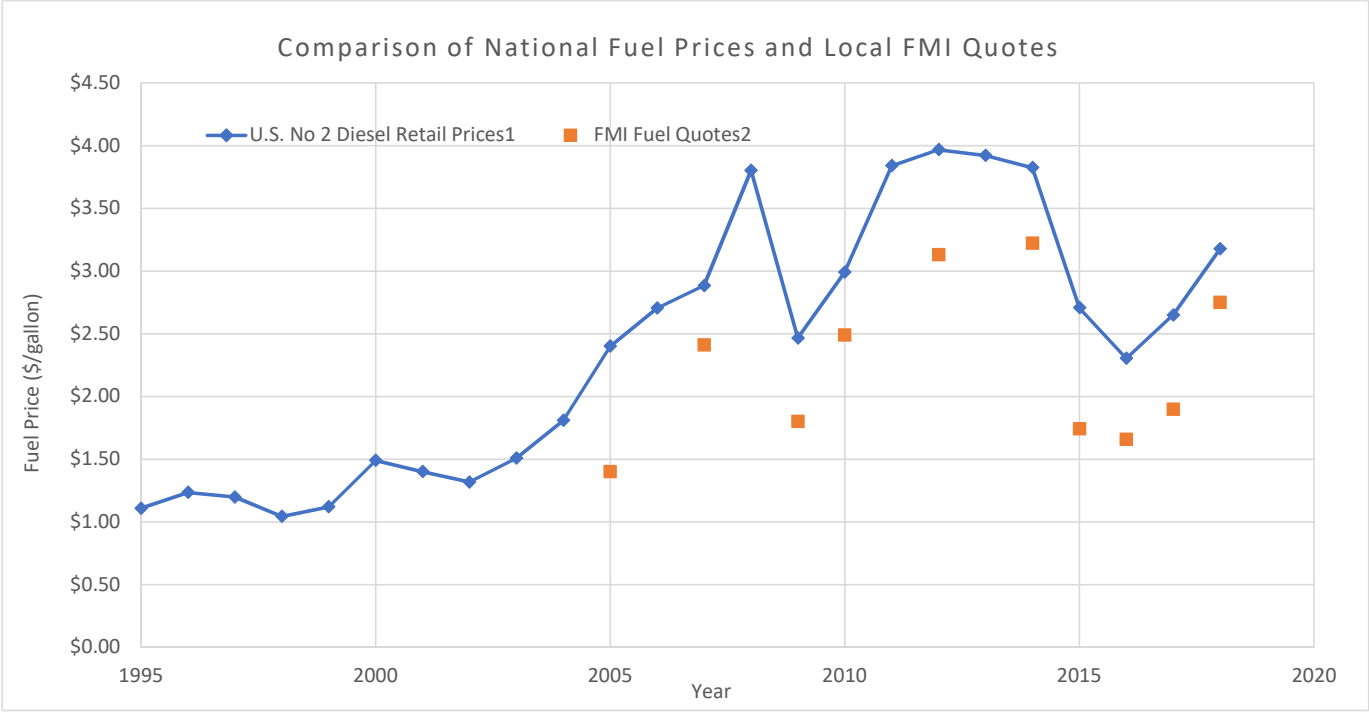
FMI Fuel Quotes[2]			
Site	Date	Dyed, low-sulfur diesel	Notes
Continental	1/21/2005	$1.40	Tom Shelley - quote from fuel broker
Chino & Tyrone	5/9/2007	$2.41	Porter Oil Quote (7500 gal capacity)
Continental	1/23/2009	$1.80	Porter Oil Quote (7500 gal capacity)
Tyrone (Little Rock)	1/14/2010	$2.49	Porter 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)

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

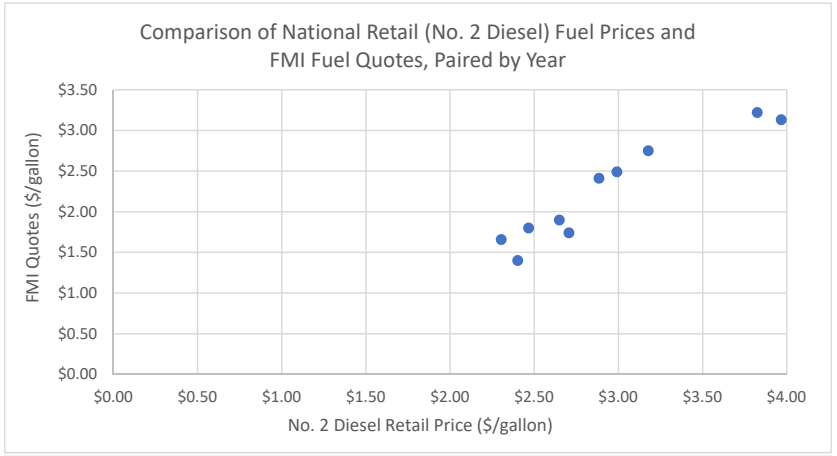
Correlatior 0.952

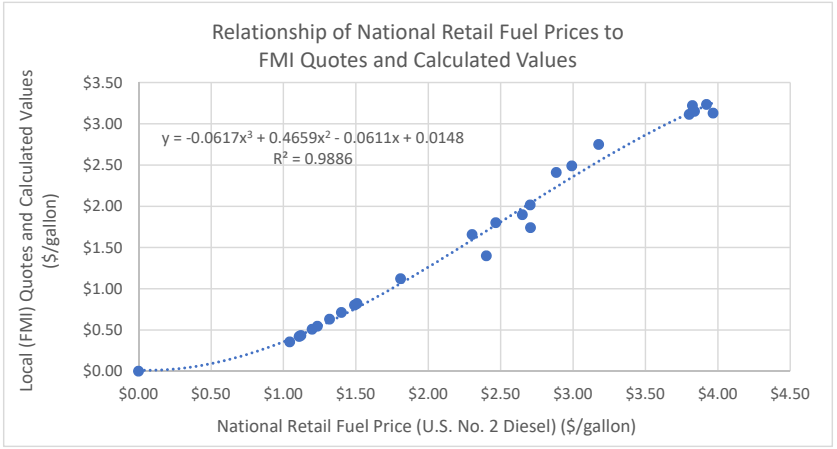


1. U.S. Energy Information Administration
http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M
2. Quotes obtained from Freeport-McMoRan (FMI)

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 = -0.0617x3 + 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			





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
	Jan 2019	$2.98	$2.34

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)

Appendix C

Engineering Take-offs

APPENDIX C.1
REGRADE ESTIMATES
PROVIDED BY MWH

TYRONE MINE STOCKPILE CONCEPTUAL RECLAMATION PLAN
Quantities

Note: Updated channel and downdrain lengths (by Stantec, 5/1/19) are included in this section.

Area		Task	Length (ft)	Volume (cy)	Area (ac)	Dozer Work Distance (ft)	Dozer Work Slope (%)	Haul Leg 1 Distance (ft)	Haul Leg 1 Grade (%)	Haul Leg 2 Distance (ft)	Haul Leg 2 Grade (%)	Haul Leg 3 Distance (ft)	Haul Leg 3 Grade (%)
1A and 1B Leach	Exterior Slope	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		140,000		250	-29						
		Regrade benches from truck/shovel pullback		1,329,670	240	90	-29						
		Terrace Bench Construction	44,800										
		Cover Placement (Haul)		1,239,000	256			2,320	2.2%	2,170	7.8%	1,770	0.0%
		Cover Placement (Placement)		1,239,000	256	600	-29						
		Terrace Channel Construction	45,200										
		Terrace Gravel Placement		17,600									
		Down Drain Construction	3,727										
		Down Drain Riprap Placement		15,200									
		Down Drain Bedding Layer		2,600									
		Channel Construction	4,813										
		Channel Riprap Placement		7,100									
		Channel Bedding Layer		3,600									
		Revegetation			256								
		Infrastructure Relocation	n/a										
1A and 1B Leach	Top	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		79,000		430	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		82,300	17			2,320	2.2%	2,170	7.8%	1,770	0.0%
		Cover Placement (Placement)		82,300	17	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gavel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	5,980										
		Channel Riprap Placement		10,000									
		Channel Bedding Layer		5,100									
		Revegetation			17								
		Infrastructure Relocation	n/a										
2A Leach and 2B Waste	Exterior Slope	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		8,060,000		470	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	58,600										
		Cover Placement (Haul)		2,182,800	451			7,780	0.8%	6,580	1.4%	4,940	6.9%
		Cover Placement (Placement)		2,182,800	451	600	-29						
		Terrace Channel Construction	58,600										
		Terrace Gravel Placement		22,800									
		Down Drain Construction	7,999										
		Down Drain Riprap Placement		32,700									
		Down Drain Bedding Layer		5,600									
		Channel Construction	10,950										
		Channel Riprap Placement		14,000									
		Channel Bedding Layer		7,100									
		Revegetation			451								
		Infrastructure Relocation	n/a										
2A Leach and 2B Waste	Top/Flat Area	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		143,000		370	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		174,200	36			7,780	0.8%	6,580	1.4%	4,940	6.9%
		Cover Placement (Placement)		174,200	36	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	n/a										
		Channel Riprap Placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			36								
		Infrastructure Relocation	n/a										
3A/3B	Exterior Slope	Truck/Shovel Pull Back		17,500,000				3,900	-				
		Dozer Rough Grade		3,500,000		560	-29						
		Regrade benches from truck/shovel pullback		1,590,064	287	90	-29						
		Terrace Bench Construction	65,200										
		Cover Placement (Haul)		2,042,500	422			4,411	-7.0%	6,810	6.6%		
		Cover Placement (Placement)		2,042,500	422	600	-29						
		Terrace Channel Construction	65,200										
		Terrace Gravel Placement		25,400									
		Down Drain Construction	6,069										
		Down Drain Riprap Placement		24,800									
		Down Drain Bedding Layer		4,300									
		Channel Construction	1,010										
		Channel Riprap placement		1,200									
		Channel Bedding Layer		600									
		Revegetation			422								
		Infrastructure Relocation	n/a										
3A/3B	Top	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		199,000		560	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		159,700	33			4,411	-7.0%	6,810	6.6%		
		Cover Placement (Placement)		159,700	33	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Channel Construction	0										
		Channel Riprap placement		3,500									
		Channel Bedding Layer		1,800									
		Revegetation			33								
		Infrastructure Relocation	n/a										
5A	Exterior Slope	Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		6,300,000		540	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	44,000										
		Cover Placement (Haul)		1,490,700	308			1,450	6.2%	3,300	0.0%		
		Cover Placement (Placement)		1,490,700	308	600	-29						
		Terrace Channel Construction	44,000										
		Terrace Gravel Placement		17,100									
		Down Drain Construction	2,754										
		Down Drain Riprap Placement		11,300									
		Down Drain Bedding Layer		1,900									
		Channel Construction	6,330										
		Channel Riprap placement		9,400									
		Channel Bedding Layer		4,700									
		Revegetation			308								
		Infrastructure Relocation	n/a										

Regrade Estimates

Area		Task	Length (ft)	Volume (cy)	Area (ac)	Dozer Work		Haul Leg 1		Haul Leg 2		Haul Leg 3	
						Distance (ft)	Slope (%)	Distance (ft)	Grade (%)	Distance (ft)	Grade (%)	Distance (ft)	Grade (%)
5A	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		413,000		610	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		304,900	63			1,450	6.2%	3,300	0.0%		
		Cover Placement (Placement)		304,900	63	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	500										
		Channel Riprap placement		5,200									
		Channel Bedding Layer		2,700									
		Revegetation			63								
		Infrastructure Relocation	n/a										
San Salvador Pit													
		Truck/Shovel Pit Backfill		3,500,000				1,300	-1				
		Dozer Rough Grade		1,600,000		185	-5						
		Regrade benches from truck/shovel pullback											
		Terrace Bench Construction	4,700										
		Cover Placement (Haul)		556,600	115			7,780	0.8%	3,020	9.9%	1,770	-9.6%
		Cover Placement (Placement)		556,600	115	150	-5						
		Terrace Channel Construction	4,700										
		Terrace Gravel Placement		1,800									
		Down Drain Construction	1,227										
		Down Drain Riprap Placement		5,000									
		Down Drain Bedding Layer		900									
		Channel Construction	4,117										
		Channel Riprap placement		7,800									
		Channel Bedding Layer		3,900									
		Revegetation			115								
		Infrastructure Relocation	n/a										
Savanna Pit	(Backfill)	Flat Area (In-Pit Stockpile)											
		Truck/Shovel	n/a										
		Dozer Rough Grade		350,000		500	1						
		Dozer Rough Grade (Slopes)		135,000		160	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		314,600	65			5,730	1.6%				
		Cover Placement (Placement)		314,600	65	200	-5						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	n/a										
		Channel Riprap placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			65								
		Drilling and Blasting	n/a										
		Infrastructure Relocation	n/a										
4C	Exterior Slopes												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		2,700,000		430	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	16,100										
		Cover Placement (Haul)		822,800	170			7,780	0.8%	3,020	9.9%	7,030	2.6%
		Cover Placement (Placement)		822,800	170	500	-29						
		Terrace Channel Construction	16,100										
		Terrace Gravel Placement		6,300									
		Down Drain Construction	3,125										
		Down Drain Riprap Placement		12,800									
		Down Drain Bedding Layer		2,200									
		Channel Construction	3,450										
		Channel Riprap Placement		11,000									
		Channel Bedding Layer		5,600									
		Revegetation			170								
		Infrastructure Relocation	n/a										
4C	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		67,000		480	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		62,900	13			7,780	0.8%	3,020	9.9%	7,030	2.6%
		Cover Placement (Placement)		62,900	13	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	0										
		Channel Riprap Placement		1,600									
		Channel Bedding Layer		800									
		Revegetation			13								
		Infrastructure Relocation	n/a										
2C, 4A, 7B, 4B	Slopes												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		2,300,000		420	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	26,700										
		Cover Placement (Haul)		1,205,200	249			7,780	0.8%	6,210	7.9%		
		Cover Placement (Placement)		1,205,200	249	400	-29						
		Terrace Channel Construction	26,700										
		Terrace Gravel Placement		10,400									
		Down Drain Construction	2,943										
		Down Drain Riprap Placement		12,000									
		Down Drain Bedding Layer		2,100									
		Channel Construction	n/a										
		Channel Riprap placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			249								
		Infrastructure Relocation	n/a										
2C, 4A, 7B, 4B	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		1,003,000		740	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		609,800	126			7,780	0.8%	6,210	7.9%		
		Cover Placement (Placement)		609,800	126	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	6,320										
		Channel Riprap placement		16,600									
		Channel Bedding Layer		8,400									
		Revegetation			126								
		Infrastructure Relocation	n/a										

Regrade Estimates

Area		Task	Length (ft)	Volume (cy)	Area (ac)	Dozer Work		Haul Leg 1		Haul Leg 2		Haul Leg 3	
						Distance (ft)	Slope (%)	Distance (ft)	Grade (%)	Distance (ft)	Grade (%)	Distance (ft)	Grade (%)
6B	Slopes												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		183,000		180	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		72,600	15			7,780	0.8%	2,270	6.2%		
		Cover Placement (Placement)		72,600	15	200	-29						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	800										
		Down Drain Riprap Placement		3,300									
		Down Drain Bedding Layer		600									
		Channel Construction	n/a										
		Channel Riprap placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			15								
		Infrastructure Relocation	n/a										
6B	Flat Area												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		147,000		350	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		188,800	39			7,780	0.8%	2,270	6.2%		
		Cover Placement (Placement)		188,800	39	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	1,550										
		Channel Riprap placement		3,700									
		Channel Bedding Layer		1,900									
		Revegetation			39								
		Infrastructure Relocation	n/a										
6C	Slopes												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		650,000		325	-29						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	4,100										
		Cover Placement (Haul)		271,000	56			7,780	0.8%	4,053	5.9%		
		Cover Placement (Placement)		271,000	56	400	-29						
		Terrace Channel Construction	4,100										
		Terrace Gravel Placement		1,600									
		Down Drain Construction	550										
		Down Drain Riprap Placement		2,200									
		Down Drain Bedding Layer		400									
		Channel Construction	n/a										
		Channel Riprap placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			56								
		Infrastructure Relocation	n/a										
6C	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		19,000		180	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		48,400	10			7,780	0.8%	4,053	5.9%		
		Cover Placement (Placement)		48,400	10	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	8,387										
		Channel Riprap placement		14,400									
		Channel Bedding Layer		7,300									
		Revegetation			10								
		Infrastructure Relocation	n/a										
9A	Exterior Slopes												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade	n/a										
		Regrade benches from truck/shovel pullback		642,674	116	90	-29						
		Terrace Bench Construction	23,700										
		Cover Placement (Haul)	n/a					4,400	2	6,300	1	16,100	1
		Cover Placement (Placement)	n/a			600	-29						
		Terrace Channel Construction	23,700										
		Terrace Gravel Placement		9,200									
		Down Drain Construction	2,300										
		Down Drain Riprap Placement		10,200									
		Down Drain Bedding Layer		1,800									
		Channel Construction	1,448										
		Channel Riprap Placement		2,100									
		Channel Bedding Layer		1,100									
		Revegetation			116								
		Infrastructure Relocation	n/a										
9A	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade		40,000		285	1						
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)	n/a					4,400	2	6,300	1	16,100	1
		Cover Placement (Placement)	n/a			100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	0										
		Channel Riprap Placement		1,400									
		Channel Bedding Layer		700									
		Revegetation			13								
		Infrastructure Relocation	n/a										
1C	Top												
		Truck/Shovel Pull Back	n/a										
		Dozer Rough Grade	n/a										
		Regrade benches from truck/shovel pullback	n/a										
		Terrace Bench Construction	n/a										
		Cover Placement (Haul)		82,300	17			7,780	0.8%	4,053	5.9%		
		Cover Placement (Placement)		82,300	17	100	1						
		Terrace Channel Construction	n/a										
		Terrace Gravel Placement	n/a										
		Down Drain Construction	n/a										
		Down Drain Riprap Placement	n/a										
		Down Drain Bedding Layer	n/a										
		Channel Construction	n/a										
		Channel Riprap Placement	n/a										
		Channel Bedding Layer	n/a										
		Revegetation			17								
		Infrastructure Relocation	n/a										

Area		Task	Length (ft)	Volume (cy)	Area (ac)	Dozer Work Distance (ft)	Dozer Work Slope (%)	Haul Leg 1 Distance (ft)	Haul Leg 1 Grade (%)	Haul Leg 2 Distance (ft)	Haul Leg 2 Grade (%)	Haul Leg 3 Distance (ft)	Haul Leg 3 Grade (%)
Tailing Series 1		Revegetation maintenance			1,547								
Tailing 2		Revegetation maintenance			606								
Tailings 3X		Revegetation maintenance			365								
Tailings 3		Revegetation maintenance			643								
Copper Mountain Pit		Fencing	12,800										
Main Pit		Fencing	25,700										
Savanna Pit		Fencing	8,300										
Gettysburg		Fencing	10,700										

9AX Stockpile Earthwork Volumes July 23, 2014

from Modification to the Closeout Plan GR010RE - Construction of the 9AX Borrow Material Stockpile

Freeport-McMoRan Tyrone Inc.

Description	Location	Area (acre)	Bank/Stockpile Volume (bcy)	Swell Factor (%)	Loose/Stockpile Volume (lcy)
Grade Surface	9AX - North	48	451,017	0%	451,017
Grade Surface	9AX - South	16	150,339	0%	150,339
Grade Cover	9AX - North	48	77,077	0%	77,077
Grade Cover	9AX - South	16	25,692	0%	25,692
Dozer Assist	Borrow	0	102,769	0%	102,769

Total 9AX Stockpile channel length (bench channels), by Stantec (5/1/201 12,300 ft

Dozer Push Estimates

2A 2B		
Section	Push Distance (ft)	Grade (%)
1	149	30
2	600	30
3	600	30
4	543	30
Average	473	30

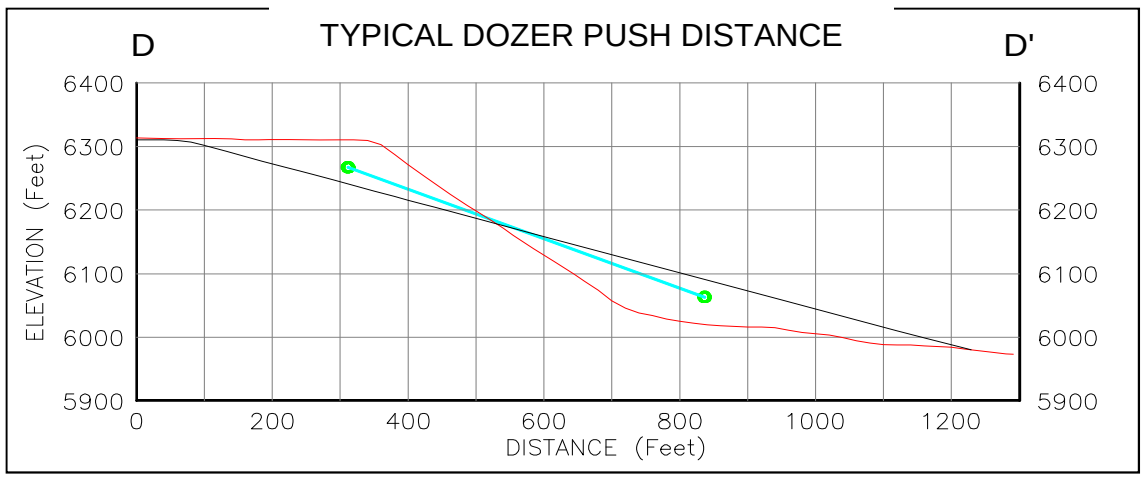
4C		
Section	Push Distance (ft)	Grade (%)
1	529	30
2	328	30
Average	429	30

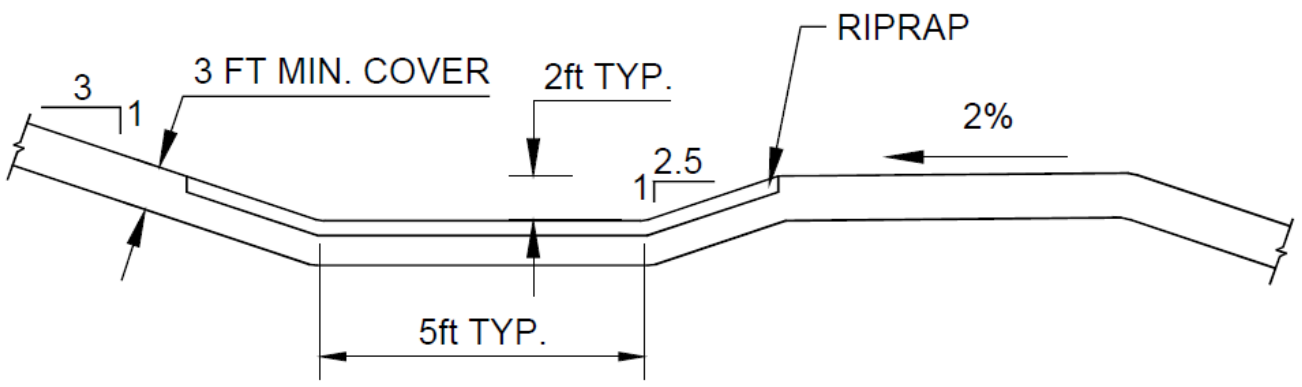
7B		
Section	Push Distance (ft)	Grade (%)
1	231	30
2	600	30
Average	416	30

5A		
Section	Push Distance (ft)	Grade (%)
1	600	30
2	487	30
Average	544	30

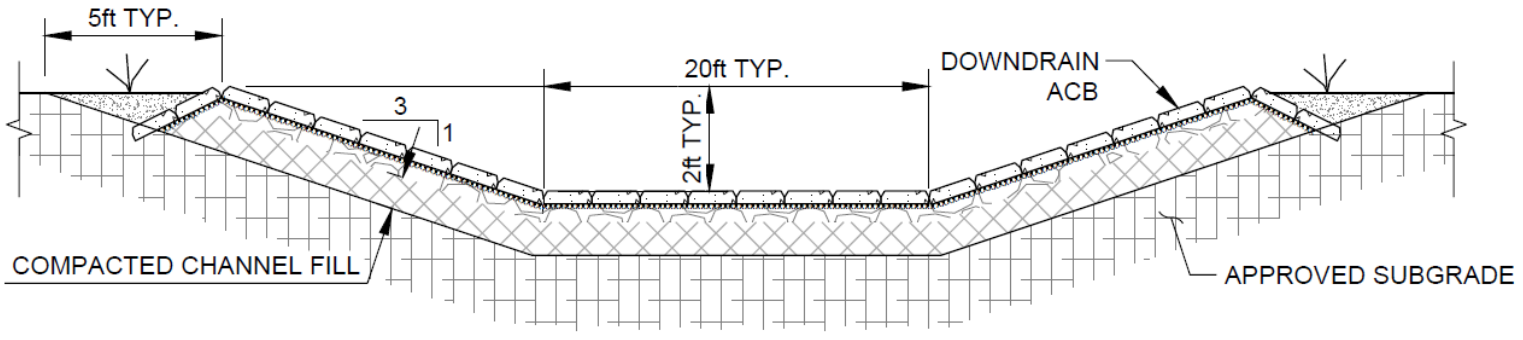
6B		
Section	Push Distance (ft)	Grade (%)
1	180	30
Average	180	30

6C		
Section	Push Distance (ft)	Grade (%)
1	172	30
2	477	30
Average	325	30





TYPICAL SECTION – BENCH AND OTHER CHANNELS



TYPICAL DOWNDRAIN SECTION

APPENDIX C.2
BUILDINGS
PROVIDED BY GOLDER

Post-Mining Land Use Designations of Tyrone Mine Buildings

Tyrone Tag. No.	Description	Dimensions[1]	PMLU	Description
Mine Maintenance Facilities Area				
MM-01	General Office	195-114x23	Industrial	Multiple office space, large open bays
MM-02	Mine Operations Office	254x60x33	Industrial	Multiple office space and change rooms
MM-03	Security	41x26x17	Industrial	Truck Scale
MM-04	Safety Building	80x24x20	Industrial	Multiple office spaces and classrooms
MM-05	Human Resources/Training	102x41x20	Industrial	Multiple office spaces and classrooms
MM-06	Jerome Building	204x63x50	Wildlife Habitat	To Be Demolished
MM-07	Plant Warehouse	250x100x_	Wildlife Habitat	To Be Demolished
MM-08	Truck Shop/ Machine Shop/Welding Shop	344x236x60	Industrial	Overhead Cranes (five 35-ton and one 20-ton)
MM-09	Electric Shop	120x51x50	Wildlife Habitat	To Be Demolished
MM-10	Pipe Shop	145x41x40	Wildlife Habitat	To Be Demolished
MM-11	Carpenter Shop	119x69x27	Wildlife Habitat	To Be Demolished
MM-12	Lumber Storage	102x61x33	Wildlife Habitat	To Be Demolished
MM-13	Shovel Repair	121x70x66	Wildlife Habitat	To Be Demolished
MM-14	Environmental Lab	112x27x17	Wildlife Habitat	To Be Demolished
MM-15	Chapel	50x25x_	Industrial	Potential Historic Building; (Poor Condition rating)
MM-16	Electric Building & Chlorine Shack	35x35x10	Industrial	Potable Water Supply
MM-18	Analytical Lab	120x50x14	Industrial	
MM-20	Diesel Tank Farm	120x120x_	Industrial	
MM-21	Electrical Power Substation	180x120x_	Industrial	
MM-24	Fire Truck Barn	25x25x12	Industrial	
MM-25	Ambulance Barn	35x25x12	Industrial	
	Security Building Expansion	20 x 30	Industrial	
SX-EW Plant Area				
	Tankhouse	150x465x30	Wildlife Habitat	To Be Demolished
	SX/EW Plant Area Shop	31x71x30	Wildlife Habitat	To Be Demolished
	Leach Crew Office	15x15x15	Wildlife Habitat	To Be Demolished
	SX/EW Warehouse	48x150x20	Wildlife Habitat	To Be Demolished
	Substation	100x90x10	Industrial	Remain for post-closer use
	Raffinate Storage Tanks (2)	120 dia x 34; 65 dia x 16	Industrial	Remain for post-closer use
	Gonzales Cells	25x52x10	Wildlife Habitat	To Be Demolished
	Jamison Cells	35x44x10	Wildlife Habitat	To Be Demolished
	Organic Tanks (4)	2x32x16	Wildlife Habitat	To Be Demolished
	Mixer/Settler Tanks (8)	200x366x10	Wildlife Habitat	To Be Demolished
	Tank Farm (5)	92x370x10	Wildlife Habitat	To Be Demolished
	Water Tank	1x30x16	Wildlife Habitat	To Be Demolished
	PLS Feed Pond	130x130	Industrial	Remain for post-closer use
	Acid Tanks (2)	2x20x16	Wildlife Habitat	To Be Demolished
	MCC Building	14x30x12	Wildlife Habitat	To Be Demolished
	Toolroom and Storage	60x70x12	Wildlife Habitat	To Be Demolished
	Chlorinator Room	19x66x12	Wildlife Habitat	To Be Demolished
	2A West Raff Tank	30x46x16	Wildlife Habitat	To Be Demolished
	Rectifiers	20x24x12	Wildlife Habitat	To Be Demolished
	Workroom	66x75x12	Wildlife Habitat	To Be Demolished
	Pump Mixer Control Room	41x41x12	Wildlife Habitat	To Be Demolished
	Cobalt Sulfate Tank	1x18x16	Wildlife Habitat	To Be Demolished
	Reagent Tanks	25x36x12	Wildlife Habitat	To Be Demolished
	Toolroom and Storage	8x32x12	Wildlife Habitat	To Be Demolished
	Diluent Storage Tank	1x18x16	Wildlife Habitat	To Be Demolished
	Pacesetter Filters (2)	48x80x12	Wildlife Habitat	To Be Demolished
	Wash Pad	45x68x_	Wildlife Habitat	To Be Demolished

Post-Mining Land Use Designations of Tyrone Mine Buildings

Tyrone Tag. No.	Description	Dimensions[1]	PMLU	Description
		Lubrication Shop Area		
	Prill Tanks (2 each)	20 ft dia. each	Waiver Area	To be demolished
	Dispatch Building	41x15x_	Waiver Area	Demolished
	Lubrication Shop	110x60x_	Waiver Area	Future borrow pit area
	Southwest Energy Building	42x42x_	Not Specified	Owned by others
	Electric Power Substation	52x36x_	Waiver Area	Future borrow pit area
	Powder Magazines	10x10x_	Waiver Area	Future borrow pit area
	Storage Sheds	110x60x_	Waiver Area	To be demolished
	Lubeshop Addition	50 x 70 x _		
	#2 Fuel Dock Concrete Slab for Haul Trucks	14 x 42		
		Acid Unloading Facility & Former Precipitation Area		
	Acid Unloading Facility	20x10x_	Wildlife	Demolish and salvage
	Former Precipitation Plant Building	400x100x_	Wildlife	Demolish and salvage
		Mill and Concentrator Area		
MC-01	Tailing Thickeners (8)	325 ft dia.	Industrial	Reserved for water treatment
MC-02	Reclaim Water Storage Tanks (3)	1 at 600 ft dia & 2 at 40 ft dia.	Industrial	Reserved for water supply
MC-04	Reclaim Water Pump House	138x60x10	Industrial	Demolish; (pumps (9X), 7-ton overhead crane (trolly only)
MC-05	Terminal Tanks (3 each)	150 ft dia.	Industrial	Pumps
MC-06	Flotation Units (3 each)	NA	Wildlife Habitat	Demolished
MC-07	Secondary Crusher	NA	Wildlife Habitat	Demolished
MC-08	Mill Pumphouse	NA	Wildlife Habitat	Demolished
MC-09	SX/EW Changeroom	NA	Wildlife Habitat	Demolished
MC-10	Intermediate Ore Storage	NA	Wildlife Habitat	Demolished
MC-11	Primary Crusher	NA	Wildlife Habitat	Demolished
MC-12	Process Water Tanks	NA	Wildlife Habitat	Demolished
MC-13	Concentrator- Filter Plant & Dryer	NA	Wildlife Habitat	Demolished
MC-14	Lime Storage	NA	Industrial	Demolished
MC-15	Warehouse and Core Storage	235x101x33	Wildlife Habitat	To be demolished
MC-16	Warehouse/ Concentrator Unloading	NA	Wildlife Habitat	Demolished
MC-17	Radiators/Power Plant (Powerhouse)	420x120x30	Industrial	15 diesel engine generators
MC-19	Concentrator Building	NA	Wildlife Habitat	Demolished
MC-20	Reagent Building	150x50x16	Wildlife Habitat	Demolished
MC-21	Fuel Station	60x50	Wildlife Habitat	To be demolished
MC-22	Tire Shop	79x44x23	Wildlife Habitat	To be demolished
MC-24	Spigot Underflow Pump House	60x50x_	Wildlife Habitat	Demolished
MC-25	Tailing Pump House	110x50x_	Industrial	Raw water pumps, 5 ton overhead crane
MC-27	Inactive Diesel Storage Tanks (2)	1x20x15	Wildlife Habitat	To be demolished
		#1 Fuel Dock Area		
	#1 Fuel Dock	70 x 40	Industrial	
	Water Fill	14 x 31	Industrial	
		2B Leach / Little Rock Haul Road Fuel Dock Area		
	Fuel Dock	70 x 40	Wildlife Habitat	To be demolished

[1.] Length and width of facility determined from facility map, height of facility assumed.
Cost estimate used actual tank dimensions where possible.

APPENDIX C.3
SURFACE IMPOUNDMENTS
PROVIDED BY GOLDER

Tyrone Mine Surface Impoundments

Impoundment Designation[1]	Surface Area[1] (acres)	Mine Use[1]	Liner[1]	Status	Post 2014	Reclaimed Prior to 2014 (acres)	Covered (no reveg) (acres)	Reclaimed After 2014 (acres)	Replaced (acres)	PMLU up to and after year 100 (acres)	PMLU up to year 100 (acres)
DP-27 SA Northern Mangas Valley Tailing Area											
						3.19	0	0	0	0	0
Facility Area 2 - Southern Mangas Valley Tailing											
No. 1X Tailing Seepage Collection Pond (1X-1) [4.]	0.81	Seep	Synthetic	Existing	PMLU						0.81
					Totals =	**7.59**	**0**	**0**	**0**	**0**	**0.81**
DP-166 No. 2 Leach System, SX/EX Plant, Open Pits											
Seep Collection DC2-1	0.02	Seep	Synthetic	Existing	PMLU						0.02
Seep 2 Collection	0.002	Seep	None	Existing	PMLU						0.002
Seep 3 Collection	0.02	Seep	Clay	Existing	PMLU						0.02
Seep 4 Collection	0.02	Seep	Clay	Existing	PMLU						0.02
Seep 5E Collection	0.02	Seep	Clay	Existing	Covered & Replace		0.02		0.02		0.02
Seep 9 Collection	NA	Seep	NA	Existing	PMLU						NA
Main Pit Sump [4.]	15.43	Pit Dewatering	None	Existing	PMLU					15.43	
Copper Mountain Pit Sump [4.]	2.64	Pit Dewatering	None	Existing	PMLU					2.64	
Lube Shop Pond	0.09	Stormwater	None	Existing	Covered		0.09				
No. 2 PLS Pond [4.]	1.22	PLS	Synthetic	Existing	PMLU						1.22
No. 2A Decant Ponds [4.]	4.42	Pit Dewatering	Synthetic	Existing	PMLU						4.42
4C PLS Pond [4.]	0.495	PLS	Synthetic	Existing	PMLU						0.495
Future 6150 Pond [4.]	0.46	PLS	Synthetic	Existing in 2014	PMLU						0.460
North Racket PLS Pond [2.]	0.93	PLS	Synthetic	Existing	PMLU						0.93
SX/EW PLS Feed Pond [4.]	0.39	PLS	Synthetic	Existing	PMLU						0.39
5E Pond 1	NA	Seep	Synthetic	Existing	Covered		NA				
5E Pond 2	0.36	Seep	Synthetic	Existing	PMLU						0.36
					Totals =	**0.005**	**0.11**	**0**	**0.02**	**18.07**	**8.357**
DP-286 No. 3 Leach System											
Canyon 1 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 2 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 3 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 4 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 5 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 6 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 7 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 8 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 9 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 10 PLS Catchment	NA	PLS	Clay/Concrete	Existing	PMLU						NA
Canyon 11 PLS Catchment	NA	PLS	Synthetic	Existing	PMLU						NA
No. 3A PLS Pond [4.]	1.67	PLS	Synthetic	Existing	PMLU						1.67
No. 3A PLS Overflow [4.]	1.43	PLS	Synthetic	Existing	PMLU						1.43
Crusher Pond	0.37	Stormwater	None	Existing	PMLU					0.37	
Land Farm and Stage Pond (two)	0.62	Stormwater	Synthetic & Concrete lined	Existing	PMLU						0.62
Niagara Stormwater	0.16	Stormwater	None	Existing	Covered		0.16				
Other Thickeners (six)	0.46	Stormwater	Synthetic & Concrete lined	Existing	PMLU						0.46
Plant Oxidation Pond (a)	0.28	Sewage	Synthetic	Existing	PMLU						0.28
Plant Oxidation Pond (b)	0.3	Sewage	Synthetic	Existing	PMLU						0.3
SPCC Pond	0.96	Stormwater	Synthetic	Existing	PMLU						0.96
					Totals =	**0.54**	**0.16**	**0**	**0**	**0.37**	**5.72**

Tyrone Mine Surface Impoundments

Impoundment Designation[1]	Surface Area[1] (acres)	Mine Use[1]	Liner[1]	Status	Post 2014	Reclaimed Prior to 2014 (acres)	Covered (no reveg) (acres)	Reclaimed After 2014 (acres)	Replaced (acres)	PMLU up to and after year 100 (acres)	PMLU up to year 100 (acres)
DP-363 No. 1A Leach System											
1A PLS Tank [4.]	0.01	PLS/Seepage	Stainless Steel	Existing	PMLU						0.01
No. 1A PLS Overflow Pond [4.]	1.24	PLS	Synthetic	Existing	PMLU						1.24
No. 1A Stormwater Pond	0.11	Stormwater	Clay	Existing	Covered		0.11				
Totals =					**Totals =**	**0.5**	**0.11**	**0**	**0**	**0**	**1.25**
DP-383 No. 1B Leach System											
1B PLS Tank [4.]	0.02	PLS/Seepage	Stainless Steel	Existing	PMLU						0.02
No. 1B Overflow Pond [4.]	1.24	PLS	Synthetic	Existing	PMLU						1.24
					Totals =	**0.33**	**0**	**0**	**0**	**0**	**1.26**
DP-396 No. 1C Waste Rock Stockpile											
Oak Grove Pond	0.18	Stormwater	Synthetic	Existing	PMLU						0.18
Oak Grove Sediment Basin	2.2	Stormwater	Unlined	Existing	PMLU						2.2
					Totals =	**0.55**	**0**	**0**	**0**	**0**	**2.38**
DP-435 No. 2A and 2B Leach Systems, and 2B and 9A Waste Rock Stockpiles											
2A East PLS Tank [4.]	0.01	PLS	Stainless Steel	Existing	PMLU to year 6			0.01			
2A West PLS Tank [4.]	0.01	PLS	Stainless Steel	Existing	PMLU to year 6			0.01			
No. 2A (a) aka Seep 5E Pond Discharge	0.1	Stormwater	None	Existing	Covered		0.1				
No. 2A (b) Surge	0.46	PLS	Synthetic	Existing	PMLU						0.46
Pond					PMLU						0
No. 2A East PLS Overflow (Pennington Pond) [4.]	0.49	PLS	Synthetic	Existing	PMLU						0.49
Totals =					**Totals =**	**0.65**	**0.1**	**0.02**	**0**	**0**	**0.95**
DP-455 Gettysburg Pit and Leach System											
Gettysburg Collection Pit (a)	0.17	PLS	Unlined	Existing	PMLU					0.17	
6C PLS Collection Pond [4.]	0	PLS	Synthetic	Existing	PMLU						0
					Totals =	**0.06**	**0**	**0**	**0**	**0.17**	**0**
DP-670 Savannah Pit and East Main Leach System											
East Main Booster Pond [4.]	0.16	PLS	Synthetic	Existing	PMLU						0.16
Savannah Pit Seepage Sump	0.07	Stormwater	Synthetic	Existing	PMLU						0.07
					Totals =	**0**	**0**	**0**	**0**	**0**	**0.23**
DP-896 No. 1 Leach Stockpile											
No. 1 Stockpile Seepage AST	0.001	Seepage Collection	Fiberglass	Existing	PMLU						0.001
No. 1 Overflow Pond	0.17	Overflow for Seepage Collection	Synthetic	Existing	PMLU						0.17
Precipitation Plant Launders	0.1	Stormwater	Concrete Lined	Existing	PMLU						0.1
					Totals =	**2.84**	**0**	**0**	**0**	**0**	**0.271**

Notes

NA = not analyzed

PMLU - Post Mining Lanud Use

PLS = Pregnant leach solution storage, collection, conveyance structure

TDRW = Tailing Decant Return Water

[1.] Original information from DBS&A. *Tyrone Mine Surface Impoundment Study Work Plan, DP-1341 Condition 87*. November 13, 2006, unless otherwise noted. Modified based on current reclamation.

[2.] Based on as-built pond design information provided by FMI.

[3.] Based on digitized area of approximate pond dimensions from 2011 aerial photograph in Stage 2 APP (DBS&A, 2011).

[4.] Based on information provided by Tyrone Hydrometallurgical Division and Environmental Department. The 4C and 6C PLS collection ponds are actually collection points with drains at the base and do not store PLS.

The 4C and 6C PLS collection ponds are actually collection points with drains at the base and do not store PLS.

Impoundment Takeoffs (Golder CCP Update, 2013 Table 2-1)

Impoundment Area	Reclaimed Prior to 2014	Covered (no vegetation)	Reclaimed After 2014	Replaced	PMLU up to and after year 100 (acres)	PMLU up to year 100 (acres)
	Area (acres)					
DP-27 SA Northern Mangas Valley Tailing Area	3.19	0.00	0.00	0.00	0.00	0.00
Facility Area 2 - Southern Mangas Valley Tailing	7.59	0.00	0.00	0.00	0.00	0.81
DP-166 No. 2 Leach System, SX/EX Plant, Open Pits	0.01	0.11	0.00	0.02	18.07	8.36
DP-286 No. 3 Leach System	0.54	0.16	0.00	0.00	0.37	5.72
DP-363 No. 1A Leach System	0.50	0.11	0.00	0.00	0.00	1.25
DP-383 No. 1B Leach System	0.33	0.00	0.00	0.00	0.00	1.26
DP-396 No. 1C Waste Rock Stockpile	0.55	0.00	0.00	0.00	0.00	2.38
DP-435 No. 2A and 2B Leach Systems, and 2B and 9A Waste Rock Stockpiles	0.65	0.10	0.02	0.00	0.00	0.95
DP-455 Gettysburg Pit and Leach System	0.06	0.00	0.00	0.00	0.17	0.00
DP-670 Savannah Pit and East Main Leach System	0	0.00	0.00	0.00	0.00	0.23
DP-896 No. 1 Leach Stockpile	2.84	0.00	0.00	0.00	0.00	0.27
Total:		0.48	0.02	0.02		21.23
		Ripping Only See Sheet 1	See PLS Tank Demo cost on Sheet 15 Other	See Seep 5E collection replacment cost on Sheet 15 Other	Remain Post Closure	See rip, grade, cover, veg costs on sheets 13 and 14
Notes						

APPENDIX C.4
WELLS
PROVIDED BY GOLDER

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
1	Fortuna No. 1	Regional	MW	18377	14942	683
2	Fortuna No. 2	Regional	MW	18210	14870	615
4	Nigger Canyon	Regional	MW	22979	11635	75
5	Thompson Well	Regional	MW	20095	7689	1200
10	Flying A Well	Regional	EXW	31349	-1743	400
11	PWLCO Ranch House Well	Regional	MW	32037	-3485	100
13	Whitehill Well	Regional	MW	43845	-11084	107
14	No. 14 Well	Regional	MW	45368	-11660	100
15	No. 15 Well	Regional	MW	45180	-11860	100
18	Well 18	Regional	MW	28975	-1208	72
19	Well 19	Regional	MW	39298	-5404	80
20	Well 20	Regional	MW	28973	-1212	110
22	Eileen	Regional	MW	21906	12345	170
23	Paws	Regional	MW	27634	5721	260
24	Rowdy	Regional	MW	23792	9272	240
25	Cassie	Regional	MW	22516	10709	216
26	Bosworth	Regional	MW	18250	3385	352
27	Pokey	Regional	MW	18883	4821	303
29	Fang	Regional	MW	18976	5856	252
32	1D Leach Monitor Well 32	Regional	MW	18602	13799	300
33	1D Leach Monitor Well 33	Regional	MW	18860	13200	315
34	1D Leach Monitor Well 34	Regional	MW	17628	13366	340
35	Graves Canyon Well	Regional	MW	19763	-2616	400
36	Foley Well	Regional	MW	23379	10761	380
37	Wind Canyon Well 37	Regional	MW	45490	-11070	100
41	Shorty Water	Regional	MW	34540	-4713	60
42	Mangas Valley Well 42	Regional	MW	31368	-1658	82
43	Mangas Valley Well 43	Regional	MW	34532	-4726	101
44	Mangas Valley Well 44	Regional	MW	38802	-8391	91
45	Mangas Valley Well 45	Regional	MW	28815	810	70
46	Mangas Valley Well 46	Regional	MW	24937	6474	118
47	Mangas Valley Well 47	Regional	MW	39656	-7201	98
2-4	No. 2 Leach Test Well 2-4	Regional	MW	9520	5262	502
2-7	No. 2 Leach Test Well 2-7	Regional	MW	10059	11839	265
2-11	South Side Regional Well 2-11	Regional	MW	2831	5422	175
2-12	South Side Regional Well 2-12	Regional	MW	2809	11104	361
2-13	South Side Regional Well 2-13	Regional	MW	3141	9376	228
2-15		Regional	MW	3596	4811	384
2-16		Regional	MW	5605	3595	520
4-4	No. 2 Leach Test Well 4-4	Regional	MW	9530	10054	333
4-6	No. 2 Leach Test Well 4-6	Regional	MW	12123	6890	765
6-1	No. 2 Leach Test Well 6-1	Regional	MW	2800	3740	460
6-5	No. 2 Leach Test Well 6-5	Regional	MW	10019	11748	263
1236-2012-01	Monitor Well, LRW-6 replacement	Regional	MW	17588	-824	401
166-2006-01	Deadman Canyon Well	Perched	MW	6178	2776	21
166-2006-02	Deadman Canyon Well	Regional	MW	12260	3048	85
166-2006-03	Deadman Canyon Well	Perched	MW	12200	3030	12
166-2006-05	Deadman Canyon Well	Regional	MW	14572	2069	194
166-2006-06	Deadman Canyon Well	Regional	MW	17162	1472	65
166-2009-01		Regional	MW	16361	7721	963
166-2011-01		Regional	MW	7146	3780	250
1A-1	No. 1A Stockpile Well	Perched	MW	8516	19355	14
1A-10	No. 1A Stockpile Well	Perched	EXW	9009	19296	16
1A-11	No. 1A Stockpile Well	Perched	EXW	7781	19253	24
1A-12	No. 1A Stockpile Well	Perched	MW	7788	19258	24
1A-13	No. 1A Stockpile Well	Perched	EXW	7488	19234	27
1A-14	No. 1A Stockpile Well	Perched	EXW	7385	19357	44
1A-15	No. 1A Stockpile Well	Perched	EXW	7290	19333	43
1A-16	No. 1A Stockpile Well	Perched	EXW	7228	19322	44
1A-17A	No. 1A Stockpile Well	Perched	MW	6764	19315	48
1A-19	No. 1A Stockpile Well	Perched	EXW	8585	19297	15
1A-2	No. 1A Stockpile Well	Perched	MW	8806	19408	22
1A-20	No. 1A Stockpile Well	Perched	EXW	8571	19299	15
1A-21	No. 1A Stockpile Well	Perched	EXW	8850	19285	21
1A-22	No. 1A Stockpile Well	Perched	EXW	8864	19286	20
1A-23	No. 1A Stockpile Well	Perched	MW	7763	19280	27
1A-24	No. 1A Stockpile Well	Perched	MW	7750	19274	26
1A-25	No. 1A Stockpile Well	Perched	MW	7747	19270	25
1A-26	No. 1A Stockpile Well	Perched	MW	7342	19402	40
1A-27	No. 1A Stockpile Well	Perched	MW	7382	19406	41
1A-28	No. 1A Stockpile Well	Perched	MW	7310	19398	37
1A-3	No. 1A Stockpile Well	Perched	MW	8770	19354	15
1A-30	No. 1A Stockpile Well	Perched	EXW	7340	19347	50
1A-31	No. 1A Stockpile Well	Perched	MW	7319	19194	39
1A-32	No. 1A Stockpile Well	Perched	MW	7378	19189	42
1A-33	No. 1A Stockpile Well	Perched	MW	8993	19296	14
1A-34	No. 1A Stockpile Well	Perched	MW	8971	19293	17
1A-35	No. 1A Stockpile Well	Perched	MW	8893	19424	27
1A-36	No. 1A Stockpile Well	Perched	MW	8947	19291	18
1A-37	No. 1A Stockpile Well	Perched	MW	8923	19288	19
1A-38	No. 1A Stockpile Well	Perched	MW	8898	19285	17
1A-4	No. 1A Stockpile Well	Perched	MW	8591	19437	17
1A-5	No. 1A Stockpile Well	Perched	MW	8588	19461	17
1A-6	No. 1A Stockpile Well	Perched	MW	8131	19370	20
1A-7	No. 1A Stockpile Well	Perched	MW	8131	19400	20
1A-8	No. 1A Stockpile Well	Perched	EXW	8578	19294	17
1A-9	No. 1A Stockpile Well	Perched	EXW	8856	19283	21
1B-1	No. 1B Stockpile Well	Perched	MW	10935	19613	36
1B-2	No. 1B Stockpile Well	Perched	MW	10982	19605	36
1B-3	No. 1B Stockpile Well	Perched	MW	11198	19338	32
1B-4	No. 1B Stockpile Well	Perched	MW	11165	19299	31

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
1B-8	No. 1B Stockpile Well	Perched	MW	10066	19531	14
1B-9	No. 1B Stockpile Well	Perched	MW	10802	19396	37
1C-1	No. 1C Well 1C-1	Perched	MW	3399	13411	15
1C-10	No. 1C Well 1C-10	Perched	MW	2564	13510	15
1C-2	No. 1C Well 1C-2	Perched	MW	3296	13756	37
1C-3	No. 1C Well 1C-3	Perched	MW	3211	14017	35
1C-4	No. 1C Well 1C-4	Perched	MW	3191	14006	31
1C-6	No. 1C Well 1C-6	Perched	MW	5219	17773	40
1C-7	No. 1C Well 1C-7	Perched	MW	5560	18217	42
1C-9	No. 1C Well 1C-9	Perched	MW	3332	15776	45
2-5A	No. 2 Leach Test Well 2-5A	Regional	MW	5461	10478	484
27-2004-02	Section 29 replacement well	Regional	MW	35505	-5170	105
27-2005-01	Monitor Well	Regional	MW	22643	7237	222
27-2005-02	Monitor Well	Regional	MW	24666	-2027	212
27-2005-03	Monitor Well	Regional	MW	37220	2607	258
27-2005-04	Monitor Well	Regional	MW	41570	-929	352
27-2005-05	Monitor Well	Regional	MW	45243	-5022	307
27-2005-06	Monitor Well	Regional	MW	39758	-5037	147
27-2010-01		Regional	MW	36085	-4463	84
27-2010-02		Regional	MW	36915	-2544	216
27-2010-03		Regional	MW	36195	-3536	96
27-2011-15	Monitor Well	Regional	MW	23250	7162	167
286-2005-01	Monitor Well	Regional	MW	20651	7954	215
286-2005-02	Monitor Well	Regional	MW	21338	8027	142
286-2005-03	Monitor Well	Regional	MW	16129	16171	345
286-2006-01	Extraction Well	Regional	EXW	20493	9790	186
286-2006-02	Monitor Well	Regional	MW	20536	9744	191
286-2006-03	Extraction Well	Regional	EXW	21120	8592	177
286-2006-04	Monitor Well	Regional	MW	21147	8628	157
286-2006-05	Extraction Well	Regional	EXW	20960	7259	267
286-2006-06	Monitor Well	Regional	MW	21015	7312	236
286-2007-01	Deep Monitor Well	Regional	MW	20527	9754	235
286-2007-02	Deep Monitor Well	Regional	MW	20839	9020	262
286-2007-03	Monitor Well	Regional	MW	21380	8496	150
286-2007-04	Monitor Well	Regional	MW	21365	8177	141
286-2007-05	Monitor Well	Regional	MW	21361	7855	146
286-2007-06	Monitor Well	Regional	MW	21435	7566	178
286-2007-07	Monitor Well	Regional	MW	21428	7260	225
286-2007-08	Monitoring/Extraction Well	Regional	EXW	21044	8812	169
286-2007-09	Monitor Well	Regional	MW	20811	6984	240
286-2007-10	Monitor Well	Regional	MW	20795	6671	221
286-2007-11	Monitor Well	Regional	MW	20652	6420	238
286-2007-12	Monitor Well	Regional	MW	20806	9174	167
286-2007-13	Monitor Well	Regional	MW	20842	8998	179
286-2007-14	Monitor Well	Regional	MW	21526	8842	106
286-2007-15	Extraction Well	Regional	EXW	21118	8487	194
286-2007-16	Monitor Well	Regional	MW	21149	8542	160
286-2007-17	Extraction Well	Regional	EXW	21113	8392	213
286-2007-18	Monitor Well	Regional	MW	21150	8435	175
286-2007-19	Extraction Well	Regional	EXW	21120	8278	208
286-2007-20	Monitor Well	Regional	MW	21151	8330	188
286-2007-21	Extraction Well	Regional	EXW	21120	8173	202
286-2007-22	Monitor Well	Regional	MW	21152	8224	180
286-2007-23	Extraction Well	Regional	EXW	21124	8074	207
286-2007-24	Monitor Well	Regional	MW	21155	8123	180
286-2007-25	Extraction Well	Regional	EXW	21120	7961	210
286-2007-26	Monitor Well	Regional	MW	21139	8007	187
286-2007-27	Extraction Well	Regional	EXW	21081	7862	228
286-2007-28	Monitor Well	Regional	MW	21125	7896	186
286-2007-29	Extraction Well	Regional	EXW	21049	7762	246
286-2007-30	Monitor Well	Regional	MW	21096	7804	205
286-2007-31	Extraction Well	Regional	EXW	21011	7662	258
286-2007-32	Monitor Well	Regional	MW	21054	7700	228
286-2007-33	Extraction Well	Regional	EXW	20991	7561	264
286-2007-34	Monitor Well	Regional	MW	21028	7605	234
286-2007-35	Extraction Well	Regional	EXW	20970	7461	269
286-2007-36	Monitor Well	Regional	MW	21009	7508	238
286-2007-37	Extraction Well	Regional	EXW	20960	7360	270
286-2007-38	Monitor Well	Regional	MW	21005	7411	238
286-2007-39	Extraction Well	Regional	EXW	20794	9123	192
286-2007-40	Monitoring/Extraction Well	Regional	EXW	21091	8693	175
286-2007-41	Extraction Well	Regional	EXW	20817	9037	214
286-2007-42	Monitor Well	Regional	MW	20833	9086	190
286-2007-43	Extraction Well	Regional	EXW	20841	8950	212
286-2007-44	Monitor Well	Regional	MW	20895	8941	185
286-2007-45	Extraction Well	Regional	EXW	20903	8882	192
286-2007-46	Monitor Well	Regional	MW	20721	9590	143
286-2007-47	Extraction Well	Regional	EXW	20860	9348	196
286-2007-48	Monitor Well	Regional	MW	20493	9888	164
286-2007-49	Extraction Well	Regional	EXW	20653	9660	207
286-2007-50	Extraction Well	Regional	EXW	20417	9947	223
286-2007-51	Extraction Well	Regional	EXW	20704	9486	201
286-2008-01	Monitor Well	Regional	MW	20681	7769	221
286-2008-02	Monitor Well	Regional	MW	21680	8171	128
286-2008-03	Extraction Well	Regional	EXW	22241	9439	118
286-2008-04	Extraction Well	Regional	EXW	20188	10329	191
286-2008-05	Extraction Well	Regional	EXW	20057	10317	198
286-2008-06	Monitor Well	Perched	MW	20302	7600	61
286-2008-07	Monitor Well	Perched	MW	19724	10697	45
286-2008-08	Extraction Well	Regional	EXW	19233	11164	252
286-2010-01		Perched	MW	20137	10997	50

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
286-2010-02		Perched	MW	19304	11602	60
363-2005-01	Monitor Well	Regional	MW	8123	19425	592
363-2005-02	Monitor Well	Regional	MW	6443	29562	619
363-2005-03	Monitor Well	Regional	MW	6821	30096	613
363-2005-04	Monitor Well	Regional	MW	6929	22283	588
363-2006-01	363-2006-01-Tyrone; MB-30 replacement	Regional	MW	5438	19337	533
363-2008-01		Perched	EXW	6227	29314	64
363-2008-02		Perched	EXW	6208	29414	65
363-2008-03		Perched	EXW	6186	29510	50
363-2008-04		Regional	MW	7159	24823	745
363-2011-01		Regional	MW	11730	18582	515
383-2005-02	Monitor Well	Regional	MW	12880	18331	468
383-2008-01	MB-36 replacement well	Regional	MW	11419	19546	440
396-2011-01		Perched	MW	4304	16377	85
435-2005-01	Monitor Well	Regional	MW	17375	6491	703
435-2005-02	Monitor Well	Regional	MW	14956	3603	902
435-2005-03	Monitor Well	Regional	MW	18289	4551	407
455-2001-01	Gettysburg monitor well	Regional	MW	8170	16950	650
455-2005-01	Monitor Well	Regional	MW	9058	17010	709
455-2005-02	Monitor Well	Regional	MW	6101	15392	487
455-2007-01	Gettysburg 5700 bench monitor well	Regional	MW	8667	16323	160
455-2008-01	Gettysburg 6060 bench monitor well	Regional	MW	8849	16680	558
455-2008-02	Gettysburg 5700 bench monitor well	Regional	MW	8775	16158	157
455-2008-03	Gettysburg 5700 bench monitor well	Regional	MW	8534	16450	158
455-2010-01		Regional	MW	13060	14608	974
455-2010-02		Regional	MW	10209	15603	735
6-2R	No. 3 Leach Well 6-2R	Regional	MW	21056	9843	347
670-2005-01	Monitor Well	Regional	MW	11023	15365	764
670-2005-02	Monitor Well	Perched	MW	13242	14872	396
896-2005-01	Monitor Well	Regional	MW	10543	23922	897
896-2010-01		Perched	MW	10870	21509	19
896-2010-02		Perched	MW	10578	22033	30
896-2010-03		Perched	MW	10405	22656	29
896-2010-04		Perched	MW	10467	23106	32
BK-1	Brick Kiln Gulch Well	Perched	MW	8837	24832	35
BK-10	Brick Kiln Gulch Well	Perched	MW	10756	21056	28
BK-11	Brick Kiln Gulch Well	Perched	MW	8802	24821	84
BK-2	Brick Kiln Gulch Well	Perched	MW	8808	24821	33
BK-3	Brick Kiln Gulch Well	Perched	MW	8954	24876	37
BK-4	Brick Kiln Gulch Well	Perched	MW	9198	23700	28
BK-5	Brick Kiln Gulch Well	Perched	MW	9145	23658	25
BK-6	Brick Kiln Gulch Well	Perched	MW	9882	22843	40
BK-8	Brick Kiln Gulch Well	Perched	MW	10384	22025	52
BK-9	Brick Kiln Gulch Well	Perched	MW	10806	21071	41
BMH-MW-1		Regional	MW	6424	-4591	215
C10-28	No. 3 Leach Well	Perched	MW	21235	8844	33
C10-40	No. 3 Leach well	Perched	MW	21540	8932	37
C10-41	No. 3 Leach well	Perched	MW	21714	9001	40
C10-42	No. 3 Leach Well C10-42	Regional	MW	21543	8913	90
C10-50	No. 3 Leach Well	Perched	MW	21639	8969	41
C10-51	No. 3 Leach Well	Perched	MW	21644	8960	41
C10-52	No. 3 Leach Well	Perched	MW	21641	8965	37
C10-53	No. 3 Leach Well	Perched	MW	21038	8686	45
C10-54	No. 3 Leach Well C10-54	Regional	MW	21065	8642	115
C10-62	No. 3 Leach Well	Perched	MW	21654	8970	36
C11-12	No. 3 Leach Well C11-12	Regional	MW	21530	8252	100
C4TU-1	No. 3 Trench Well C4TU-1	Perched	EXW	19561	11297	52
C4TU-2	No. 3 Trench Well C4TU-2	Perched	EXW	19618	11154	52
C7-33	No. 3 Leach Well	Perched	MW	20490	9668	37
C7-34	No. 3 Leach Well	Perched	EXW	20489	9634	37
C7-35	No. 3 Leach Well	Perched	MW	20489	9620	39
C7-36	No. 3 Leach Well	Perched	MW	20490	9658	32
C7-37	No. 3 Leach Well	Perched	MW	20488	9627	35
C7-38	No. 3 Leach Well	Perched	MW	20531	9646	40
C7-39	No. 3 Leach Well	Perched	MW	20490	9627	38
C8-22	No. 3 Leach Well	Perched	MW	20988	9457	29
C8-23	No. 3 Leach Well	Perched	MW	20984	9460	32
C8-24	No. 3 Leach Well	Perched	MW	20975	9469	33
C8-26	No. 3 Leach Well	Perched	MW	20999	9447	30
C8-27	No. 3 Leach Well	Perched	MW	20701	9294	23
C8-30	No. 3 Leach Well	Perched	MW	20723	9248	23
C8-46	No. 3 Leach Well	Perched	MW	20711	9264	27
C8-49	No. 3 Leach Well	Perched	MW	20736	9281	38
C8-50	No. 3 Leach Well	Perched	MW	20743	9261	35
E	Willow Creek Well	Regional	MW	28520	-8395	111
EM-2	East Main Slot	Perched	MW	8907	13951	105
G	McMillen Ranch Well A	Regional	MW	56577	-19262	103
GLD-3A	Gettysburg Leach Dump Monitor Well 3	Regional	MW	9760	15920	655
GLD-5A		Regional	MW	5643	13796	385
GLD-7A	Gettysburg Leach Dump Monitor	Regional	MW	9091	17038	652
K	HW Well (East)	Regional	MW	67531	-25433	102
K-1	HW Well (West)	Regional	MW	67531	-25433	104
L	Stage Stand Well	Regional	MW	89891	-25124	151
LRW-1	Little Rock Well LRW-1	Regional	MW	15474	-763	220
LRW-2	Little Rock Well LRW-2	Regional	MW	13966	-2868	360
LRW-3	Little Rock Well LRW-3	Regional	MW	14568	-1366	500
LRW-4	Little Rock Well LRW-4	Regional	MW	13196	-1548	122
LRW-5	Little Rock Well LRW-5	Regional	MW	11319	-1867	180
LRW-6	Little Rock Well LRW-6	Regional	MW	18611	-673	295
LRW-7	Little Rock Well LRW-7	Regional	MW	14741	719	398
MB-10	Mimbres Basin Well 10, No. 1B Leach Monitor	Perched	MW	12996	18328	65

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
MB-12	Mimbres Basin Well 12, No. 1B Leach	Regional	MW	11143	20050	449
MB-13	Mimbres Basin Well 13	Perched	MW	2620	13491	183
MB-15	Mimbres Basin Well 15	Regional	MW	5245	18481	193
MB-15A	Mimbres Basin Well 15A	Regional	MW	5245	18480	240
MB-16	Mimbres Basin Well 16, No. 1C Well	Perched	MW	5566	18238	87
MB-18S	Mimbres Basin Well 18S	Perched	MW	5444	18064	65
MB-20	Mimbres Basin Well 20	Perched	MW	5417	18033	65
MB-27	Mimbres Basin Well 27	Regional	MW	8891	19434	620
MB-28	Mimbres Basin Well 28	Regional	MW	8031	24856	665
MB-29	Mimbres Basin Well 29	Regional	MW	6885	22314	588
MB-31	Mimbres Basin Well 31	Regional	MW	6684	20929	550
MB-32	Mimbres Basin Well 32	Regional	MW	5422	18750	300
MB-33	Mimbres Basin Well 33	Regional	MW	10019	22862	660
MB-34	Mimbres Basin Well 34	Perched	MW	11086	23704	360
MB-35	Mimbres Basin Well 35	Regional	MW	12164	19913	400
MB-37	Mimbres Basin Well 37, South Side Regional Well	Regional	MW	5393	18421	229
MB-39	Mimbres Basin Well 39, South Side Regional Well	Regional	MW	2941	13197	271
MB-4	Mimbres Main Well 4	Regional	EXW	-2537	48361	1020
MB-40	Mimbres Basin Well 40	Perched	MW	11588	24390	382
MB-41	Mimbres Basin Well 41	Regional	MW	8764	19901	628
MB-42	Mimbres Basin Well 42	Regional	MW	6939	29621	630
MB-43	Mimbres Basin Well 43	Regional	MW	4619	33539	583
MB-44	Mimbres Basin Well 44	Regional	MW	3200	17989	481
MB-5	Mimbres Basin Well 5, Mimbres Watershed Monitor Well No. 1	Regional	MW	-2506	48320	980
MB-6	Mimbres Basin Well 6, Mimbres Watershed Monitor Well No. 2	Regional	MW	-2479	48281	1000
MB-8	Mimbres Basin Well, Section 35 Well	Regional	MW	-1254	43233	407
MPP-1		Regional	EXW	13941	11448	210
MPP-4		Regional	EXW	13770	11576	210
MPP-5		Regional	EXW	13751	11479	205
MPP-6		Regional	EXW	13848	11444	210
MPWM-1	mpwm-1 (Copper Mtn. Pit)	Regional	MW	7680	4476	824
MS-2	Gensen Well	Regional	MW	47909	-14104	136
MV-4		Perched	MW	19721	11200	57
MV-5		Perched	MW	17969	13948	60
MVR-1		Regional	MW	24712	6162	135
MVR-3		Regional	MW	25398	5873	110
O-2	No. 3 Leach Observation Well 2	Regional	MW	18232	9058	498
O-3R	No. 3 Leach Observation Well 3R	Regional	MW	21138	9732	350
O-4	No. 3 Leach Observation Well 4	Regional	MW	20759	8187	350
O-5	No. 3 Leach Observation Well 5	Regional	MW	19880	10772	310
OG-1	Oak Grove Well	Perched	MW	7385	24537	34
OG-10	Oak Grove Well	Perched	MW	6993	21179	41
OG-11	Oak Grove Well	Perched	MW	6972	20936	47
OG-12	Oak Grove Well	Perched	MW	6864	20920	42
OG-13	Oak Grove Well	Perched	EXW	7664	24667	42
OG-14	Oak Grove Well	Perched	EXW	7510	24662	41
OG-15	Oak Grove Well	Perched	EXW	7373	24632	36
OG-16	Oak Grove Well	Perched	MW	4809	33586	64
OG-17	Oak Grove Well	Perched	MW	5000	33773	87
OG-18	Oak Grove Well	Perched	MW	5099	33870	95
OG-19	Oak Grove Well	Perched	MW	2804	35933	87
OG-2	Oak Grove Well	Perched	MW	7584	24561	65
OG-20	Oak Grove Well	Perched	MW	2921	36024	94
OG-21	Oak Grove Well	Perched	MW	3741	34880	89
OG-22	Oak Grove Well	Perched	MW	4915	33689	88
OG-23	Oak Grove Well	Perched	MW	7028	27961	52
OG-24	Oak Grove Well	Perched	MW	6944	27906	65
OG-25	Oak Grove Well	Perched	MW	8096	26569	38
OG-26	Oak Grove Well	Perched	MW	7427	24544	36
OG-27	Oak Grove Well	Perched	MW	7572	24553	33
OG-28	Oak Grove Well	Perched	MW	7623	24563	34
OG-29	Oak Grove Well	Perched	MW	7684	24567	33
OG-2S	Oak Grove Well	Perched	MW	7587	24552	36
OG-3	Oak Grove Well	Perched	MW	7498	24503	37
OG-30	Oak Grove Well	Perched	MW	7637	23735	37
OG-31	Oak Grove Well	Perched	MW	7824	23739	44
OG-32	Oak Grove Well	Perched	MW	7375	22501	39
OG-33	Oak Grove Well	Perched	MW	7535	22433	38
OG-34	Oak Grove Well	Perched	MW	7612	24122	33
OG-35	Oak Grove Well	Perched	MW	7028	21890	37
OG-36	Oak Grove Well	Perched	EXW	8032	26518	55
OG-37	Oak Grove Well	Perched	EXW	7979	26603	50
OG-38	Oak Grove Well	Perched	EXW	7905	26553	51
OG-39	Oak Grove Well	Perched	MW	6198	29461	68
OG-4	Oak Grove Well	Perched	MW	7510	24650	40
OG-40	Oak Grove Well	Perched	MW	6603	29754	115
OG-41	Oak Grove Well	Perched	MW	5812	31626	101
OG-42	Oak Grove Well	Perched	MW	5684	31537	104
OG-43	Oak Grove Well	Perched	MW	4909	33816	104
OG-44	Oak Grove Well	Perched	MW	5286	33636	102
OG-45	Oak Grove Well	Perched	EXW	5146	33495	103
OG-46	Oak Grove Well	Perched	EXW	5860	31543	110
OG-47	Oak Grove Well	Perched	EXW	6035	31322	108
OG-48	Oak Grove Well	Perched	EXW	5843	31174	114
OG-49	Oak Grove Well	Perched	MW	7587	24574	80
OG-5	Oak Grove Well	Perched	EXW	7495	24552	41
OG-50	Oak Grove Well	Perched	MW	7907	26444	94
OG-51	Oak Grove Well	Perched	MW	6638	29666	135
OG-52	Oak Grove Well	Perched	MW	4966	33740	194
OG-53	Oak Grove Well	Perched	MW	4897	33832	193
OG-54	Oak Grove Well	Perched	MW	5619	31367	88

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
OG-55	Oak Grove Well	Perched	MW	6803	29775	83
OG-56	Oak Grove Well	Perched	MW	6218	29364	80
OG-57	Oak Grove Well	Perched	MW	6610	29735	94
OG-58	Oak Grove Well	Perched	EXW	6494	29561	96
OG-60	Oak Grove Well	Perched	MW	7905	26435	67
OG-61	Oak Grove Well	Perched	MW	5943	31431	97
OG-62	Oak Grove Well	Perched	EXW	7929	26512	50
OG-7	Oak Grove Well	Perched	MW	6770	21060	38
OG-8	Oak Grove Well	Perched	MW	6843	21101	46
OG-9	Oak Grove Well	Perched	MW	6926	21141	38
P-100	No. 3 Leach Well P-100	Regional	MW	22411	8913	60
P-101	No. 3 Leach Well P-101	Regional	MW	22310	8911	55
P-106	No. 3 Leach Well P-106	Regional	MW	20626	10242	85
P-10AR	No. 3 Leach Well 10AR	Regional	MW	19977	10695	288
P-114	No. 3 Leach Well P-114	Regional	MW	20765	10089	75
P-115	No. 3 Leach Well P-115	Regional	MW	20768	9937	75
P-116	No. 3 Leach Well P-116	Regional	MW	20815	9780	75
P-117	No. 3 Leach Well P-117	Regional	MW	20334	10287	100
P-149	No. 3 Leach Well P-149	Regional	MW	20533	10261	160
P-14A	No. 3 Leach Well 14	Regional	MW	20466	10437	125
P-15S	No. 3 Leach Well P-15S	Perched	MW	19979	10335	30
P-162	No. 3 Leach Well P-162	Regional	EXW	20529	10265	110
P-164	No. 3 Leach Well P-164	Regional	EXW	20545	10219	115
P-168	No. 3 Leach Well P-168	Regional	MW	20417	10007	137
P-173	No. 3 Leach Well P-173	Regional	MW	20418	9877	135
P-176	No. 3 Leach Well P-176	Regional	MW	20492	9599	150
P-2	No. 3 Leach Well 2	Regional	MW	16833	7228	500
P-219	No. 3 Leach Well P-219	Regional	MW	20479	9395	171
P-21A	No. 3 Leach Well P-21A	Regional	MW	20443	10591	100
P-22A	No. 3 Leach Well P-22A	Regional	MW	20294	10862	103
P-23A	No. 3 Leach Well P-23A	Regional	MW	20886	10077	105
P-24	No. 3 Leach Well P-24	Regional	MW	21130	10123	71
P2-5		Perched	MW	24703	6204	50
P-29	No. 3 Leach Well P-29	Regional	EXW	21031	9869	72
P-3	No. 3 Leach Well 3	Regional	MW	19063	5528	350
P-30	No. 3 Leach Well P-30	Regional	EXW	20560	10319	111
P-31	No. 3 Leach Well P-31	Regional	MW	21295	9758	71
P-32	No. 3 Leach Well P-32	Regional	MW	21209	9645	67
P3-3	Monitor Well P3-3	Regional	MW	45413	-10036	60
P-33	No. 3 Leach Well P-33	Regional	EXW	21084	9750	68
P-34	No. 3 Leach Well P-34	Regional	MW	20562	10304	142
P-37	No. 3 Leach Well P-37	Regional	MW	21350	9480	61
P-38	No. 3 Leach Well P-38	Regional	EXW	21022	9880	100
P-39	No. 3 Leach Well P-39	Regional	EXW	20558	10349	87
P-40	No. 3 Leach Well P-40	Regional	EXW	20555	10286	107
P-41	No. 3 Leach Well P-41	Regional	EXW	20569	10149	115
P-42	No. 3 Leach Well P-42	Regional	EXW	20554	10200	114
P-43	No. 3 Leach Well P-43	Regional	MW	21511	9306	65
P-44	No. 3 Leach Well P-44	Regional	MW	21035	9873	140
P-45	No. 3 Leach Well P-45	Regional	MW	21872	8937	68
P-46	No. 3 Leach Well P-46	Regional	MW	22032	9040	70
P-47	No. 3 Leach Well P-47	Regional	MW	22097	9149	65
P-48	No. 3 Leach Well P-48	Regional	MW	21604	9289	67
P-49	No. 3 Leach Well P-49	Regional	MW	22075	9111	65
P-4A	No. 3 Leach Well 4A	Regional	MW	18525	6886	288
P-5	No. 3 Leach Well 5	Regional	MW	20716	8205	350
P-50	No. 3 Leach Well P-50	Regional	MW	22121	9185	65
P-51	No. 3 Leach Well P-51	Regional	MW	21337	9490	76
P-52	No. 3 Leach Well P-52	Regional	MW	21470	9240	66
P-53	No. 3 Leach Well P-53	Regional	EXW	20537	10235	110
P-54	No. 3 Leach Well P-54	Regional	EXW	22143	9236	70
P-55	No. 3 Leach Well P-55	Regional	EXW	22085	9131	101
P-56	No. 3 Leach Well P-56	Regional	EXW	22172	9273	61
P-57	No. 3 Leach Well P-57	Regional	EXW	22133	9207	101
P-58	No. 3 Leach Well P-58	Regional	MW	22357	9451	65
P-59	No. 3 Leach Well P-59	Regional	MW	22248	9375	60
P-60	No. 3 Leach Well P-60	Regional	MW	22829	8550	60
P-61	No. 3 Leach Well P-61	Regional	MW	22797	8522	60
P-62	No. 3 Leach Well P-62	Regional	MW	22410	8340	64
P-63	No. 3 Leach Well P-63	Regional	MW	22459	8361	63
P-64	No. 3 Leach Well P-64	Regional	MW	22496	8391	58
P-65	No. 3 Leach Well P-65	Regional	MW	22541	8413	60
P-66	No. 3 Leach Well P-66	Regional	MW	22588	8440	59
P-67	No. 3 Leach Well P-67	Regional	MW	22639	8460	58
P-68	No. 3 Leach Well P-68	Regional	MW	22686	8477	59
P-70	No. 3 Leach Well P-70	Regional	EXW	22159	9259	100
P-72R	No. 3 Leach Well P-72R	Regional	MW	22053	9121	115
P-73	No. 3 Leach Well P-73	Regional	MW	22732	8505	60
P-74	No. 3 Leach Well P-74	Regional	MW	21993	9012	65
P-75	No. 3 Leach Well P-75	Regional	MW	23035	8637	60
P-76	No. 3 Leach Well P-76	Regional	EXW	20494	10410	108
P-77	No. 3 Leach Well P-77	Regional	MW	21339	9834	53
P-79	No. 3 Leach Well P-79	Regional	MW	21553	9558	65
P-80	No. 3 Leach Well P-80	Regional	MW	21572	9497	65
P-81	No. 3 Leach Well P-81	Regional	MW	21571	9432	65
P-82	No. 3 Leach Well P-82	Regional	MW	21550	9413	60
P-84	No. 3 Leach Well P-84	Regional	MW	22160	9268	121
P-85	No. 3 Leach Well P-85R	Regional	MW	22121	9202	120
P-92	No. 3 Leach Well P-92	Regional	MW	20455	10211	83
P-99	No. 3 Leach Well P-99	Regional	MW	22407	9026	58
PT-1	TD1X Interceptor System PT.1	Regional	EXW	29003	-1141	75

Wells Abandoned After Closure

LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth_Tota
PT-2	Monitor Well PT-2	Regional	MW	45295	-11736	97
PT-3	TD1X Interceptor System PT.3	Regional	MW	28977	-1180	80
PT-3R	TD1X Interceptor System PT.3-R	Regional	EXW	28990	-1189	75
PT-4	TD1X Interceptor System PT.4	Regional	EXW	29039	-1075	80
PT-5	TD1X Interceptor System PT.5	Regional	EXW	28925	-1270	75
PT-6	TD1X Interceptor System PT.6	Regional	EXW	28872	-1356	75
PZ-1	Mangas Valley Well PZ-1	Regional	MW	28933	-1096	84
PZ-10	Mangas Valley Well PZ-10	Regional	MW	29163	-1298	68
PZ-2	Mangas Valley Well PZ-2	Regional	MW	29071	-1005	37
PZ-3	Mangas Valley Well PZ-3	Regional	MW	28929	-1263	56
PZ-4	Mangas Valley Well PZ-4	Regional	MW	28858	-1345	50
PZ-5	Mangas Valley Well PZ-5	Regional	MW	29028	-1063	65
PZ-6	Mangas Valley Well PZ-6	Regional	MW	28743	-1510	21
PZ-9	Mangas Valley Well PZ-9	Regional	MW	28961	-1206	61
SXMW01	SXEW monitor well 01	Regional	MW	16524	8056	744
SXMW02	SXEW monitor well 02	Regional	MW	15903	7211	806
SXMW03	SXEW monitor well 03	Regional	MW	15651	8094	825
TWS-19	USNR DC well	Regional	MW	17970	1278	107
TWS-24	Deadman Canyon Well TWS24	Perched	MW	11516	3101	20
TWS-25	Deadman Canyon Well TWS25	Perched	MW	11537	3107	15
TWS-26	Deadman Canyon Well TWS26	Perched	MW	9598	3574	17
TWS-27	Deadman Canyon Well TWS27	Perched	MW	10124	3060	12
TWS-28	Deadman Canyon Well TWS28	Perched	MW	11850	2924	12
TWS-29	Deadman Canyon Well TWS29	Perched	MW	11580	2652	13
TWS-30	Deadman Canyon Well TWS30	Perched	MW	10676	2574	15
TWS-32	Deadman Canyon Well TWS32	Perched	MW	7624	3122	14
TWS-33	Deadman Canyon Well TWS33	Perched	MW	6773	2690	14
TWS-34	Deadman Canyon Well TWS34	Perched	MW	7502	2957	10
TWS-35	Deadman Canyon Well TWS35	Perched	MW	3267	1035	11
TWS-36	Deadman Canyon Well TWS36	Perched	MW	8269	3003	11
TWS-37	Deadman Canyon Well TWS37	Perched	MW	9208	3099	17
TWS-38	Deadman Canyon Well TWS38	Perched	MW	9366	3208	14
TWS-39	Deadman Canyon Well TWS39	Perched	MW	10064	2779	26
TWS-40	Deadman Canyon Well TWS40	Perched	MW	10587	1878	22
TWS-42	Deadman Canyon Well TWS42	Regional	MW	20026	544	154
TWS-8	Deadman Canyon Well	Regional	MW	6159	2779	131
TWS-9	USNR Leach Well	Regional	MW	10105	2314	175
3	Nigger Canyon	Regional	MW	22934	11568	100
16	D. Graves Well	Regional	MW	17735	2265	100
48		Regional	MW	18759	13444	100
1BU-1	1B north trench	Perched	MW	11268	19243	100
1BU-2	1B south trench	Perched	MW	10857	19369	100
1C-15		Perched	MW	2804	11104	100
1C-16		Perched	MW	3141	9376	100
396-2006-01		Perched	MW	5261	17695	100
396-2006-02		Regional	MW	5428	18036	100
396-2006-03		Perched	MW	5442	18054	100
396-2006-05		Perched	MW	6773	18966	100
396-2006-06		Perched	MW	6280	18516	100
EM-W1	East Main Dewtr. Well W1	Regional	MW	10145	13544	100
F	Wind Canyon Well	Regional	MW	51465	2526	100
MB-21	Mimbres Basin Well 21	Regional	EXW	1058	38301	100
MB-22	Mimbres Basin Well 22	Regional	EXW	-136	40867	100
MB-23	Mimbres Basin Well 23	Regional	EXW	-1151	45337	100
MB-7	Mimbres Basin Well, Section 35 Well	Regional	EXW	-1253	43283	100
MS-5	Fleming Jr. Well	Regional	MW	46572	-12433	100
MV-1		Perched	MW	18158	13848	100
MV-2		Perched	MW	18699	13400	100
MV-6		Perched	MW	19656	5787	100
OG-59	Oak Grove Well	Perched	EXW	7969	26478	100
OGTU-1	trench	Perched	MW	7019	20792	100
OGTU-2	trench	Perched	MW	6950	20785	100
OGTU-3	trench	Perched	MW	6887	20764	100
P-232		Regional	MW	19602	12401	100
P-233		Regional	MW	19568	13214	100
R38-76	RCH 38-76	Regional	MW	19549	5339	100
SMPDW2	Mn. Pit Dewtr. Well No. 2	Regional	MW	9400	13400	100

NOTE: Values in red are estimated

Total Depth

84,824 feet (TD)
3,000 feet (assumed TD)
87,824 Total

Wells Abandoned At Closure

CAD Pt #	LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth Total (feet)	Casing Depth (feet)	Casing Diameter (ID-inches)	Casing Type	2" Casing Diameter Length (ft)	4" Casing Diameter Length (ft)	6" Casing Diameter Length (ft)
154	166-2008-03		Regional	MW	4973.7	10355.3	173.0	173.0	4	PVC		173	
155	166-2008-04		Regional	MW	4953.5	10358.6	56.5	56.5	4	PVC		56.5	
294	28A	28A Crusher Well	Regional	MW	17280.7	12400.3	463.0	463.0	4	PVC		463	
531	MVR-4		Regional	MW	16731.4	14159.1	200.0	200.0	4	PVC		200	
152	166-2008-01		Regional	MW	3553.4	8263.7	170.4	170.4	4	PVC		170.4	
153	166-2008-02		Regional	MW	3544.3	8251.3	474.2	474.2	4	PVC		474.2	
361	C1-10	No. 3 Leach Well	Perched	MW	17772.5	11387.6	51.5	51.5	2	PVC	51.5		
365	C1-13	No. 3 Leach Well	Perched	MW	17809.0	11394.0	43.0	43.0	4	PVC		43	
366	C1-14	No. 3 Leach Well	Perched	MW	17824.9	11397.0	16.4	16.4	4	PVC		16.4	
367	C1-15	No. 3 Leach Well	Perched	EXW	17840.4	11400.0	43.0	43.0	4	PVC		43	
369	C1-18	No. 3 Leach Well	Perched	EXW	17867.8	11451.9	46.2	46.2	4	PVC		46.2	
370	C1-19	No. 3 Leach Well	Perched	EXW	17815.7	11450.9	46.8	46.8	4	PVC		46.8	
371	C1-22	No. 3 Leach Well	Perched	EXW	17891.6	11451.8	44.7	44.7	4	PVC		44.7	
372	C1-23	No. 3 Leach Well	Perched	EXW	17842.7	11454.5	44.9	44.9	4	PVC		44.9	
373	C1-25	No. 3 Leach Well	Perched	EXW	17969.1	11522.4	32.0	32.0	4	PVC		32	
374	C1-28	No. 3 Leach Well	Perched	EXW	17971.3	11536.7	32.1	32.1	4	PVC		32.1	
375	C1-30	No. 3 Leach Well	Perched	EXW	17822.9	11397.6	45.8	45.8	4	PVC		45.8	
376	C1-31	No. 3 Leach Well	Perched	MW	17814.6	11387.2	46.6	46.6	4	PVC		46.6	
377	C1-33	No. 3 Leach Well	Perched	EXW	17880.9	11452.4	47.3	47.3	4	PVC		47.3	
378	C1-4	No. 3 Leach Well	Perched	MW	17840.5	11394.5	45.0	45.0	2	PVC	45		
379	C1-5	No. 3 Leach Well	Perched	MW	17813.8	11390.8	45.0	45.0	2	PVC	45		
724	P-6A	No. 3 Leach Well P-6A	Regional	MW	17741.6	11466.9	445.5	445.5	4	PVC		445.5	
725	P-6B	No. 3 Leach Well P-6B	Regional	MW	17829.4	11576.8	550.0	550.0	4	PVC		550	
726	P-6RRRR	No. 3 Leach Well P6RRRR	Regional	MW	17828.0	11439.0	405.0	405.0	4	PVC		405	
380	C2-11	No. 3 Leach Well	Perched	MW	18243.9	11431.8	32.0	32.0	2	PVC	32		
381	C2-12	No. 3 Leach Well	Perched	MW	18242.1	11432.1	33.0	33.0	4	PVC		33	
382	C2-4	No. 3 Leach Well	Perched	MW	18236.7	11400.7	32.3	32.3	2	PVC	32.3		
741	P-8A	No. 3 Leach Well P-8A	Regional	MW	18271.1	11360.4	425.0	424.8	4	PVC		425	
383.0	C3-1	No. 3 Leach Well	Perched	MW	18513.4	11349.2	23.0	23.0	2	PVC	23		
384.0	C3-11	No. 3 Leach Well	Perched	MW	18543.8	11381.2	20.0	20.0	2	PVC	20		
385.0	C3-13	No 3. Leach Well	Perched	MW	18542.8	11382.1	22.8	22.8	4	PVC		22.8	
386	C4-24	No. 3 Leach Well	Perched	EXW	19336.7	11116.2	44.2	44.2	6	PVC			44.2
387	C4-25	No. 3 Leach Well	Perched	EXW	19345.5	11108.6	43.8	43.8	6	PVC			43.8
388	C4-26	No. 3 Leach Well	Perched	MW	19339.3	11112.5	37.8	37.8	4	PVC		37.8	
389	C4-28	No. 3 Leach Well	Perched	EXW	19321.9	11137.1	42.0	42.0	4	PVC		42	
390	C4-29	No. 3 Leach Well	Perched	MW	19357.6	11115.3	42.0	42.0	4	PVC		42	
391	C4-30	No. 3 Leach Well C4-30	Perched	EXW	19435.4	11253.7	70.5	70.5	4	PVC		70.5	
392	C4-31	No. 3 Leach Well C4-31	Perched	EXW	19386.6	11273.8	69.5	69.5	4	PVC		69.5	
393	C4-4	No. 3 Leach Well	Perched	MW	19306.1	11098.4	36.0	36.0	4	PVC		36	
394	C4-6	No 3. Leach Well	Perched	MW	19312.3	11090.0	34.0	34.0	4	PVC		34	
613	P-13A	No. 3 Leach Well 13A	Regional	EXW	19269.1	11222.3	180.0	180.0	4	PVC		180	
397	C5-10	No. 3 Leach Well	Perched	EXW	19714.8	10681.3	37.3	37.3	4	PVC		37.3	
398	C5-14	No. 3 Leach Well	Perched	MW	19715.5	10685.2	37.0	37.0	2	PVC	37		
399	C5-15	No. 3 Leach Well	Perched	MW	19715.6	10684.9	42.0	42.0	6	PVC			42
400	C5-3	No. 3 Leach Well	Perched	MW	19710.7	10689.6	39.5	39.5	4	PVC		39.5	
401	C5-6	No. 3 Leach Well	Perched	MW	19704.5	10697.7	11.0	11.0	4	PVC		11	
402	C5-9	No. 3 Leach Well	Perched	EXW	19712.0	10685.3	36.9	36.9	4	PVC		36.9	
536	O-5R	No. 3 Leach Observation Well 5R	Regional	MW	19879.5	10771.9	208.7	208.7	4	PVC		208.7	
605	P-10A	No. 3 Leach Well 10A	Regional	MW	19977.0	10695.2	295.0	295.0	9	Steel			
728	P-71A		Regional	MW	19924.0	10732.0	119.0	119.0	4	PVC		119	
403	C6-1	No. 3 Leach Well	Perched	MW	20043.4	10384.2	40.0	40.0	4	PVC		40	
404	C6-10	No. 3 Leach Well	Perched	MW	20126.2	10421.0	45.0	45.0	4	PVC		45	
405	C6-11	No. 3 Leach Well	Perched	EXW	19967.5	10360.0	44.0	44.0	4	PVC		44	
406	C6-14	No. 3 Leach Well	Perched	MW	20138.1	10402.5	50.0	50.0	4	PVC		50	
407	C6-15	No. 3 Leach Well	Perched	EXW	19973.7	10352.1	40.3	40.3	4	PVC		40.31	
408	C6-16	No. 3 Leach Well	Perched	EXW	19976.4	10347.3	40.5	40.5	4	PVC		40.5	
409	C6-17	No. 3 Leach Well	Perched	MW	19979.2	10309.3	40.1	40.1	4	PVC		40.1	
410	C6-18	No. 3 Leach Well	Perched	MW	19959.0	10370.0	42.0	42.0	4	PVC		42	
411	C6-19	No. 3 Leach Well	Perched	MW	19978.9	10354.6	38.7	38.7	4	PVC		38.7	
412	C6-2	No. 3 Leach Well	Perched	MW	19964.3	10365.2	35.5	35.5	4	PVC		35.5	
413	C6-20	No. 3 Leach Well	Perched	EXW	19977.1	10359.1	43.1	43.1	4	PVC		43.1	
414	C6-33R	No. 3 Leach Well	Perched	MW	19997.2	10374.0	40.0	40.0	4	PVC		40	
415	C6-34	No. 3 Leach Well	Perched	EXW	19988.7	10385.9	41.0	41.0	6	PVC			41
416	C6-35	No. 3 Leach Well	Perched	EXW	20004.8	10354.7	40.1	40.1	6	PVC			40.1
417	C6-36	No. 3 Leach Well	Perched	EXW	20008.9	10347.0	38.7	38.7	6	PVC			38.7
418	C6-4	No. 3 Leach Well	Perched	MW	19979.2	10309.3	30.5	30.5	4	PVC		30.5	
419	C6-43	No. 3 Leach Well	Perched	MW	19993.0	10378.4	38.9	38.9	4	PVC		38.9	
420	C6-44	No. 3 Leach Well	Perched	MW	20005.9	10350.8	35.8	35.8	2	PVC	35.8		
421	C6-45	No. 3 Leach Well	Perched	EXW	20000.6	10360.8	40.5	40.5	6	PVC			40.5
422	C6-46	No. 3 Leach Well	Perched	EXW	20000.4	10367.4	43.9	43.9	6	PVC			43.9
423	C6-47	No. 3 Leach Well	Perched	MW	20002.5	10357.8	38.7	38.7	2	PVC	38.7		
424	C6-48	No. 3 Leach Well	Perched	MW	19998.5	10369.9	39.5	39.5	2	PVC	39.5		
425	C6-5	No. 3 Leach Well	Perched	MW	20108.6	10379.2	42.5	42.5	4	PVC		42.5	
426	C6-53	No. 3 Leach well	Perched	EXW	19997.2	10374.0	44.5	44.5	4	PVC		44.5	
427	C6-59	No. 3 Leach Well	Perched	MW	19988.8	10299.2	33.0	33.0	4	PVC		33	
428	C6-6	No. 3 Leach Well	Perched	MW	19983.3	10332.6	38.0	38.0	4	PVC		38	
429	C6-60	No. 3 Leach Well	Perched	MW	19977.0	10299.2	36.5	36.5	4	PVC		36.5	
430	C6-61	No. 3 Leach Well	Perched	MW	19981.5	10360.1	42.0	42.0	4	PVC		42	
431	C6-62	No. 3 Leach Well	Perched	MW	19981.2	10363.1	42.0	42.0	4	PVC		42	
432	C6-63	No. 3 Leach Well	Perched	EXW	19978.5	10365.8	43.0	43.0	4	PVC		43	
433	C6-64	No. 3 Leach Well	Perched	MW	19978.2	10369.9	43.0	43.0	4	PVC		43	
434	C6-65	No. 3 Leach Well	Perched	EXW	19968.5	10295.4	38.0	38.0	4	PVC		38	
435	C6-9	No. 3 Leach Well	Perched	MW	20157.5	10385.3	47.0	47.0	4	PVC		47	
612	P-12A	No. 3 Leach Well 12A	Regional	EXW	20082.6	10343.8	125.0	125.0	6	PVC			125
617	P-16	No. 3 Leach Well P-16	Regional	MW	20021.3	10265.5	163.0	160.0	4	PVC		163	
631	P-17A	No. 3 Leach Well P-17A	Regional	MW	19966.9	10403.3	130.0	129.2	4	PVC		130	
645	P-19A	No. 3 Leach Well P-19A	Regional	MW	20234.5	10283.5	100.0	98.4	4	PVC		100	
618	P-161	No. 3 Leach Well P-161	Regional	MW	19998.3	10296.8	110.0	110.0	6	PVC			110
620	P-163	No. 3 Leach Well P-163	Regional	MW	20056.6	10263.4	116.0	115.0	6	PVC			116
622	P-165	No. 3 Leach Well P-165	Regional	MW	20162.1	10369.9	102.0	102.0	6	PVC			102
624	P-167	No. 3 Leach Well P-167	Regional	MW	20030.5	10269.6	111.0	106.0	6	PVC			111
632	P-182	No. 3 Leach Well P-182	Regional	EXW	20075.5	10255.8	150.0	146.0	6	PVC			150
633	P-183	No. 3 Leach Well P-183	Regional	MW	20075.4	10259.3	113.0	111.0	6	PVC			113
634	P-184	No. 3 Leach Well P-184	Regional	MW	20027.5	10277.2	115.0	113.0	6	PVC			115
636	P-187	No. 3 Leach Well P-187	Regional	MW	20065.5	10242.2	179.7	179.7	4	PVC		179.7	
637	P-188	No. 3 Leach Well P-188	Regional	EXW	20099.4	10227.9	179.8	179.4	4	PVC		179.8	
638	P-189	No. 3 Leach Well P-189	Regional	EXW	20146.7	10206.3	149.6	149.2	4	PVC		149.6	
640	P-193	No. 3 Leach Well P-193	Regional	MW	20165.7	10319.1	159.9	159.5	4	PVC		159.9	
644	P-198	No. 3 Leach Well P-198	Regional	EXW	20095.2	10268.1	155.0	150.0	4	PVC		155	
663	P-226	No. 3 Leach Well P-226	Regional	MW	20104.4	10223.3	240.0	240.0	4	PVC		240	
436	C7-15	No. 3 Leach Well	Perched	EXW	20318.4	9623.1	34.5	34.5	4	PVC		34.5	
627	P-174	No. 3 Leach Well P-174	Regional	EXW	20350.5	9554.2	150.0	150.0	6	PVC			150
629	P-177	No. 3 Leach Well P-177	Regional	EXW	20352.9	9564.8	150.7	148.7	6	PVC			150.7
641	P-194	No. 3 Leach Well P-194	Regional	EXW	20359.1	9575.4	155.0	152.0	6	PVC			155
643	P-196	No. 3 Leach Well P-196	Regional	EXW	20360.7	9752.9	170.0	170.0	4	PVC		170	
651	P-209	No. 3 Leach Well P-209	Regional	EXW	20291.1	9437.2	164.5	159.5	6	PVC			164.5
653	P-211	No. 3 Leach Well P-211	Regional	EXW	20293.3	9528.5	167.0	162.0	6	PVC			167
654	P-212	No. 3 Leach Well P-212	Regional	EXW	20299.5	9643.1	164.5	159.0	6	PVC			164.5
444	C8-10	No. 3 Leach Well	Perched	EXW	20275.0	9058.0	52.0	52.0	4	PVC		52	
445	C8-11	No. 3 Leach Well	Perched	EXW	20281.0	9073.0	52.4	52.4	4	PVC		52.4	
452	C8-33	No. 3 Leach well	Perched	EXW	20514.3	9124.2	36.0	36.0	6	PVC			36
453	C8-34	No. 3 Leach well	Perched	EXW	20512.7	9111.1	36.3	36.3	4	PVC		36.3	
454	C8-36	No. 3 Leach Well	Perched	MW	20511.5	9119.1	30.0	30.0	4	PVC		30	
455	C8-39	No. 3 Leach Well	Perched	MW	20507.0	9153.8	31.5	31.5	2	PVC	31.5		
456	C8-43	No. 3 Leach Well	Perched	EXW	20503.7	9150.9	32.5	32.5	4	PVC		32.5	
457	C8-44	No. 3 Leach Well	Perched	MW	20504.8	9154.0	32.5	32.5	4	PVC		32.5	
459	C8-47	No. 3 Leach Well	Perched	MW	20327.9	9080.8	60.0	60.0	4	PVC		60	
460	C8-48	No. 3 Leach Well	Perched	EXW	20332.0	9087.0	60.0	60.0	6	PVC			60
462	C8-5	No. 3 Leach Well	Perched	MW	20267.0	9043.0	50.0	50.0	4	PVC		50	

Wells Abandoned At Closure

CAD Pt #	LocID	LocDescrip	Aquifer	LocType	Northing	Easting	Depth Total (feet)	Casing Depth (feet)	Casing Diameter (ID-inches)	Casing Type	2" Casing Diameter Length (ft)	4" Casing Diameter Length (ft)	6" Casing Diameter Length (ft)
464	C8-8	No. 3 Leach Well	Perched	MW	20286.0	9085.0	46.0	46.0	4	PVC		46	
465	C8-9	No. 3 Leach Well	Perched	EXW	20279.0	9067.0	53.0	52.5	4	PVC		53	
607	P-11	No. 3 Leach Well 11	Regional	MW	20495.2	9142.5	145.3	145.3	4	PVC		145.3	
630	P-178	No. 3 Leach Well P-178	Regional	EXW	20334.0	9083.7	205.0	205.0	4	PVC		205	
635	P-185	No. 3 Leach Well P-185	Regional	EXW	20309.1	8883.1	200.0	199.5	4	PVC		200	
639	P-192	No. 3 Leach Well P-192	Regional	EXW	20315.5	8982.5	199.9	199.5	4	PVC		199.9	
642	P-195	No. 3 Leach Well P-195	Regional	EXW	20331.8	9069.5	185.0	183.0	6	PVC			185
648	P-205	No. 3 Leach Well P-205	Regional	EXW	20334.5	9109.4	175.0	170.0	6	PVC			175
649	P-206	No. 3 Leach Well P-206	Regional	EXW	20336.7	9132.7	170.0	170.0	6	PVC			170
650	P-208	No. 3 Leach Well P-208	Regional	MW	20489.4	9045.0	140.0	135.0	6	PVC			140
652	P-210	No. 3 Leach Well P-210	Regional	EXW	20361.0	9108.8	169.0	164.0	6	PVC			169
660	P-220	No. 3 Leach Well P-220	Regional	EXW	20313.4	8978.3	220.0	217.0	6	PVC			220
661	P-221	No. 3 Leach Well P-221	Regional	EXW	20315.4	8953.7	216.0	213.0	6	PVC			216
672	P-235		Regional	EXW	20270.5	8850.9	207.0	207.0	6	PVC			207
466	C9-3	No. 3 Leach Well	Perched	MW	20252.6	8659.2	52.5	52.5	4	PVC		52.5	
467	C9-5	No. 3 Leach Well C9-5	Regional	MW	20304.4	8669.3	185.0	185.0	4	PVC		185	
671	P-234		Regional	EXW	20264.5	8689.6	210.0	210.0	4	PVC		210	
344	C10-17	No. 3 Leach Well	Perched	EXW	20173.1	8225.8	53.3	53.5	4	PVC		53.3	
345	C10-18	No. 3 Leach Well	Perched	EXW	20171.0	8231.8	55.5	55.5	4	PVC		55.5	
355	C10-55	No. 3 Leach Well	Perched	EXW	20718.2	8471.5	44.4	44.4	6	PVC			44.4
356	C10-57	No. 3 Leach Well	Perched	MW	20716.0	8474.6	40.0	40.0	4	PVC		40	
357	C10-58	No. 3 Leach Well	Perched	EXW	20711.0	8482.3	45.8	45.8	6	PVC			45.8
358	C10-59	No. 3 Leach Well	Perched	MW	20709.6	8486.1	39.5	39.5	4	PVC		39.5	
360	C10-8	No. 3 Leach Well C10-8	Regional	MW	20274.7	8191.2	193.0	193.0	4	PVC		193	
655	P-215	No. 3 Leach Well P-215	Regional	EXW	20181.5	8136.5	207.2	202.2	6	PVC			207.2
656	P-216	No. 3 Leach Well P-216	Regional	EXW	20198.5	8273.4	200.0	195.0	6	PVC			200
657	P-217	No. 3 Leach Well P-217	Regional	EXW	20222.9	8407.3	199.8	194.8	6	PVC			199.8
673	P-236		Regional	EXW	20179.6	7987.3	230.0	224.0	6	PVC			230
362	C11-1	No. 3 Leach Well C11-1	Regional	MW	20223.1	7568.7	210.0	210.0	4	PVC		210	
364	C11-16	No. 3 Leach Well	Perched	EXW	20202.0	7555.1	36.0	36.0	4	PVC		36	
368	C11-6	No. 3 Leach Well	Perched	MW	20200.4	7554.1	37.8	37.8	4	PVC		37.83	
647	P-203	No. 3 Leach Well P-203	Regional	EXW	20161.1	7289.6	245.0	245.0	4	PVC		245	
662	P-225	No. 3 Leach Well P-225	Regional	MW	20154.5	7289.6	221.0	221.0	4	PVC		221	
664	P-227		Regional	MW	20180.7	7300.5	295.5	290.5	4	PVC		295.5	
665	P-228		Regional	MW	20172.6	7376.8	255.0	249.0	4	PVC		255	
666	P-229		Regional	MW	20157.1	7221.1	243.0	237.5	4	PVC		243	
668	P-230		Regional	MW	20441.0	7312.4	235.0	221.0	4	PVC		235	
674	P-237		Regional	EXW	20171.9	7833.6	230.0	224.0	6	PVC			230
675	P-238		Regional	EXW	20182.0	7690.3	235.0	229.0	6	PVC			235
676	P-239		Regional	EXW	20174.3	7442.9	244.0	238.0	6	PVC			244
679	P-240		Regional	EXW	20163.9	7552.8	242.0	236.0	6	PVC			242
680	P-241		Regional	EXW	20154.3	7092.5	260.0	259.0	4	PVC		260	
623	P-166	No. 3 Leach Well P-166	Regional	MW	20377.7	10120.0	113.0	110.0	4	PVC		113	
											Totals (feet):	**11726**	**5684**

NOTE: Values in red are estimated

APPENDIX C.5
SEEDING AREAS

Years and approximate acreage for each area that was seeded.

2004

Burro Mountain Tailing Impoundment – 58 acres December 2004 (communication from Chuck Johnson 2012)

2005

Burro Mountain – 1.3 acres December 2005 (communication from Mandy Lila 2013)
Tailing 3x - 365 acres December 2005 (MWH takeoffs Appendix C.1)

2006

Tailing 3 - 643 acres December 2006 (MWH takeoffs Appendix C.1)

2007

Mill Site – 56 acres (used 45 acres 11 acres re=done in 2010) April 2007 (communication from Mandy Lila 2013)

2009

#1 Stockpile – 500 acres December 2009 (communication from Mandy Lila 2013)
1, 1A, 1x Tailing Impoundment 1547 acres September 2009 (MWH takeoffs Appendix C.1)
Tailing 2 - 606 acres September 2009 (MWH takeoffs Appendix C.1)

2010   (communication from Mandy Lila 2013)

7AFW Stockpile – 34 acres Decmeber 2010
7AW Upper – 38.2 acres Decmeber 2010
7AW Wing – 7.7 acres Decmeber 2010

Mill Site re-do 11 acres August 2010 (communication from Chuck Johnson 2012)

2011   (communication from Mandy Lila 2013)

1C Stockpile: Ridge/Valley 15-19 - 45 acres December 2011
7AW Wing – 4 acres December 2011
7AE Upper – 18.3 acres December 2011

2012   (communication from Mandy Lila 2013)

7AE Upper - 27.2 acres December 2012
1C Stockpile – 111.7 acres December 2012

No Man’s Land – 4 acres Decmber 2012

2015 (Telesto calculation in 2012)

Copper Mountain Reclamation Area - 51.4 acres January 2015

Remaining lauder line & tailings pipeline / associated features NW of tailing thickeners - 100 acres January 2015

APPENDIX C.6
POWERLINES, UTILITIES, AND PIPELINES

Power lines, Utilities, and Pipelines

Item	Take-off	Reference
Power line Demolition (3 PLS to 1x1 Pond installed 2012)	10,300	New Powerline installed in 2012; Chuck Johnson 11/28/2012 (20120828_Fig 2 Typical 1X1 Transmission Line Pole Detail AZ.pdf)
Power pole Demolition (3 PLS to 1x1 Pond installed 2012)	36	New Powerline installed in 2012; Chuck Johnson 11/28/2012 (20120828_Fig 2 Typical 1X1 Transmission Line Pole Detail AZ.pdf)
Powerlines to substations or spurs for buildings to be demolished (closed with Building Demolition)	66,200 feet	2013 Blue Stake Map -Mandy Lila (5/23/13)
Power poles to substations or spurs for buildings to be demolished (closed with Building Demolition)	135	2013 Blue Stake Map -Mandy Lila (5/23/13)
Telephone lines around demo buildings (closed with Building Demolition)	1,400 feet	2013 Blue Stake Map -Mandy Lila (5/23/13)
Light poles around demo buildings (closed with Building Demolition)	13	2013 Blue Stake Map -Mandy Lila (5/23/13)
Fire Hydrants, mainly by SXEW (closed with Building Demolition)	14	2013 Blue Stake Map -Mandy Lila (5/23/13)
San Salvador Pit powerline demo (closed with Building Demolition)	5,222 feet	2013 Blue Stake Map -Mandy Lila (5/29/13) and Planned (2013 LOM for CCP.dwg)
San Salvador Pit powerline power poles (closed with Building Demolition)	17 (5,222 feet / 300 feet / pole)	Planned
PLS pipelines located outside stockpile regrade footprint and around exterior of the Mine Stockpile Unit (Year 6 of closure):	11,342 feet	2013 Blue Stake Map -Todd Stein (5/29/13)
PLS pipelines located within the interior portion of the Mine Stockpile Unit and outside the stockpile regrade footprint (Year 6 of closure):	18,893 feet	2013 Blue Stake Map- Todd Stein (5/29/13)
PLS pipelines located within the SX/EW Plant area and outside the stockpile regrade footprint (Year 6 of closure):	1,052 feet	2013 Blue Stake Map- Todd Stein (5/29/13)
Sewer pipelines located within the SX/EW Plant area and outside the stockpile regrade footprint (Year 6 of closure):	1,414 feet	2013 Blue Stake Map -Todd Stein (5/29/13)
Water treatment pipelines (alternative 1; demolished year 100)	74,500 feet	Planned, Todd Stein (5/29/13)
Little Rock Mine Pipeline alignment #1 and #2 (Year 34 of closure)	4, 940 feet	2013 Little Rock Mine Amendment to Mine Plan of Operations; Tyrone permit boundary to lined 1x1 pond- April Tischer (5/14/2015)

Appendix D

Key Equations and Calculations

EQUATIONS USED IN CAPITAL COST SPREADSHEET

Sheet #4 Earthwork:

Bank Volume (bcy)= Loose Volume(cy)/(1+Swell Factor)

*Loose Volume (lcy)= Area (ac)*Cover Depth (in)*43560 (ft^2/ac)/(12 (in/ft)*27 (cy/ft^3))*

*** Swell Factor only applies to the cover material volume calculations*

Sheet #5 Dozer (Grading):

Productivity Example for D11T CD:

*Normal productivity (cy/hr) = 162,758.76 * Centroid to Centroid Push Distance(ft)$^{-0.866691}$*

(Caterpillar Performance Handbook Edition 47 page 19-51)

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

$$Productivity\ (ac/hr) = Effective\ Blade\ Width\ (ft) * Speed\ \left(\frac{miles}{hr}\right) * 5{,}280\ \frac{ft}{mile} * \frac{ac}{43{,}560\ sq\ ft} * Operator * Material * \frac{Work\ Hour\ (min/hr)}{60\ (min/hr)} * Grade\ Factor * \frac{2300\ (lbs/cy)}{Material\ Weight\ (lbs/cy)} * Prod.\ Method * Visibility * Elev. * Drive\ Trans.$$

$$Total\ Task\ Time\ (hr) = \frac{Loose\ or\ Stockpile\ Volume\ (cy)}{\text{Productivity}\ (cy/hr)}$$

$$Grade\ (Dozing\ Factor) = -0.02 * Grade\ (\%) + 1$$

$$(Caterpillar\ Performance\ Handbook\ Edition\ 48\ page\ 19 - 55)$$

Sheet #7 Ripper:

$$\text{Productivity } (acres/hr) = \frac{Work\ Hour\ (min/hr)}{\left[\left(\frac{Ripping\ Length\ (ft)}{5280(ft/mi) * \frac{Speed\ (mi/hr)}{60\ (min/hr)}}\right) + Turn\ Time\ (min/pass)\right] * Passes/Acre^{*}}$$

$$Task\ Time\ (hr) = \frac{Area\ (acres)}{\text{Productivity } (acres/hr)}$$

$$Passes/Acre^{*} = \frac{43560\ (ft^2/acre)}{Ripping\ Length\ (ft) * Ripped\ Width\ Plus\ Distance\ b/n\ Passes\ (ft)}$$

**Passes are 1000 ft for large surface areas and 100 ft for reservoirs*

$$Ripped\ Width\ Plus\ Distance\ b/n\ Passes\ (ft) = ((Pocket\ Spacing\ (in) + Distance\ Between\ Passes\ (in)) * No.Shank\ Pockets)/(12(in/ft))$$

Sheet #8 Excavator:

$$Task\ Time\ (hr) = (Cycle\ Time\ (min))/(60(min/hr)) * (Area\ (ac) * 0.5 * 43560(ft^2/ac))/(Sheepsfoot\ Roller\ Width\ (ft) * Maximum\ Reach\ (ft))$$

Sheet #9 Trucks:

$$Truck\ Cycle\ Time\ (min) = Haul\ Time\ (min) + \text{Return } Time\ (min) + Loading\ Time\ (min) + Truck\ Exchange\ Time\ (min) + Dump/Maneuver\ Time\ (min)$$

$$\text{Productivity } (cy/hr) = Work\ Hour\ (min/hr) * Loader/Shovel\ Cycles\ Per\ Truck * Loader/Shovel\ Net\ Bucket\ Cap\ (cy) * \frac{Optimum\ Number\ of\ Trucks}{Truck\ Cycle\ Time\ (min)}$$

$$Task\ Time\ (hr) = Maximum\ \left[\frac{Volume\ (cy)}{\text{Productivity } (cy/hr)}, Loader\ Task\ Time\ (hr)\right]$$

$$Loader/\,Shovel\ Cycles\ Per\ Truck = Maximum\ \left[\frac{Truck\ Struck\ Capacity\ (cy)}{Loader/Shovel\ Net\ Bucket\ Capacity\ (cy)}, \frac{Truck\ Heaped\ Capacity\ (cy)}{Loader/Shovel\ Net\ Bucket\ Capacity\ (cy)}\right]$$

$$Total\ Haul\ \text{Distance}\ (ft) = \sum Segment\ Haul\ \text{Distance}\ (ft)$$

$$Haul\ \text{Distance}\ Segment\ (m) = Haul\ \text{Distance}\ (ft) * 0.3048\ \left(\frac{m}{ft}\right)$$

$$Haul\ Effective\ Grade\ (\%) = If(Haul\ Grade\ (\%) \geq Rolling\ Resistance\ (\%), \big(Haul\ Grade\ (\%) + Rolling\,Resistance\ (\%)\big), Absolute\ Value(Haul\ Grade\ (\%) + Rolling\,Resistance\ (\%))$$

$$\text{Return}\ Effective\ Grade\ (\%) = If(-Haul\ Grade\ (\%) \geq Rolling\ Resistance\ (\%), \big(-Haul\ Grade\ (\%) + Rolling\,Resistance\ (\%)\big), Absolute\ Value(-Haul\ Grade\ (\%) + Rolling\,Resistance\ (\%))$$

Travel Time Loaded and Empty (Uphill) Example for 777F:

$$777F\ Segment\ Travel\ Time\ Loaded\ Uphill\ (min/m) = 6.43 * Haul\ Effective\ Grade\ Segment\ (\%)^{4} - 3.2933 * Haul\ Effective\ Grade\ Segment\ (\%)^{3} + 0.6548 * Haul\ Effective\ Grade\ Segement\ (\%)^{2} - 0.005 * Haul\ Effective\ Grade\ Segment\ (\%) + 0.0009$$

$$777F\ Segment\ Travel\ Time\ Empty\ Uphill\ (min/m) = -0.0197 * \text{Return}\ Effective\ Grade\ Segment\ (\%)^{4} + 0.0276 * \text{Return}\ Effective\ Grade\ Segment\ (\%)^{3} + 0.011 * \text{Return}\ Effective\ Grade\ Segement\ (\%)^{2} + 0.0008 * \text{Return}\ Effective\ Grade\ Segement\ (\%) + 2.147$$

$(Caterpillar\ Performance\ Handbook\ Edition\ 41\ page\ 9-39)$

This is repeated for loaded and empty downhill travel times

$$Haul\ Time\ (min) = \sum (Segment\ Travel\ Time\ Loaded\ (min/m) * Segment\ Haul\ Dist\ (m))$$

$$\text{Return } Time\ (min) = \sum (Segment\ Travel\ Time\ Empty\ (min/m) * Segment\ Haul\ Dist\ (m))$$

$$Loading\ Time\ (min) = Loader/Shovel\ Cycle\ Time\ (min)$$

Sheet #10 Loader or Shovel:

$$Net\ Bucket\ Capacity\ (cy) = Struck\ (Rated)\ Bucket\ Capacity\ (cy) * Bucket\ Fill\ Factor$$

$$\text{Productivity } (cy/hr) = \frac{Net\ Bucket\ Capcity\ (cy) * Work\ Hour\ (min/hr)}{Loader/Shovel\ Cycle\ Time\ (min)}$$

$$Task\ Time\ (hr) = \frac{Volume\ (cy)}{\text{Productivity } (cy/hr)}$$

Sheet #12 M'grader

$$\boldsymbol{Grader\ Shaping\ Productivity}\ (\boldsymbol{acre/hr}) = \boldsymbol{WorkHour}(\boldsymbol{min/hr})/(\mathbf{60}\ (\boldsymbol{min/hr})) * \boldsymbol{MaterialFactor} * ((\mathbf{2300}\ (\boldsymbol{lb/cy}))/\boldsymbol{MaterialWeight}(\boldsymbol{lb/cy})\ ) * \boldsymbol{ProductionMethod, Blade} * \boldsymbol{OperatorFactor} * \boldsymbol{GradeFactor} * \boldsymbol{Speed}\ (\boldsymbol{mph}) * (\boldsymbol{Eff.Blade\ Width}(\boldsymbol{ft}) - \boldsymbol{Pass\ Overlap}(\boldsymbol{ft})) * \mathbf{5280}(\boldsymbol{ft/mi})/\mathbf{43560}(\boldsymbol{ft\text{^}2/ac})$$

(Motor Grader Productivity, Caterpillar Performance Handbook Edition 48)

$$Task\ Time(hr) = Area(acre)/(GradingShapingProductivity(acre/hr))$$

$$Grade\ Factor = -0.02 * \%\ Final\ Grade + 1$$

Sheet #13 Earth Sum:

$$Direct\ Equipment\ Cost\ (\$) = [Lube, Tires, GEC, \&\ Field\ Parts\ Adjusted\ Rental\ Cost\ \left(\frac{\$}{hr}\right) + Labor\ Cost\ \left(\frac{\$}{hr}\right) + Field\ Cost\ \left(\frac{\$}{hr}\right)] * TimeRequired\ (hr) * Number\ of\ Units\ of\ Equipment$$

Sheet #14 Revegetation:

$$Direct\ Fuel\ Cost\ (\$) = Fuel\ Unit\ Cost(\$/acre) * Area(acre)$$

$$Direct\ Reveg.Cost\ (\$) = Reveg.Unit\ Cost(\$/acre) * Area(acre)$$

Sheet #15 Other:

$$Fuel\ Direct\ Cost\ (\$/units) = Quantity\ (units) * Fuel\ Unit\ Cost(\$/unit)$$

$$Direct\ Cost(\$) = Quantity\ (units) *\ Unit\ Cost(\$/unit)$$

Sheet #16 Sum:

$$\boldsymbol{Subtotal\ Direct\ Costs}\ (\$)$$
$$= \boldsymbol{Facility\ and\ Structure\ Removal\ Total\ Direct\ Cost}\ (\$)$$
$$+ \boldsymbol{Earthmoving\ Total\ Direct\ Cost}\ (\$)$$
$$+ \boldsymbol{Reveg.Total\ Direct\ Cost}\ (\$)\ +\ \boldsymbol{Other\ Total\ Direct\ Cost}\ (\$)$$

$$\boldsymbol{Subtotal\ Indirect\ Costs}(\$) = \boldsymbol{SubTotal\ Direct\ Cost}\ (\$) * \frac{\boldsymbol{Indirect\ Costs}\ (\%)}{\mathbf{100}}$$

$$\boldsymbol{Total\ Cost}\ (\$) = \boldsymbol{Subtotal\ Direct\ Cost}\ (\$) + \boldsymbol{Subtotal\ Indirect\ Cost}\ (\$)$$

Sheet #18 Truck Optimization:

$$Loader/Shovel\ Time\ Per\ Truck = (Loader/Shovel\ Cycles\ per\ Truck) * (Loader/Shovel\ Cycle\ Time)$$

$$Maximum\ Number\ of\ Trucks\ Per\ Loader/Shovel = (Truck\ Cycle\ Time\ Per\ Truck)/(Loader/Shovel\ Time\ per\ Truck)$$

$$\text{Productivity } (cy/hr) = Work\ Hour\ (min/hr) * Loader/Shovel\ Cycles\ Per\ Truck * Loader/Shovel\ Net\ Bucket\ Capacity\ (cy) * \frac{Number\ of\ Trucks[n]}{Truck\ Cycle\ Time\ (min)}$$

$$Task\ Time\ (hr) = (Haul\ Volume(cy))/Productivity(cy/hr)$$

$$Cost\ of\ [n]\ Trucks\ per\ Loader\ (\$) = MAX(Truck\ Task\ Time, Loader\ Task\ Time) * (Loader\ Cost\ (\$/hr) + [n] * Truck\ Cost\ (\$/hr))$$

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 Tyrone Mine 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 site as complex as the Tyrone Mine.

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.

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

Building Demolition:
1. Building Demo
2. Building Cover
3. Building Vegetation
4. Building Waste
5. Building Summary

Unit Costs:
1. Bench Grading
2. Bench Channel (and Riprap/Gravel)
3. Downdrain
4. Pipeline (6”-8” and 20”-36”)
5. Revegetation
6. Seepage Collection
7. Trestle Demo
8. Berm
9. Substation Demo

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, Reservoirs, Haul Roads and Disturbed Areas**
24			
25			

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	139,000	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.

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

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

$$Productivity_{normal} = C * (Distance_{Push}{}^{b})$$

C = Multiplier Constant and b = Exponent Constant

EARTHWORK AND O&M EQUIPMENT

Code	Equipment Description	Equipment Type	Fuel Consumption (gal/hr)	Fuel Cost ($/hr)	Lube Cost ($/hr)	Field Parts ($/hr)	Tire Cost ($/hr)	Ground Engaging Component Cost ($/hr)	Monthly Rental Rate ($/month)	Field Labor Time Cost ($/hr)	Rental Cost (w/o fuel, lube, tires, or field parts) ($/hr)[6]	Lube, Tires, GEC, & Field Parts Adjusted Rental Cost (w/o fuel) ($/hr)	Dozing Production (lcy/hr)[1] Production = C(Avg. dozing distance in ft)[b] C	b
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[5]	-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	$ 8.70	$ 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	$ 20.70	$ 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)

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

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

EARTHWORK AND O&M EQUIPMENT

Code	Equipment Description	Equipment Type	Haul Travel Time (min/m) = A(Eff. Grade %)^4 + B(Eff. Grade %)^3 + C(Eff. Grade %)^2 + D(Eff. Grade %) + E																				
			Loaded Uphill					Empty Uphill					Loaded Downhill					Empty Downhill				
			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	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.

		EARTHWORK AND O&M LABOR	
50			
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 "1BuildingDemo", "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 Manqus 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			
32									

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)

	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.

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

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

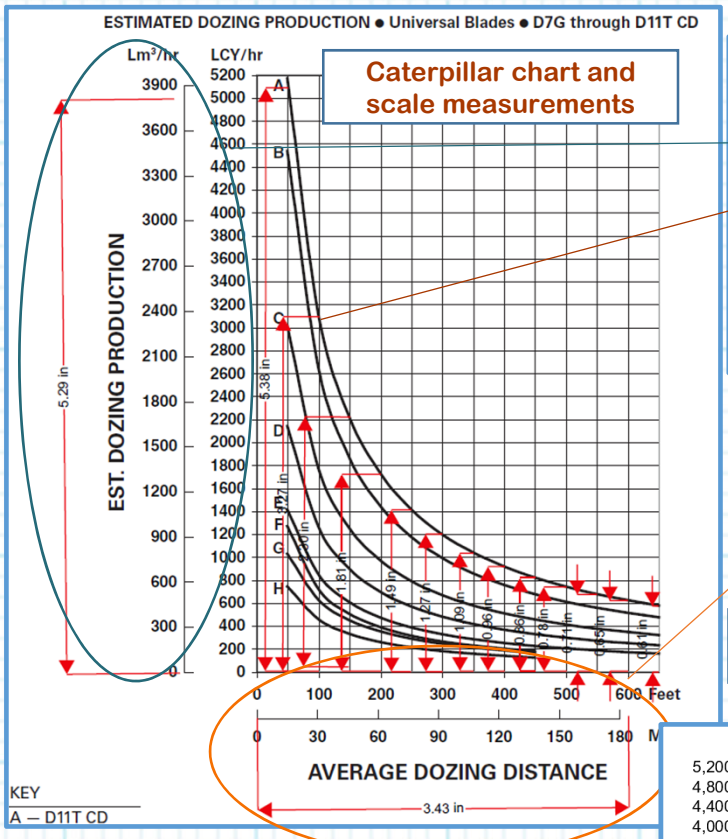
M325/(1+L325)

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

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.

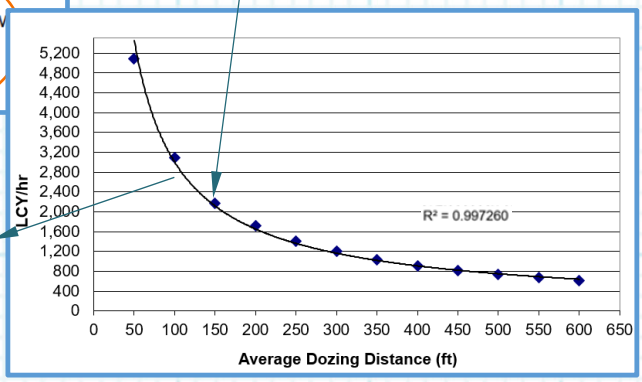
Results cont'd:

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		=B10/F6*G6			
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					

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 – Dozer cont'd: 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	-23%

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

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

Sheet 6 –Road Maint: 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
Productivity and Hours Required for Dust Suppression and Road Maintenance
Stockpile Spreadsheet Worksheet #6
04/29/19

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

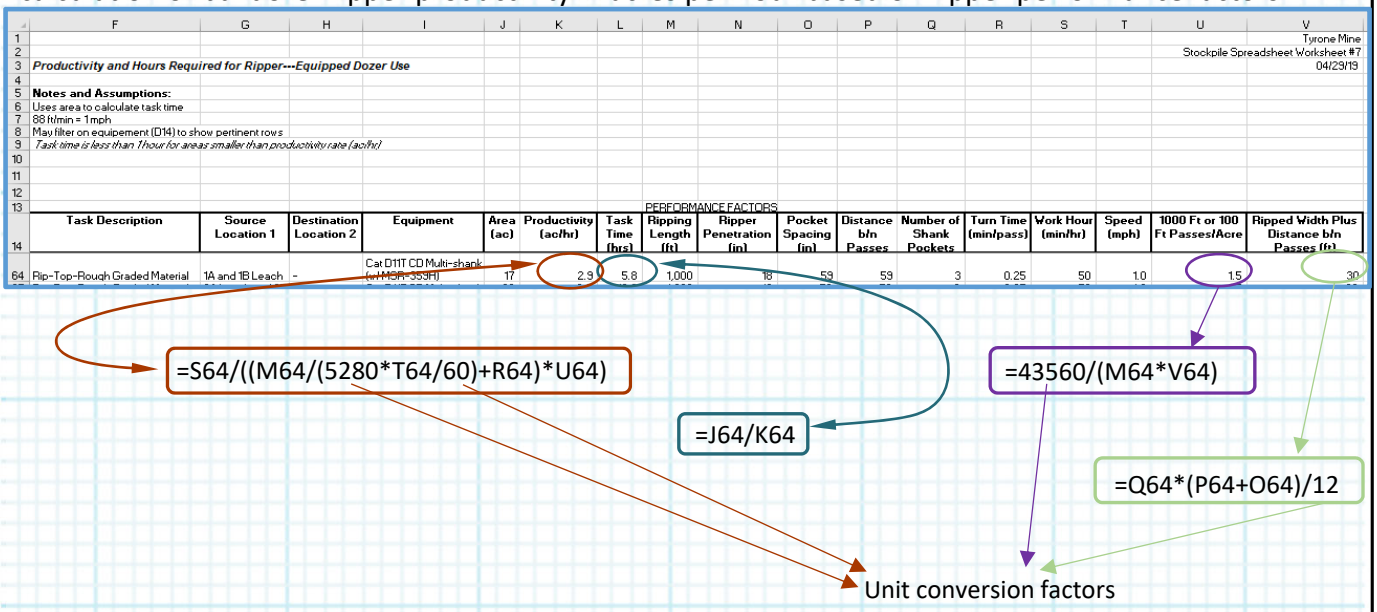
ID	Task Description	Source Location 1	Destination Location 2	Equipment	Operational Maintenance Time
1000-P-b-Comb1	Road Maintenance	Gila Borrow Area	1A and 1B Leach	Cat 14M, Off-Hwy Water Tanker Truck,6,000-gal.	423

Equals loading time on Loader/Shovel sheet

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

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:



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

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

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)

	Task Description	Source Location 1	Destination Location 2	Equipment	Area (ac)	Productivity (ac/hr)	Task Time (hrs)	PERFORMANCE FACTORS: 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-353H)	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)

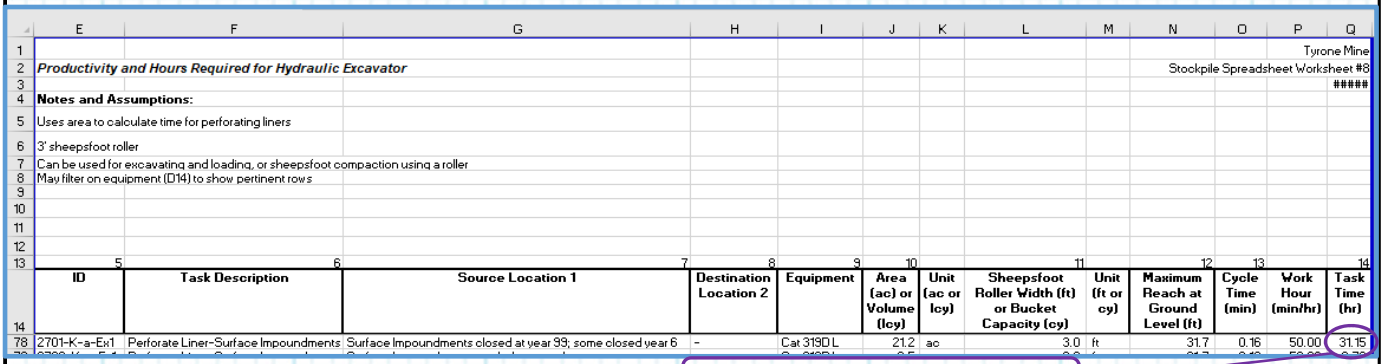
=J64/K64

=43560/(M64*V64)

=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.



Productivity and Hours Required for Hydraulic Excavator

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

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

	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

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

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.

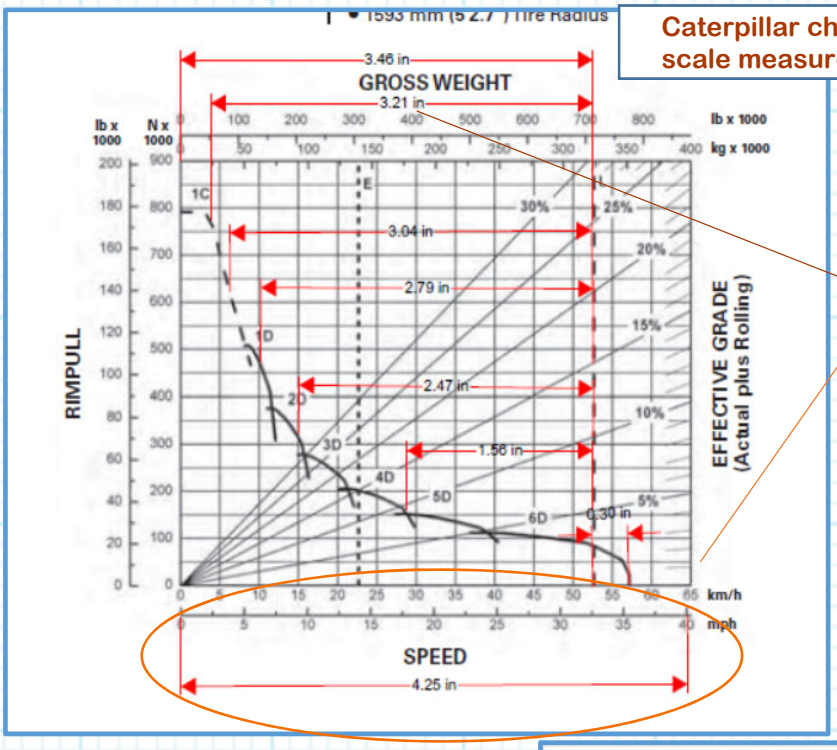
	AR	AS	AT	AU	AV	AW
1						Tyrone Mine
2						Stockpile Spreadsheet Worksheet #9
3						04/29/19
13	44	45	46	47	48	49
14	Travel Time Loaded Segment 1 (min/m)	Travel Time Loaded Segment 2 (min/m)	Travel Time Loaded Segment 3 (min/m)	Travel Time Empty Segment 1 (min/m)	Travel Time Empty Segment 2 (min/m)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

Results cont'd

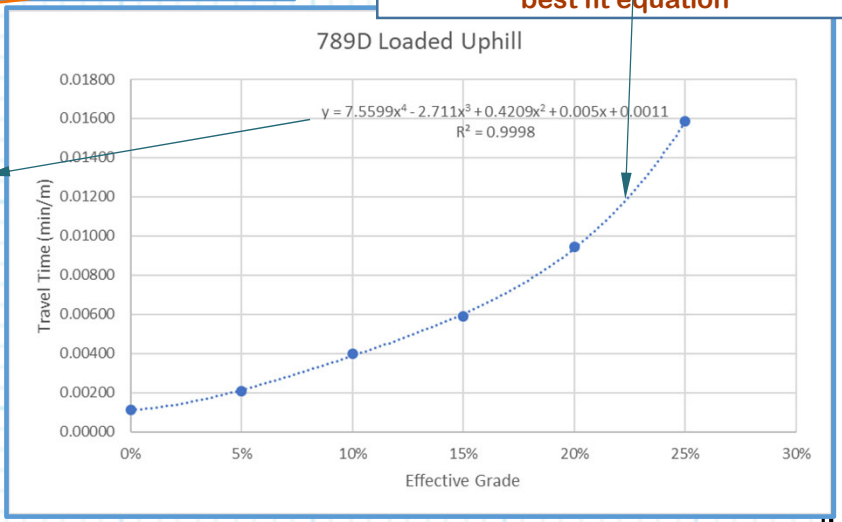
Sheet 9 – Trucks cont'd: Haul times are calculated for the trucks by using rimpull-speed-gradeability curves and retarding curves to create a relationship for travel time vs. effective resistance for travel uphill and downhill, respectively. A formula is derived by curve fit to the rimpull-speed-gradeability 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

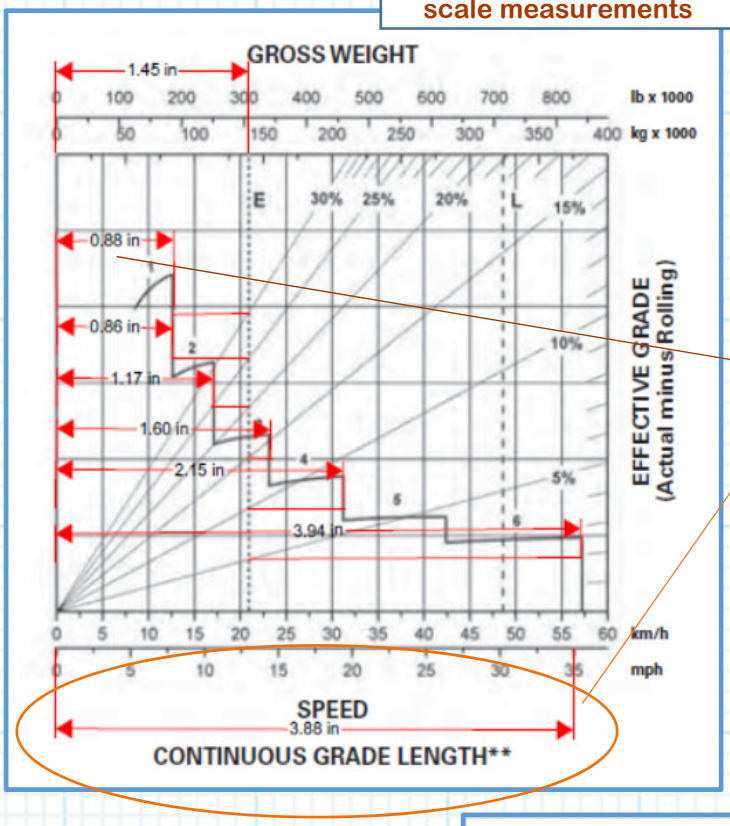
These coefficients are listed for each type of truck in columns P-AI of the Equipment sheet.

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

Results cont'd

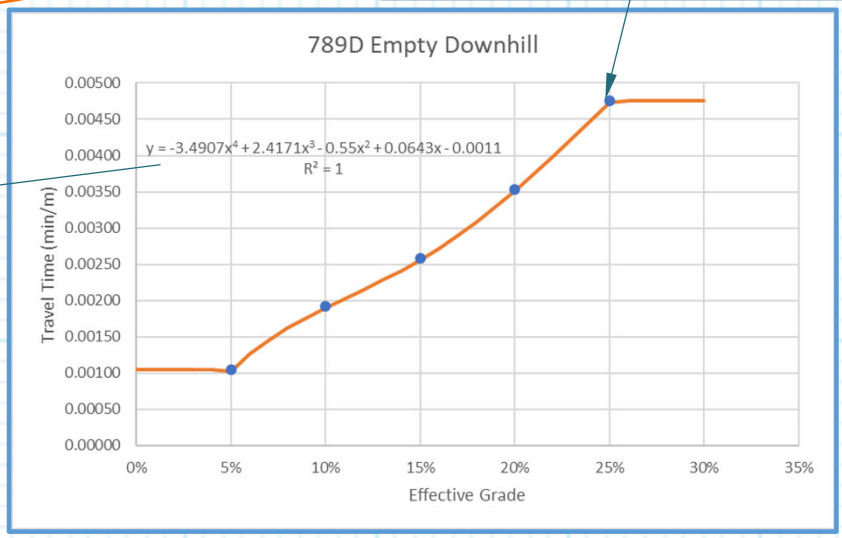
Sheet 9 – Trucks cont'd: The example below shows how travel time is calculated for downhill routes, assuming an empty truck:

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.

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 3

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.

Results cont'd

Sheet 13 – EarthSum cont'd:

=SUM(O15:Q15)

=J15*N15*M15

	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)							
7								
8								
9								
10								
11								
12								
13								
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	3,386.9	$647,837	$2,368,057	$255,101	$3,271,055	8,060,000	-

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.

Tyrone Mine
Revegetation Costs
Stockpile Spreadsheet Worksheet #14
04/29/19

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 ($)	Reveg w/o Fuel Direct Cost ($)
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)

Page 1

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

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.

	E	F	G	H	I	J	K	L	M	N
1										Tyrone Mine
2	*Other Reclamation Activity Costs*									Stockpile Spreadsheet Worksheet #15
3										04/29/19
4	**Assumptions:**									
5	1 - Cost to construct drain or channel on re-graded stockpile									
6	2 - The downdrain, ACB, well plug & abandon, and well replacement costs include fuel									
7	May filter on equipement (D14) to show pertinent rows									
8										
9										
10										
11										
12										
13										
14	**ID**	**Description**	**Source Location 1**	**Destination Location 2**	**Quantity**	**Unit**	**Fuel Unit Cost ($/unit)**	**Unit Cost w/o Fuel ($/unit)**	**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-U7t	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
283										
284										
285										
286										
287										
288										
289										
290										
291								TOTAL	$ 547,382	$ 19,979,626

=I259*K259

=SUM(M15:M261)

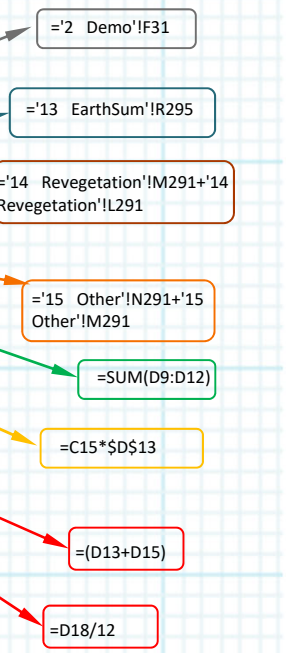
For example use only. Values may not match the current spreadsheet.

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				

Page 1



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
- Building Demo
- Bench Grading Unit Cost
- Bench Channel Unit Cost (and Riprap/Gravel Unit Cost)
- Downdrain Unit Cost
- Pipeline 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 Tyrone Mine Closure/Closeout Plan (CCP). A reliable estimate of the local 2019 fuel price is needed, based on local and national data for past years.

Objective:

1. Develop an equation to predict the estimated 2019 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 2019 fuel price for use in the earthwork closure costs.

Data and Assumptions:

1. Data used for the calculations are shown below (1995-2018) 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)

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

Data and Assumptions (continued):

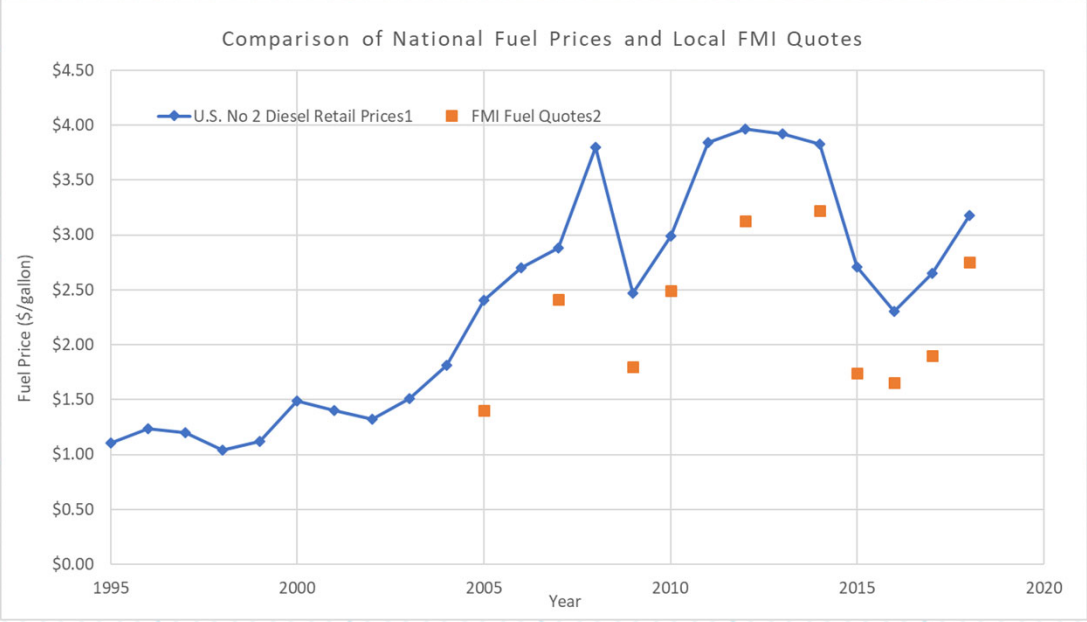
2. The local FMI fuel quotes and annual national retail fuel (U.S. No. 2) prices are assumed to trend similarly – if the national prices increase the local prices also increase.
3. A correlation between national and local fuel prices is assumed to be a reasonable predictor of local fuel prices for any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



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Calculations and Results (continued):

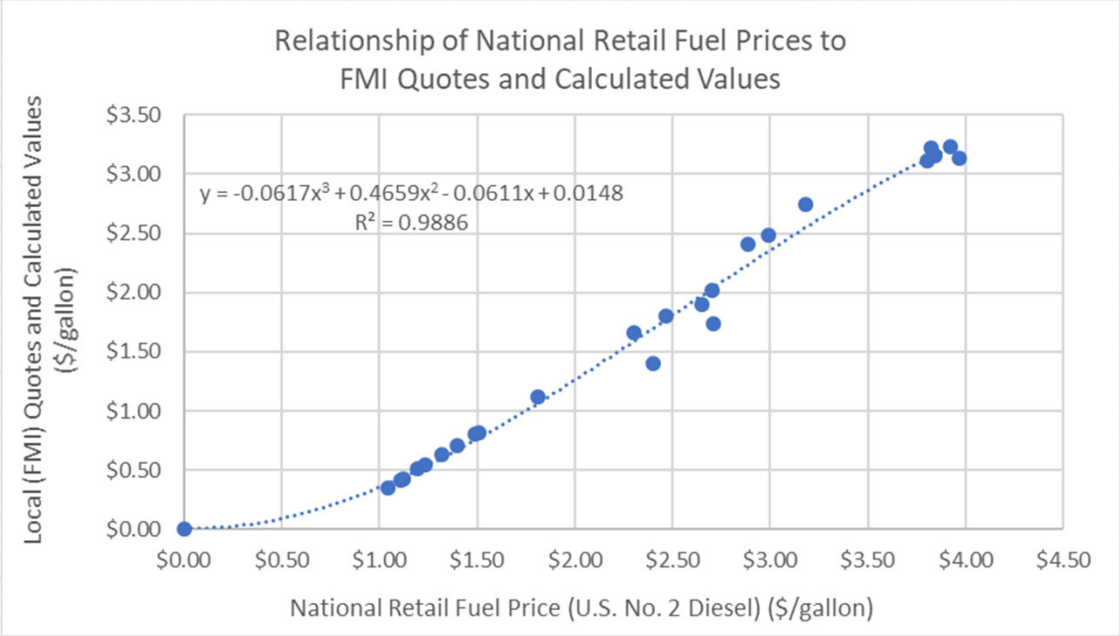
2. The annual national fuel retail prices are ranked from lowest to highest, and corresponding local FMI fuel quotes are listed for matching years in which they are available. (see Col. A and B, below)
3. The difference between the national fuel retail prices and FMI fuel quotes is calculated for each 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 January 2019 of $2.98, the predicted local FMI fuel price for U.S. No. 2 diesel (January 2019) is

$$Local\ fuel\ price = (-0.0617)(2.98)^3 + (0.4659)(2.98)^2 - (0.0611)(2.98) + 0.0148 = \$2.34/gallon$$

Summary and Conclusions:

1. National and local (FMI) fuel price data were used to develop a strongly-correlated (R^2 = 0.9886) 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 2019 local fuel price for use in earthwork closure costs:

$$Local\ fuel\ price = -0.0617x^3 + 0.4659x^2 - 0.0611x + 0.0148$$

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

Bench Grading
Unit Cost

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 Tyrone Mine 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

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:

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

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

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 Tyrone Mine 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 3 Deck Portable Screening Plant w/ 5x16 screen & 42"x60' conveyor + 1 Operator	$ 64.25	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)	$ 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 Factor^2	Grade Factor^2	Material Weight^2 (lb/cy)	Production Method/ Blade Factor^2
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 Distance^2 (feet)	Normal Production (cy/hr)	Operator Factor^2	Work Hour^2 (min/hr)	Visibility Factor^2	Elevation Factor^2	Transmission Factor^2
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).

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

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)

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

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	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.

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

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

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

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

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

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:

$$Daily\ Total\ Equipment\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ equipment, \frac{\$}{hr}\right) x\ \left(8\frac{hr}{day}\right) = \left(\frac{\$1{,}108}{hr}\right) x\ \left(8\frac{hr}{day}\right) = \frac{\$8{,}867}{day}$$

$$Daily\ Total\ Fuel\ Cost, \frac{\$}{day} = \left(Sum\ for\ all\ fuel, \frac{\$}{hr}\right) x\ \left(8\frac{hr}{day}\right) = \left(\frac{\$223}{hr}\right) x\ \left(8\frac{hr}{day}\right) = \frac{\$1{,}785}{day}$$

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

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

Truck 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 Tyrone Mine 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.

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

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

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.

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 Tyrone Mine 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

$$\textbf{\textit{Total downdrain installation cost (after rough grading)}} = \$373.55/ft$$

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

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

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**

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**

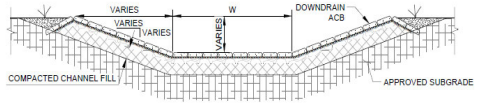
Install Cutoff Wall

Cutoff Wall (cast in place concrete)	cubic yard	$/cubic yard	**$/dissipater[2]**
RSMeans (2019)	14	$ 254.97	**$3,569.58**

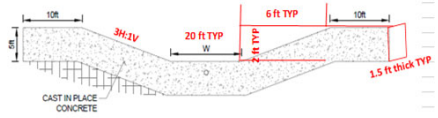
Total Dissipator Cost ($/each)	**$14,556.48**

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

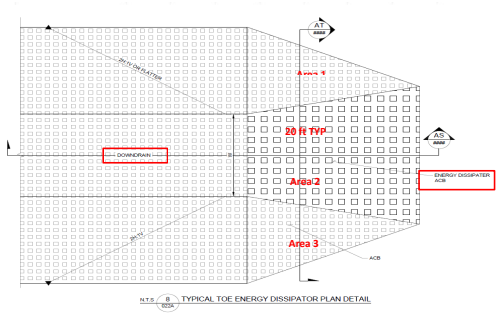
DISSIPATERS	**ACB**				**Cutoff Wall[3]**		
	Surface Area 1	**Surface Area 2**	**Surface Area 3**	**Total**	**Cross-Sectional Area**	**Thickness**	**Volume**
	(sf)	**(sf)**	**(sf)**	**(sf)**	**(sf)**	**(ft)**	**(cy)**
	253	320	253	825	260	1.5	14



N.T.S AU 022A TYPICAL DOWNDRAIN SECTION



N.T.S AX 022A TYPICAL CUTTOFF WALL SECTION



N.T.S B 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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Building Demolition Cost

Calculation Documentation

Problem Statement:

Freeport-McMoRan (FMI) utilizes cost information for demolition of buildings (including storage tanks) as part of earthwork closure cost estimation associated with the Tyrone Mine Closure/Closeout Plan (CCP). The demolition costs need to account for site-specific conditions including building dimensions and footprint areas which are used with available construction/earthwork unit rates to estimate the demolition cost.

This calculation set presents a summary of the approach and results for estimating the building demolition cost. Detailed information is presented in the Tyrone 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 cost estimate for demolition of buildings (including storage tanks) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

1. The data, assumptions, calculations, and results for the building demolition cost estimate are presented within the Tyrone earthwork RCE spreadsheet file in a series of sheets (tabs) that address building demolition, cover placement, revegetation, and removal/disposal of building waste materials requiring special handling. An additional tab presents a summary of the costs.
2. The approach for estimating building demolition costs is as follows:
   - Compile building and storage tank dimension/footprint area data and assumptions used in the calculations.
   - Estimate the cost for demolition to account for volume of structural materials, volume of cover material placement, area of revegetation, and tonnage of waste requiring special handling.

Results:

1. The results of the building demolition cost calculations are summarized 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 30% 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 Facility Demolition Summary

			Current Value
DIRECT COSTS	Facility and Structure Removal		$666,916
	Cover		$24,132
	Ripping & Revegetation		$2,061
	Hazardouse Waste Removal		$2,534,217
	Subtotal, Direct Costs		**$3,227,325**
INDIRECT COSTS[1]	**Subtotal, Indirect Costs**	**30.0%**	**$968,198**
TOTAL COST			**$4,195,523**

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

Pipeline Demolition Unit Cost

Calculation Documentation

Problem Statement:
Freeport-McMoRan (FMI) utilizes unit cost information for pipeline demolition as part of earthwork closure cost estimation associated with the Tyrone Mine Closure/Closeout Plan (CCP). The unit costs need to account for site-specific conditions and pipeline information which are used with available construction/earthwork unit rates to estimate the pipeline demolition cost.

This calculation set presents a summary of the approach and results for estimating the unit cost for pipeline demolition (remove sludge/water, place cover). 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 pipeline demolition unit cost ($/ft) for use in estimating earthwork closure costs at FMI's mining operations in Grant County, NM.

Approach:

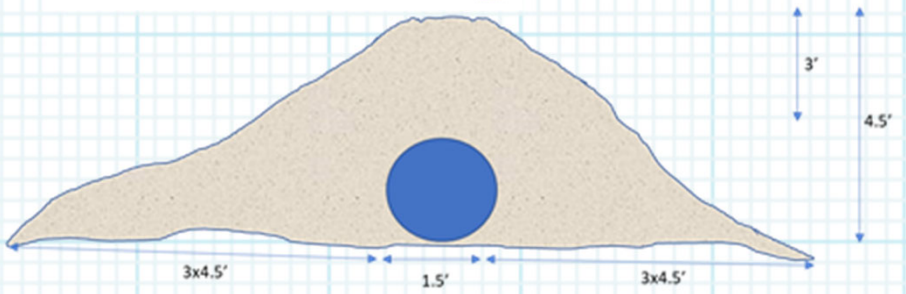
1. The data, assumptions, calculations, and results for the pipeline demolition unit cost estimate are presented within the Tyrone earthwork RCE spreadsheet fil in sheets (tabs) named "6"-8" Pipeline_UC", "18" Pipeline_UC", and 20"-36" Pipeline UC".
2. The approach for estimating the pipeline demolition unit cost is as follows:
   - Compile pipeline data and assumptions used in the calculations.
   - Identify a unit rate for pipeline sludge/water removal from available construction/earthwork data. For the required sludge/water removal, use a similar operation for storage tank sludge/water removal from R.S. Means Online to develop a pipeline cost ($/ft).
   - Estimate the volume of cover (cubic yard [cy]) required and cost to excavate, haul, and grade the cover material over the pipeline areas. Calculate a site-wide average unit cost ($/cy) to excavate, haul, and grade cover material.
   - Based on an assumed cover volume per foot of pipeline, calculate a weighted cost ($/ft) for all pipeline areas.

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

Approach:

- For the calculation shown below for an 18" pipe, 65 sf of cover per foot of pipeline is assumed based on 3 ft of cover over the pipeline with 3:1 side slopes:

$$3 \cdot 4.5\ \text{ft} \cdot 4.5\ \text{ft} + 3\ \text{ft} \cdot 1.5\ \text{ft} = 2.417\ \frac{\text{yd}^3}{\text{ft}}$$



- Calculate the total unit cost by adding the unit rate for sludge/water removal and the site-wide average cost to excavate, haul, and grade cover.

Results:

1. The results of the pipeline demolition 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.
   - The total unit cost for 18" pipeline demolition is $3.12/ft. Results for the other sizes are shown in the earthwork RCE spreadsheet..
   - The total unit cost for 18" pipeline demotion is the sum of the unit rate for removing sludge/water ($0.13/ft) and the calculated unit cost to cover the pipeline areas ($2.99/ft).

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 Tyrone Mine 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.

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:

$$EQW\ base\ rate\ for\ tractor\ rental = (\$5{,}210.05/\text{month})/(176\ \text{hours/month}) = \$29.60/\text{hour}$$

$$Fuel\ cost = (\text{EQW burn rate}) \text{ x (local fuel cost)} = (5.98\ \text{gallons/hour}) \text{ x } (\$2.34/\text{gallon}) = \$13.99/\text{hour}$$

$$Total\ tractor\ cost = \text{sum of rows } 7, 8, 9, 10, 11, 14, 15 =$$
$$29.60 + 2.53 + 2.84 + 0.61 + 2.42 + 13.99 + 24.27 = \$76.27/\text{hour}$$

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.

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**	
66	*Summary for operations*			

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.

EquipmentWatch

www.equipmentwatch.com

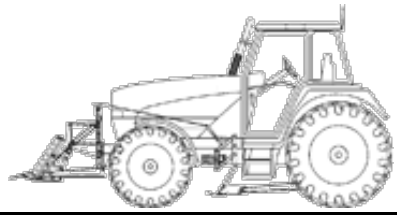
All prices shown in US$

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

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EquipmentWatch

www.equipmentwatch.com

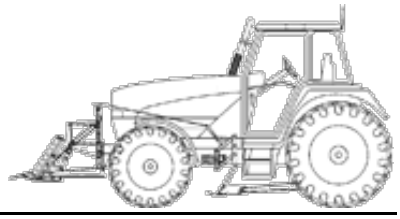
All prices shown in US$

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

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EquipmentWatch

www.equipmentwatch.com

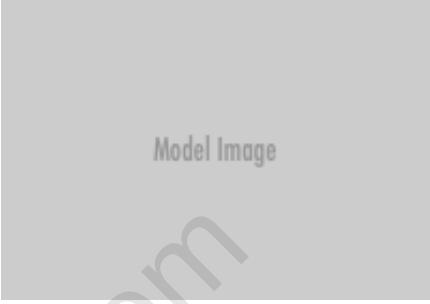
All prices shown in US$

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

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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.



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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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

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EquipmentWatch™

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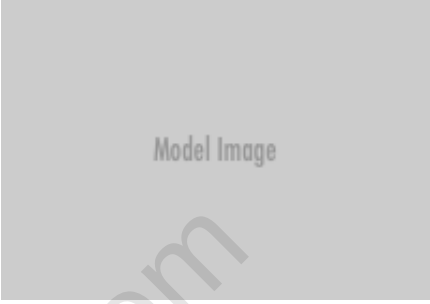
All prices shown in US$

Rental Rate Blue Book®

February 21, 2019

Finn B260
Trailer Mounted Mulchers

Size Class:
51 HP & Over
Weight:
4,880 lbs.



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.

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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 Tyrone Mine 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. Tailing cover maintenance for areas reclaimed in the past will take place for the first 7 years of closure reclamation.

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 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.

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 E

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

DRAFT