CLOSURE/CLOSEOUT PLAN

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION CLOSURE / CLOSEOUT PLAN

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List of Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
ABA	acid-base accounting
ac-ft/yr	acre-feet per year
amsl	above mean sea level
AOC	Administrative Order on Consent
APP	Abatement Plan Proposal
Bgs	below ground surface
BLM	Bureau of Land Management
CCP	Closure/Closeout Plan
CDQAP	Construction Design Quality Assurance Plan
CFR	Code of Federal Regulations
CGCS	Comprehensive Groundwater Characterization Study
Chino	Chino Mines Company
cm	centimeter
CQAP	Construction Quality Assurance Plan
CQAR	Construction Quality Assurance Report
DBS&A	Daniel B. Stephens and Associates, Inc.
DP	Discharge Permit
DSM	dynamic system model
EOY	end of year
EPA	U.S Environmental Protection Agency
ETS	Evaporative Treatment System
EnviroGroup	EnviroGroup Limited
FS	Feasibility Study
FSIR	Final Site Investigation Report
ft	Feet
Golder	Golder Associates Inc.
Guidelines	Closeout Plan Guidelines
HDPE	high density polyethylene
HDS	high-density sludge
IRA	Interim Remedial Act
IU	investigation unit
JSAI	John Shomaker and Associates, Inc.
M3	M3 Engineering & Technology Corp.
MMD	Mining and Minerals Division
MWWCA	Middle Whitewater Creek Area

List of Acronyms and Abbreviations (Continued)

NMA	North Mine Area
NMED	New Mexico Environment Department
NMMA	New Mexico Mining Act
NMOSE	New Mexico Office of the State Engineer
NMWQA	*New Mexico Water Quality Act*
NMWQCC	New Mexico Water Quality Control Commission
NSR	New Source Review
O&M	Operation and Maintenance
OPCZ	Open Pit Capture Zone
OPSDA	Open Pit Surface Drainage Area
PCA	Pipeline Corridor Area
PLS	pregnant leach solution (economic copper-bearing leach solution)
PMLU	post-mining land use
RCRA	*Resource Conservation and Recovery Act*
Rules	New Mexico Mining Rules
SCS	Soil Conservation Service
SMA	South Mine Area
SSE	self-sustaining ecosystem
SWQB	Surface Water Quality Bureau
SX/EW	solution extraction-electrowinning
TDS	total dissolved solids
UC	utility corridor
Van Riper	Van Riper Consulting
WCC	Woodward-Clyde Consultants
Y^3	cubic yards

1.0 INTRODUCTION

Freeport-McMoRan Chino Mines Company (Chino) operates an open-pit copper mine, concentrator, and solution extraction-electrowinning (SX/EW) plant located approximately 10 miles east of Silver City in Grant County, New Mexico (Figure 1-1). Chino intends to extend the existing Main Lampbright Stockpile to the north as part of the current mine plan (Figure 1-2). The extension of the Main Lampbright is referred herein as the North Lampbright Waste Rock Stockpile (NLS) extension. The NLS extension will be composed of waste rock and will not be leached. The proposed project is located on lands owned by Chino.

The proposed NLS extension partially occurs within the Santa Rita Open Pit, Stockpile, and Beneficiation Unit design limits (design limits) currently approved by the Mining and Minerals Division (MMD) of the Energy, Minerals, and Natural Resources Department. Thus, the proposed change in operations constitutes an expansion of the current approved design limits. The proposed NLS extension will increase the design limits by approximately 273 acres. This increase will allow for the construction of the proposed NLS as well as a contemplated expansion of the Northeast Stockpile at the Reservoir 6 location. This application only includes the regulatory information for the NLS extension. Chino will submit the regulatory information for an extension of the Northeast Stockpile under a separate application. There will be no change in the mine permit boundary because the proposed NLS extension occurs within the current mine permit boundary.

1.1 Regulatory Authority

In 1993, the New Mexico legislature enacted the *New Mexico Mining Act* (NMMA) requiring that closeout plans be put in place for applicable mines within the state. Rules to implement the requirements of the NMMA were promulgated in 1994. This plan was prepared to comply with applicable regulations and requirements stipulated in the NMMA (NMAC Title 19, Chapter 10, Part 5), *New Mexico Water Quality Act* (NMWQA), and the New Mexico Water Quality Control Commission (NMWQCC) Regulations (NMAC Title 20, Chapter 6, Parts 2 and 7). In 2013, NMED adopted new rules for the copper mining industry. Applicable conditions of these new rules (Copper Mine Rules Section 20.6.7 NMAC) have been addressed in this CCP.

1.2 Purpose of Plan

The purpose of this CCP is to present a reclamation plan consistent with all applicable federal and state regulatory requirements and permit conditions so that a financial assurance cost estimate can be calculated to meet the financial assurance requirements of Part 19.10.12 NMAC. The reclamation plan will demonstrate, where required, that the disturbed area will be reclaimed to a condition that allows for the re-establishment of self-sustaining ecosystem as well to meet the closure requirements of Section 20.6.7.33 NMAC.

1.3 Plan Organization

This CCP consists of the following sections:

- **Section 1.0** provides an overview of the CCP for NLS extension;
- **Section 2.0** describes the existing facilities and current environmental setting at the Chino Mine and the NLS extension area, and permits associated with the mine;
- **Section 3.0** describes the proposed NLS extension configuration;
- **Section 4.0** describes the proposed reclamation plan and associated design criteria and performance objectives for the NLS extension;
- **Section 5.0** describes the closure and post-closure monitoring plans for the NLS extension along with contingency plans and reporting schedules;
- **Section 6.0** provides details of the proposed post-mining land use and associated requirements for the NLS extension;
- **Section 7.0** presents a summary of the material take-offs and factors that will be applied in the capital and operations and maintenance (O&M) cost estimates associated with the proposed reclamation and post-closure monitoring plans presented in Sections 5.0 and 6.0;
- **Section 8.0** presents the proposed reclamation schedule associated with this CCP;
- **Section 9.0** is the signature page for the CCP; and
- **Section 10.0** lists the references used in preparation of this CCP.

The following appendix is also included in the CCP:

- **Appendix A** includes the earthwork cost estimate process report and reclamation design drawings that illustrate the CCP for the NLS extension.

1.4 Development of CCP Cost Estimates

This CCP will support future financial assurance cost estimates for closure/closeout based on the NLS extension mine plan. A cost estimate for the purpose of determining the value of the financial assurance performance bond will be prepared following approval of the proposed NLS extension reclamation plan included in this CCP. The basis upon which these cost estimates will be developed are outlined in Section 7.0 and detailed in Appendix A.

2.0 EXISTING SITE CONDITIONS

The following sections describe the site-specific characteristics of the proposed NLS extension area.

2.1 Description of North Lampbright Waste Rock Stockpile Extension Area

The proposed NLS extension area occupies the ridge crest and valley slopes north of the existing Main Lambright Stockpile. This area is in the North Mine Area (NMA) and is underlain mostly by sedimentary rocks (limestone, shale, and sandstone) associated with the Syrena and Oswaldo Formations and is vegetated with trees, grasses and shrubs. Approximately 82 acres of the northern portion of the Main Lampbright Stockpile will be covered by the NLS extension. The NLS extension will cover approximately 187 acres, including approximately 101 acres outside the current design limit boundary, and 86 acres within the current design limit boundary.

The PLS system along the north side of the Main Lampbright Stockpile in the area of the proposed stockpile consists of the North Diversion Channel and three sumps (Lampbright Sumps 1, 2, and 3) (Figure 1-2). Sumps 1 and 2 collect impacted stormwater and pregnant leach solution (PLS i.e., copper rich solution) that is pumped to Chino's SX/EW facility for the production of copper cathodes. Process water that is not captured at these two locations moves below the stockpile and is captured at the south end of the Main Lampbright Stockpile in Pond 8. Sump 3, located along the northeast edge of the stockpile, is a buried french-drain and vertical sump system designed to intercept seepage from the Main Lampbright Stockpile. All of these features lie within the footprint of the NLS extension.

As discussed below, Chino is submitting a separate application to NMED to obtain approval for the modification of the PLS collection and impacted stormwater system currently in place along the northern toe of the existing Main Lampbright Stockpile. These facilities are all located within the current design limit boundary (Figure 1-2). A total of 31 monitoring wells are located around the Main Lampbright Stockpile and 18 existing groundwater monitoring wells lie within the footprint of the NLS extension and associated infrastructure. These wells will be selectively abandoned as the NLS expands in accordance with New Mexico Office of the State Engineer (OSE) regulations and the NMED Monitoring Well Construction and Abandonment Guidelines. The specific number, schedule, and location of the replacement wells will be determined in consultation with the NMED.

2.2 Past and Current Land Uses

Mining has been the principal land use and economic support for the area since open-pit mining began in 1910. Current land uses in the immediate vicinity of NLS extension area include mining and wildlife habitat. Additional surrounding land uses outside the mine permit area include private residences, livestock grazing, mining, recreation, and wildlife habitat. Recreation outside the permit area includes camping, picnicking, hunting, off-road vehicle use, hiking, horseback riding, and bicycling.

2.3 Environmental Setting

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

2.3.1 Topography

The general topography of the North Lampbright extension area is depicted on Figure 2-1. Chino operations in the NMA are located near the base of the Cobre Mountains. The NLS extension area occupies the ridge crest and valley slopes north of the existing Main Lambright Stockpile. The natural ground surface elevation ranges from approximately 6,500 feet above mean sea level (ft amsl) in the southern part of the area adjacent to the Main Lampbright Stockpile to approximately 6,900 ft amsl immediately north of the stockpile extension area. The proposed NLS extension area is bounded on the south by access roads and on the north by a ridge with scattered rock outcrops of limestone and shale. The SX/EW facility abuts the northwest corner of the project area.

2.3.2 Geology

The Santa Rita ore deposit that has been mined at Chino lies in the southeastern corner of the Central Mining District (Rose and Baltosser, 1966). Chino lies in the transition zone between the Colorado Plateau and the Basin and Range physiographic provinces. **Figure 2-1** shows a geological map of the NMA and the North Lampbright extension area. The NLS extension area is underlain mostly by sedimentary rocks, including Paleozoic sandstone, limestone, and shale. In addition, upper Cretaceous rocks occur in the NLS extension area consisting of sandstone, siltstone, shale, quartzite, and minor amounts of shaley limestone. The main geologic units within the extension area consist of, from youngest to oldest:

- Colorado Formation (Kc), composed primarily of laminated to thinly-bedded dark shale and sandstone;
- Beartooth Quartzite (Kb) , composed of coarse to fine grained, fractured interbedded orthoquartzite (silica cemented sandstone) and shale;
- Abo Formation (Pa) composed of red shale, mudstone and limy mudstone, limestone and chert conglomerate;
- Syrena Formation (Cs), composed of fossiliferous limestone with some shale interbeds, calcareous shale, and limestone conglomerate; and the
- Oswaldo Formation (Co), composed of thickly-bedded limestone and calcareous sediment.

An east-west fault zone called the Nancy Fault has been mapped just north of the Main Lampbright Stockpile (Figure 2-1). Chino geologic maps indicate that the Nancy Fault dips up to 80 degrees to the south-southeast.

2.3.3 Climate

The Chino Mine is located in a semiarid region in southwestern New Mexico, with elevations ranging from about 5,200 to 7,700 ft amsl. The climate at Chino is warm and dry, with mean annual precipitation of about 16 inches (400 mm) and a mean annual temperature near 50°F (10°C). Precipitation falls mainly as rain, but snow may occur from November to March. Most of the precipitation in the area falls during July through October in the form of rain during short, intense, thunderstorms. About 60 percent of the precipitation falls during the summer months. Monthly precipitation is generally less than an inch per month from November through June, peaks in July, August, and September with between 2 and 3 inches per month, and generally falls to about 1 inch in October. Annual precipitation averages 17.2 inches at the Santa Rita weather station (elevation of 6,312 ft amsl), which is located about 1,000 feet to the west of the Santa Rita Open Pit. Near Hurley, annual precipitation averages approximately 14 inches where the elevation is approximately 5,700 ft amsl.

Evaporative demand in this region is high and annual evaporation far exceeds annual precipitation. Annual potential evaporation is estimated to range from 53 to 70 inches per year (Golder, 2007a).

2.3.4 Surface Water Hydrology

Lampbright Draw is an ephemeral drainage that runs along the eastern portions of the NMA and has been altered in its upper reaches by mining activities. Lampbright Draw commences approximately 6 miles east of Santa Rita Open Pit and east of the NLS extension area. Two ephemeral drainages, called Tributary 1 and Tributary 2 occur in the vicinity of the Main Lampbright Stockpile and proposed NLS extension (Figure 2-2). The headwaters of Tributary 1 begin just north of the proposed NLS and Main Lampbright Stockpile, and currently extends to the south directly beneath the Main Lampbright Stockpile. The Tributary 2 drainage occurs east of the extension area and joins Tributary 1 approximately one mile to the south. The drainage continues to the southeast approximately two miles where it joins the main fork of Lampbright Draw.

Just north of the Main Lampbright Stockpile and the PLS containment system an east-west stormwater diversion channel was constructed to divert stormwater from native ground around this area. The diversion channel system intersects Tributary 2 to the east so stormwater from native ground can continue to flow downstream. This diversion will be buried by the proposed stockpile. As shown on Figure 1-2, a new stormwater diversion channel will be constructed to again divert stormwater from native ground around the proposed NLS to the east and into the Tributary 2 drainage. Details of this new stormwater diversion are presented in Section 3.0.

2.3.5 Groundwater Hydrology

Groundwater hydrology at the Chino Mine has been analyzed for several decades with the most recent comprehensive report entitled *Chino Mines Company DP-1340 Condition 83 – Hydrologic Study Final*

Report submitted in June of 2007. Twice a year, potentiometric maps are submitted to the agency (see Figure 2-2) based on groundwater elevation data collected in a monitoring well network system located around the Lampbright Stockpile area. Conditions are stable and show that the ground water system below Lampbright is an upwelling system which allows for process water capture at Reservoir 8 located at the southeast corner of the Main Lampbright Stockpile.

Shallow perched groundwater zones of limited nature and saturated thickness have been identified in the vicinity of the NLS extension area. Shallow ground water in the area generally flows south beneath the Lampbright leach system. Depth to shallow ground water below the site ranges from approximately 5 to 125 feet below ground surface (bgs). No changes to the hydrologic conditions are anticipated by the construction of the NLS extension.

The existing PLS containment system will be replaced by a new system constructed outside the footprint of the proposed NLS. This new PLS containment system is described in the NMED application.

2.3.6 Soils and Vegetation

The soils in the Chino area were mapped by the U.S. Soil Conservation Service (SCS) (Parnham et al. 1983). The SCS map units were composed primarily of complexes of soil series and miscellaneous land areas. The dominant soils in the northern portion of the survey area (Luzena and Muzzler series) are shallow (<50 cm [centimeters]) and fine-textured with moderate to high rock fragment contents. The soils in the uplands are mostly shallow, although moderately deep (50 to 100 cm) and deep (>100 cm) soils occur to a minor extent. The soils in the valley bottoms are generally deep, vary considerably in texture, but tend to be somewhat coarser textured than the upland soils. The NLS extension area consists of a weakly dissected pediment with moderate to steep slope segments.

The distribution of native vegetation around Chino is locally complex and reflects the combined influences of environmental gradients (soils and climate), disturbance histories (drought, floods, fire, and predation) and management practices. The major structural characteristics of vegetation are controlled primarily by the prevailing environment gradients. The vegetation at Chino was classified using the nomenclature and hierarchical classification of the U. S. National Vegetation Classification (USNVC) system (Grossman et al., 1998) and mapped at the Alliance level, which represents the sixth tier in a seven-tiered hierarchy. The vegetation alliances in the area surrounding Chino (DBS&A, 2000) are listed in Table 2-1. Golder evaluated terrestrial habitats in the NLS extension area and confirmed that the USNVC alliance present in the area is the Alligator juniper-Oak Woodland Alliance.

2.3.7 Wildlife

The NLS extension is not expected to markedly change wildlife populations in the area due to the fact that similar habitat is common on undisturbed mine property and in other nearby areas. Chino contracted

Golder to conduct a pedestrian wildlife survey in August 2015. The results of this survey indicated that the vegetated portions of the proposed NLS extension area provide potential foraging, breeding, and nesting locations for different wildlife species. Twenty-seven wildlife species or their sign were observed by Golder during the August 2015 survey. Most inhabited the juniper-oak woodland habitat, which is similar in structure to the alligator juniper/oak woodlands that occur extensively in the surrounding area. These included 20 birds, 5 mammals, and 2 reptiles. The most common birds observed were spotted towhees, juniper titmouse, black-chinned hummingbirds and western scrub jays. The most common mammal sighted was the black-tailed jackrabbit. Mule deer tracks and possible mountain lion tracks were found in the NLS extension area. Whiptail and greater short-horned lizards were seen in various locations during the site visit. No amphibian species occurred in the area. Furthermore, no State or Federal threatened or endangered species were identified in the project area.

2.3.8 Material Characteristics

Stockpile and cover borrow source materials found at the Chino Mine have previously been characterized with respect to their chemical composition and physical properties.

Stockpile Materials

Pursuant to Subsection A, 20.6.7.21 NMAC, a material characterization plan and if applicable a material handling plan for all waste rock excavated at the copper mine facility will be included in an application. Chino underwent a site wide waste rock characterization effort in the 1990's (*Waste Rock Characterization, Chino Mines* – Golder, August 10, 1998). Chino continually characterizes mined materials during operation and uses the information to route ore and waste rock to appropriate stockpile storage facilities.

Chino also maintains a State approved material handling plan (entitled *Material Handling Plan South Pit Area,* July 7, 2007). Chino recently submitted to NMED a Material Characterization and Material Handling Plan as part of the DP-376 renewal application, which lists three types of mine rock. The mine rock that will be placed in the proposed NLS extension is characterized as *material that may produce degraded water quality*.

Borrow Materials

Suitable soils for cover material will be salvaged from the footprint of the NLS extension area prior to the initial build-out of the stockpile. For estimating purposes, it is assumed that the native soils in areas with slopes less than about 15 to 30% will be salvaged. Based on this assumption, approximately 20 to 30 acres have been identified as potential soil salvage areas, with a total estimated volume of suitable soil cover material salvageable from these areas ranging between approximately 97,000 and 145,000 cubic yards (based on an assumed 3 foot salvage thickness).

The remaining cover material required for the NLS extension will be sourced from the unmineralized volcanic conglomerate deposit that occurs east of the Main Lampbright Stockpile (Figure 2-3). This deposit was identified as the Rubio Peak Formation, which is lithologically correlative with the Kneeling Nun and Sugarlump tuffs according to the U. S. Geological Survey. The Rubio Peak Formation in this area contains poorly sorted coarse gravels from sedimentary and igneous rock in the volcanic ash matrix. The Rubio Peak Formation is the sill rock and the granodiorite of the Hanover-Fierro pluton (Jones et al., 1967). The Rubio Peak Conglomerate at this location ranges from a weakly consolidated volcanic conglomerate to a welded tuff. Ripping tests conducted by Chino indicate that the materials can be worked to produce a viable cover material. Chino proposes to use this material as cover for the CCP since it is broadly similar to the Kneeling Nun Tuff, which is approved for use in the North Mine Area.

2.4 Permits and Discharge Plans

Chino currently conducts its mining operations pursuant to numerous state and federal regulations. Table 2-2 lists the closure/close-out related permits held by Chino pertinent to the NLS extension. Information regarding those permits is summarized in the following sections.

2.4.1 Mining Act Permit

To meet requirements of the NMMA, Chino obtained approval of its existing mining operation by issuance of an existing mine permit (GR009RE) from the MMD in December 1997. MMD Permit GR009RE Revision 01-1 (MMD, 2003) incorporates Chino's March 2001 CCP (M3, 2001) and an engineering cost estimate update.

2.4.2 National Pollutant Discharge Elimination System (NPDES) Permit

In accordance with the requirements of the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit (MSGP), Chino maintains a Storm Water Pollution Prevention Plan (SWPPP). Chino operates the MSGP under authorization number NMR053259, confirmed by the most recent NOI authorized and issued by the EPA on October 24, 2015. The SWPPP identifies pollution prevention procedures for areas of the site that could potentially discharge stormwater associated with mining activities and implements best management practices (BMPs) for the management and control of storm water. The SWPPP will be reviewed and updated to reflect the planned NLS extension.

2.4.3 Water Rights

Water-right permits for the Chino Mine are recorded at the New Mexico Office of the State Engineer (NMOSE) and are administratively associated with the Mimbres Underground Water Basin and surface water diversion permits. Chino's surface and groundwater rights have been adjudicated under Subfile No. 398, Luna Cause No. 6326. Chino's groundwater rights include NMOSE File Nos. M-3527, M-4425, M-5010 through M-5019, and M-6724. Chino's current groundwater right for industrial uses totals

approximately 24,000 acre-feet per year (ac-ft/yr). Surface water rights are for capturing and storing storm water flows in Santa Rita and Whitewater Creek drainages. A total of 11,583 ac-ft/yr of surface water can be diverted, stored, and beneficially used.

The water rights permits are for use on Chino owned lands and are designated for industrial, stock, domestic and municipal use. Industrial use includes manufacturing processes and pollution control related to mine operations. With the exception of Permit M-5017 (Pond 7 pollution control wells), the NMOSE considers that all water Chino diverts for industrial, stock, domestic, and municipal uses is completely consumed and accounts for no return-flow credit. Permit M-5017 requires a return flow credit.

2.4.4 Air Quality

Chino constitutes a single "*source*" under the federal Clean Air Act, as implemented by the State of New Mexico. Therefore, current and planned Chino activities are unified in two types of air emissions permits to protect air quality: (1) construction permit (typically known as New Source Review [NSR] permit); and (2) Title V Operating permit. Chino and Cobre operate under Title V air quality Operating Permit Number P066R1, which was last renewed in December 2012. This permit covers both the Chino and Cobre mines and authorizes the operation of the open pit copper mines and associated process activities such as drilling, blasting, loading, hauling, and unloading of ore and overburden.

Chino and Cobre also operate under NSR air quality permit 0298M7 that regulates its air emissions sources that are spatially separated into three distinct areas: (1) the northernmost Cobre magnetite recovery for off-site delivery operation; (2) the centrally located Santa Rita copper mine, copper and molybdenum concentrator, and SX/EW plant; and (3) the southernmost Hurley operation that produces electricity for internal use with a natural gas power plant, and filter and blending plants that process copper and molybdenum concentrates prior to their off-site shipment. Permit 0298M7 was last issued in May 2015.

2.4.5 Administrative Order on Consent (AOC)

An AOC between the NMED and Chino became effective December 23, 1994. The AOC is designed to identify and remediate potential mining effects to the environment that are not addressed under other regulatory frameworks. The AOC is aimed at evaluating potential risk to human health and the environment from Chino's historical mining operations and is designed to be generally consistent with the Comprehensive Environmental Response, Compensation, and Liability Act.

The AOC originally identified six investigation units (IUs) within the investigation area: Hanover Creek, Hurley Soils, Lampbright, Hurley Smelter (now the Hurley Operation Area), Tailing Area Soils, and Whitewater Creek. After the AOC was finalized, an ecological IU was added to address and characterize

potential risk to ecological media on a site-wide rather than an individual geographical unit basis. Investigations began in 1995 and are ongoing.

Because the broad scope of the AOC overlaps with Chino's operational DPs and DP 1340-related investigations, the AOC contains the following language: *"….to avoid duplication of environmental closure activities to the extent that the (AOC) investigation area is subject to existing discharge plans….it is the Parties' intent that Discharge Plans within the investigation area shall continue to govern the areas described within each such Discharge Plan, including investigation, corrective action, if required, and environmental closure actions…*". The investigations pursuant to the AOC have focused on sediment, surface water, and soil, but generally not groundwater. The information collected by these investigations are used to determine risk to human health and the environment based on risk assessments. Remedial actions may or may not be required based on determinations made in the risk assessments.

2.4.6 Discharge Plans

NMWQCC regulations require a DP for any discharge of effluent or leachate that has the potential to move directly or indirectly into groundwater. Chino is separately submitting an application to NMED to modify DP-376 to include the proposed NLS extension area within this DP. DP-376, for which a timely renewal application is under NMED review, currently covers the Main and South Lampbright Leach Stockpiles; Southwest Lampbright Waste Rock Stockpile; the PLS and stormwater collection systems associated with the existing Lampbright Stockpiles; and all associated pipelines conveying PLS to the 8 Dam collection system, including the stainless steel PLS tank. Collectively these facilities are referred to as the Lampbright Leach System.

2.4.7 Supplemental Discharge Permit for Closure, DP-1340

Supplemental DP for Closure (DP-1340) was issued by the NMED on February 24, 2003 (NMED, 2003). This DP contains the closure requirements addressing the various open pits, tailing dams, leach stockpiles, waste rock piles, and associated facilities at the mine. DP-1340 supplements each of the operational DP's for Chino and contains conditions necessary to limit, contain, or prevent the exceedance of standards of Section 20.6.2.3103 NMAC or the presence of a toxic pollutant in groundwater after the cessation of operation and conditions necessary to ensure abatement of groundwater contamination. Abatement of groundwater contamination is covered in Conditions 30 through 33 of DP-1340. This CCP is written for consistency with the requirements of DP-1340 and also the requirements of section 20.6.7.33 NMAC.

3.0 PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION CONFIGURATION

The proposed NLS extension will be constructed with waste rock from the Santa Rita Open Pit. The proposed NLS extension at final build-out is presented on Figure 3-1. The stockpile will cover approximately 187 acres and is bounded by the Flemming Pond on the west, Tributary 2 on the east, the Main Lampbright Stockpile to the south, and the headwaters of Tributary 1 on the north. At total build-out the top of the stockpile will be at an elevation of 6,800 ft amsl. The stockpile will be constructed by end dumping in lifts approximately 50 feet high. The outslope of the stockpile will be built at angle of repose with approximate 100-foot benches on each lift, which will result in an overall interbench slope of approximately 3.0H:1V. This operational design will allow for efficient reclamation at closure due to the shallow overall outslope, and top surface constructed to the reclamation design slope of one percent (1%) (see Section 4.0).

4.0 NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION RECLAMATION PLAN

This section presents the reclamation plan and associated design criteria for closure/closeout of the NLS extension. Reclamation design criteria were developed in consideration of the site-specific conditions that exist at Chino including soil, ecological, operational, and economic constraints. The reclamation design criteria conform to the closure requirements described in Section III of DP-1340, 20.6.7.33 NMAC, and Section 8 of MMD Permit GR009RE. Conceptual level reclamation design drawings for the NLS extension are presented in Appendix A. Final designs for reclamation of this facility will be prepared and submitted to the agencies as part of the CDQAP and may alter the 3.0H:1V inter-bench slope assumed in this conceptual design.

Performance objectives and design criteria were developed with the intent of meeting the NMWQA, NMWQCC Regulations and NMMA rules. The reclamation designs were developed to provide enough information to calculate the financial assurance cost estimate. A summary of the key design criteria for the NLS extension is presented in Table 4-1. The performance objectives for closure/closeout of the NLS extension include: establishment of a self-sustaining ecosystem; stabilize the reclaimed area to minimize future impacts to the environment and to protect air and water resources; limit ponding on the final cover surfaces; reduction of infiltration; containment of seeps and sediment transport; and control of run-on, runoff, and releases to perched and regional groundwater.

The conceptual designs presented in this CCP for the NLS extension are based on an inter-bench slope of approximately 3.0H:1V, 15-foot wide terrace benches, 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. The top surface will be graded to a minimum final grade of 1%.

Structural Stability

The operational NLS extension will be constructed to allow for efficient closure of the facility and to ensure that the slope stability requirements listed in the Copper Rules (20.6.7.33.B NMAC) are met. The stockpile is abutted by a natural hillside on the north and the massive Main Lampbright Stockpile on the south. On the east side the overall outslope will be approximately 3.5H:1V and approximately 300 feet high. Based on a comparison of this configuration to the cross sections of waste and leach stockpiles evaluated in (Golder, 2007b; 2008) it is expected that the proposed stockpile will easily meet the slope stability criteria of 20.6.7.33.B NMAC.

Stockpile Erosion and Drainage Control

The proposed reclamation design meets the criteria stipulated in permits GR009RE and DP-1340 and section 20.6.7.33.C NMAC. Erosion and drainage control for the stockpile will be achieved by providing

mechanisms for regrading, stormwater conveyance, and revegetation. Upon reclamation, the NLS extension top surface will be graded and covered to direct non-impacted stormwater to designated discharge areas. The stockpile top surface will be graded to a minimum final grade of 1%. The slopes will be graded to armored storm water conveyance structures. Armored channels, perimeter berms, and hydraulic structures will be designed to control erosion on the top surfaces and outslopes and safely convey storm water for release. The stockpile inter-bench outslopes will be graded to at least 3.0H:1V with uninterrupted slope lengths of no greater than 300 feet. Storm water will be controlled using conventional terrace channels integrated to two downdrains one on the west and the other on the east side of the stockpile (Appendix A). Run-off drainage and erosion control will be achieved by storm water conveyance channels, stable outslopes, suitable cover material and revegetation.

Run-on from the surrounding terrain and the NLS will be controlled by perimeter channels located around the NLS (Appendix A). The channels will be designed to accommodate the peak discharge resulting from the 100-year, 24-hour storm event. The perimeter channel on the west and northwest sides of the extension area will be directed into the mine, and the perimeter channel on the northeast and east sides of the extension area will be directed to the south and released into Tributary 2.

Temporary erosion control measures may be provided during the construction and early vegetation establishment periods. These measures may include, but are not limited to, berms, mulch, straw bales, silt fences, and minor corrective regrading. All construction will be in compliance with federal and state regulations for temporary storm water control.

Stockpile Cover and Revegetation Specifications

Finish grading of the stockpile subgrade will be performed based on pre-construction surveys. Earth moving equipment such as bulldozers and motor graders will be used to smooth the surfaces and facilitate access for supplemental cover placement and mulching/seeding. Stockpile covers will be placed according to the following criteria:

North Lampbright Waste Rock Stockpile Extension	
Top Surface Cover Thickness	36 inches
Outslope Cover Thickness	36 inches
Top Surface Grade	1.0 to 5%
Slope (Inter-Bench Slope)	3H:1V max.

The reclamation designs and the associated estimated reclamation quantities presented in Appendix A indicate that the cover requirement for the NLS extension is approximately 924,440 yd^3. Volcanic conglomerate that occurs east of the Main Lambright Stockpile, and salvaged topsoil from the footprint of the extension area are the primary sources of cover material.

Revegetation of the covered surfaces will be achieved by seeding with a variety of native and adapted grasses, shrubs, and forbs in accordance with Appendix C of Permit GR009RE and applicable modifications. The planned seed mix is discussed in Section 7.0.

Haul roads and access roads not needed for closure and post closure access will be reclaimed. If the roads are located on non-acid generating material, compacted road material will be loosened by ripping to a depth of 18 to 24 inches and revegetated. Haul roads located on acid-generating material will be covered with 36 inches of the suitable cover material and revegetated.

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

Closure and post-closure monitoring, reporting, and contingency plans are required under Chino's current operational DP-376, DP-1340, and the MMD Permit. The costs associated with these DP and MMD permit conditions are included in the Chino CCP Update currently being finalized. All the closure and post-closure ground water, surface water, seep, spring, interceptor system, and piezometer monitoring data will be reported under Operational DP-376 and in accordance with Condition 63 of DP-1340 (NMED, 2003). Additionally, as specified under Condition 64 of DP-1340, Chino will submit to NMED quarterly reports summarizing reclamation and post-closure activities on or before January 15, April 15, July 15, and October 15 of each year. Chino will also prepare two potentiometric maps annually that include data from all monitoring wells, extraction wells, piezometers, seeps, and springs in the NMA (including the NLS extension area) in accordance with Condition 65 in DP-1340.

The MMD guidelines require periodic monitoring of revegetation and annual reports during the responsibility period to evaluate revegetation success, and DP-1340 requires the development of post-closure monitoring and contingency plans that are consistent with the terms and conditions of the applicable DP. The following sections summarize the general approach that will used to meet these requirements.

5.1 Erosion and Drainage Control Structures

The reclaimed NLS extension will be visually inspected for signs of excessive erosion and significant erosion features will be mitigated to prevent future degradation of the site in accordance with Condition 67 of DP-1340 and Section 8.N.1 of the MMD Permit. Post construction/reclamation inspection schedules will be developed to include provisions for periodic (monthly for the first year following completion of reclamation construction activities, and quarterly thereafter) and extreme event monitoring as appropriate. Chino will report evidence of excessive erosion and/or structural failures to the appropriate agencies (MMD, NMED, or NMOSE) in a timely manner. A written report detailing the nature and extent of the problem and a corrective action plan will be developed within 30 days after the problem is identified.

As specified in Condition 68 of DP-1340, Chino will routinely inspect and maintain all drainage channels, diversion structures, retention impoundments, and auxiliary erosion control features in accordance with professionally recognized standards such as Natural Resources Conservation Service and NMOSE.

5.2 Ground Water and Surface Water Control Facilities

In accordance with Condition 66 of DP-1340 (NMED, 2003) and Section 20.6.7.35, during post closure Chino will perform quarterly inspections and annual evaluations of all seepage interceptor systems and groundwater remediation systems, and perform maintenance as necessary to ensure that all water contaminants are managed in a manner that is protective of ground water quality. Monitoring of site water

quality will be accomplished through sampling and analysis of potentially impacted water in accordance with Condition 53 of DP-1340. Ground water quality will be monitored throughout the post-closure period. The monitoring schedule, analytical requirements, location, and construction specifications for the monitoring wells will be determined in consultation with NMED. The analytical results will be reported to the NMED as specified in DP-1340.

A contingency plan for closure components was prepared and submitted as required by DP-1340 Condition 75 (Chino, 2003). The plan present details for addressing potential failures of individual components of the Chino Mine closure plan, including an increase in the extent or magnitude of ground water and/or surface water contamination, potential failures associated with interceptor systems and impoundments, and potential failures of various components of closed lands. Additionally, in accordance with Condition 78 of DP-1340, Chino will verify any potential discharges not approved in DP-1340 or DP-376. If an unapproved discharge is identified, Chino will perform appropriate corrective actions in accordance with DP-1340. The current permit specifies that to contain and remove or mitigate the condition, provide verbal notification to the NMED within 24 hours after discovery of the condition, provide written notification to the NMED within one week after discovery of the condition, prepare a corrective action report within 15 days after discovery of the condition, and submit an abatement plan in accordance with Section 20.6.2.1203.A.9 NMAC or, if required by NMED, in accordance with Conditions 30 through 33 of DP-1340.

Samples will be collected in all groundwater monitoring wells that are required to be monitored in accordance with Operational DP-376, and in all new monitoring wells installed after closure for compliance monitoring purposes. Sample collection will be done in-house or under contract by an independent environmental engineering firm. Collected samples will be shipped to an independent analytical laboratory for analysis. A report will be prepared to document the sampling and analysis for review and recording by site management and review by regulatory authorities.

5.3 Revegetation Success Monitoring

The reclaimed area will be monitored in accordance with 20.6.7.35.C NMAC and Section 8.N.2 of the MMD Permit after the final grading and the initial establishment of vegetation on the reclaimed land. Chino will conduct vegetation monitoring of both volunteer revegetation and re-seeded areas during the third year after seeding. Revegetation monitoring will be performed at the sixth year after planting and for two consecutive years prior to bond release. The revegetation monitoring will be conducted to meet statistical adequacy for the monitoring conducted during the two consecutive years prior to bond release. Revegetation monitoring will include canopy cover, plant diversity, and woody stem density as specified in Section 8.N.2 of the MMD Permit (MMD, 2003a).

5.4 Wildlife Monitoring

Pursuant to Section 8.N.3 of the MMD Permit, Chino submitted a wildlife monitoring plan for post closure in December 2004 (Golder, 2004b). This plan was conditionally approved by the MMD and New Mexico Department of Game and Fish on February 15, 2006. The monitoring plan provides a description of the proposed reclamation plan as it applies to wildlife and wildlife habitat, an overview of the existing species and wildlife habitat within the vicinity of the Chino Mine, and the proposed methods for deer pellet group counts and bird diversity surveys. Results of the monitoring will be evaluated to determine wildlife use trends during re-establishment of a self-sustaining ecosystem. The results of the surveys will not be a condition of, or given consideration with regard to financial assurance release.

5.5 Construction Quality Assurance Plan

Pursuant to Sections 8.D.2.a and 8.E.2.a of the MMD Permit and 20.6.7.34.F and 20.6.7.34.G NMAC Chino will submit a CQAP to MMD for approval no less than 180 days prior to regrading of the NLS extension and placement of any cover material for final closure. The CQAP will be supplemented with a CQAR to be submitted to the MMD within 180 days after completion of construction.

6.0 POST-MINING LAND USE DESIGNATION

This section provides the PMLU for the NLS Extension based upon the requirements of the MMD Permit, NMMA Section 69-36-11.6, and Subparts 507.A, 507.B, and 508 of the NMMA Rules (MMD, 1996). PMLUs are specified in Section 3.G. of the MMD Permit. The approved PMLUs for Chino are wildlife habitat and industrial (MMD, 2003). Wildlife habitat is the primary PMLU for the majority of the Chino mine permit area and is the proposed PMLU for the NLS extension (Figure 6-1).

Reclamation of the NLS extension will result in the development of an early-stage grass/shrub community that will provide a locally important increase in community-level diversity. Some infrastructure may have a post-mining wildlife use such as power poles for raptor perches and main roads for land management. Native vegetation will be established on the reclaimed area resulting in increased erosion protection, direct habitat improvement, and reduced percolation of water into the underlying materials relative to current conditions. The proposed reclamation seed mix and seeding rates for the NLS extension are presented in Table 6-1, and is in accordance with Appendix C of the MMD Permit and applicable modifications. These species have broad ecological amplitudes and provide structural diversity.

The proposed seed mix was selected to provide early establishment of ground cover, erosion control, and diversity in growth forms. The species selected for the NLS extension have been successfully used in mine reclamation and range improvement projects in many parts of New Mexico, including the Chino Mine. The primary reclamation seed mix proposed includes cool and warm season grasses, perennial shrubs, and forbs. Depending on availability, alternate species may be substituted for the primary species. The seed mix is designed for application prior to the summer rains. Table 6-2 lists some of the major attributes of the vegetation selected for use at the NLS extension. The selected vegetation will provide erosion control, promote soil development, and provide forage, seeds, and cover for small mammals and birds. The seed mix includes a number of valuable, nutritious forage and browse species that could be used by wildlife.

6.1 Site-Specific Revegetation Success Guidelines

Section 507.A of the NMMA rules (MMD, 1996) requires that the permit area of an existing mine be reclaimed to a condition that allows the establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding area unless it conflicts with the approved PMLU. Demonstration of the establishment of a self-sustaining ecosystem is made by comparison of the vegetation on the reclaimed areas to vegetation attributes on a reference area and/or technical standards (MMD, 1996).

New disturbances located outside the current design limit will meet the reclamation standards set forth in 19.10.5.507 NMAC and will also comply with the new unit standards set forth in 19.10.5.508.E NMAC. Disturbances located within the current design limit are considered existing mine units and will meet the reclamation standards set forth in 19.10.5.507 NMAC. Site-specific revegetation success guidelines for

each of these areas (Figure 6-2) will follow the established permit conditions for vegetation cover, shrub density, and diversity. The numerical diversity guidelines for the Chino mine are listed in Table 6-3.

7.0 BASIS FOR CAPITAL AND OPERATION AND MAINTENANCE COST ESTIMATES

This section provides a brief description of the material take-offs and factors that will be applied in the capital and O&M cost estimates associated with the NLS extension reclamation plan. A detailed cost estimate for the purpose of determining the value of the financial assurance performance bond will be prepared following approval of the proposed NLS extension reclamation plan included in this CCP. The following sections provide the basis upon which these cost estimates will be developed.

7.1 North Lampbright Waste Rock Stockpile Extension Material Take-Offs

The earthworks material takeoff for reclamation of the NLS extension cost estimate was developed by Telesto Solutions, Inc. in accordance with standard engineering practice and is supported with data from various references and is fully documented in Appendix A. The material takeoffs for the major reclamation components are summarized below:

North Lampbright Waste Rock Stockpile Expansion Quantities[1]		
Item	**Quantity**	**Units**
Earthwork		
Grading	493,796	cubic yards
Bench Grading	19,885	linear feet
Cover Material	924,440	cubic yards
Cover and Revegetate	221	acres
Surface Water Conveyance Channels	31,826	linear feet
Riprap for Conveyance Channels	17,408	cubic yards
Filter/Gravel Below Rip Rap	13,478	cubic yards

Note:
[1] – Quantities developed by Telesto Solutions, Inc.

7.2 Basis for Capital Cost Estimates

The earthwork reclamation cost estimate will be based on a template originally created by the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division (MMD, 1996). The estimate will include reclamation earthwork and site operations and maintenance costs and will be based on the reclamation designs for the NLS extension included in Appendix A.

The unit rates that will be used to develop the cost estimate and equipment production factors are provided in Appendix A and are summarized below:

- **Labor Rates:** With the exception of the truck driver rate all labor rates will be developed based on the New Mexico Department of Labor (DOL) Type H (Heavy Engineering) labor

rates effective January 1, 2015. These rates include the base, fringe benefit, and apprenticeship contribution rates.

- **Truck Driver Labor Rate:** The base truck driver labor rate is assumed to be 90% of the New Mexico DOL base operator labor rate. Added to the base rate were fringe benefits, apprenticeship contributions, taxes, and Workman's Compensation Insurance.
- **Equipment Rates:** The earth-moving equipment used in the estimate would commonly be available to a contractor. The equipment unit operating costs will be taken from EquipmentWatch Custom Cost Evaluator (Penton Media, Inc., 2015).
- **Fuel Costs:** The off-road diesel fuel cost will be a vender quote for delivery of dyed ultra-low sulfur diesel to Silver City, NM.
- **Capital Indirect Costs:** Total indirect costs of 22.5% will be applied to the capital direct costs per MMD (1996) and Office of Surface Mining (OSM, 2000) guidance. The indirect costs are comprised of: Mobilization and Demobilization (1.0%), Contingencies (2.0%), Engineering Redesign Fee (2.5%), Contractor Profit and Overhead (15.0%), and Project Management Fee (2.0%).
- **Equipment Production Factors:** Production factors will be obtained from Caterpillar (2014) for each type of equipment. Productivity curves will also be developed from Caterpillar (2014). See Appendix A for further details.
- **Haul Distances:** Haul distances will be 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. A maximum of three segments will be used for each haul route.
- **Borrow Areas:** Two cover sources will be utilized: 1) a borrow area located southeast of NLS extension consisting of Rubio Peak Formation material; and 2) a nearby topsoil stockpile consisting of suitable material stripped from within the footprint of the NLS extension. Revegetation for the topsoil stockpile will be included with the NLS reclamation costs. After cover operations, borrow areas will be left in a condition such that they can be directly revegetated.
- **Dozer Push Distances:** Dozer push distances represent the distance from the centroid of the cut block to the centroid of the fill block.
- **Dust Suppression and Site Maintenance:** A full time water truck and a motor grader will be included as part of the fleet during reclamation. The water truck and grader time was set equal to loader time.
- **Revegetation Unit Costs:** The revegetation unit cost will be based on a quote obtained when the cost estimate is being developed. The quote will include: scarifying, discing, rangeland drill seeding, mulching, crimping, and daily per diem.
- **RipRap Production:** The riprap unit cost will be developed based on experience gained producing riprap at the McCain Springs Quarry.
- **Miscellaneous Unit Costs:** Additional miscellaneous unit costs will be taken from several sources including R.S. Means Heavy Construction Cost Data Edition 29 (R.S. Means, 2015). All costs taken from R.S. Means will be adjusted using the location factor for Las Cruces (84.4%).
- **Reclamation:** Reclamation will include: minor top surface grading to achieve a smooth slope following the top surface sloping to the east; pushing down operational stockpile benches to achieve a smooth slope; hauling and grading cover material for the top surfaces; completing surface water channels and benches to collect and convey storm water from the stockpile surfaces; and scarification and revegetation of covered areas;

7.3 Basis of Operation and Maintenance Cost Estimates

Details and supporting documentation for the basis of the O&M cost estimate are provided in Appendix A and summarized below.

The basis for O&M costs related to periodic erosion control and road maintenance are already included in the Chino CCP Update and will not be included as part of the NLS extension O&M cost estimate. For the NLS extension, revegetation maintenance will be based on an assumed 2% failure every year for a total of 12 years, starting the year reclamation is completed. Therefore, the 100 % of the initial vegetation is accounted for under capital costs and an additional 24% under O&M. Total indirect costs of 17.5% will be applied for long term O&M per MMD (1996) and OSM (2000) guidance and will comprise the same values and factors as the capital indirect costs with exception of contractor profit and overhead. Contractor profit and overhead for long term O&M will be 10.0%, to account for the long term contract and repetitive annual work. Indirect cost percentages are identical to the percentages presented to MMD and the NMED in meetings with Tyrone on September 20, 2012, and on November 2, 2012.

8.0 CLOSURE SCHEDULE

The proposed reclamation schedule for the NLS extension summarizes Chino's existing mine plans, near-term mine operation and reclamation commitments and longer-term projections. More specifically, the schedule is based on the following considerations:

- Ongoing reclamation projects and previous schedule commitments;
- Practical phasing of the reclamation projects to account for water management, water treatment and the anticipated labor, equipment and other resources that would be necessary to complete these projects based on current conditions;
- Sequential closure of facilities in a phased cost efficient manner (i.e., closure of select leach and waste rock piles as mining operations cease followed by closure of the leach stockpiles utilized as part of the process solution elimination system); and
- Total annual acreages that would be reclaimed over this period.

The NLS extension will be reclaimed in conjunction with the Main and South Lampbright stockpiles. The current schedule for these stockpiles specifies the start of reclamation five years following the cessation of leaching operations at the Main Lampbright Stockpile. The anticipated duration to complete closure of the Main, South, and NLS extension is approximately 5 years.

9.0 USE OF THIS REPORT

Golder has prepared this CCP for the NLS extension for the NMED and the MMD of the New Mexico Energy, Minerals and Natural Resources Department. In the compilation of this plan, Golder collaborated with Telesto Solutions, Inc., who prepared the reclamation drawings and basis of the reclamation cost estimate. The NLS extension CCP has been updated to fulfill the requirements of the following permits and rules:

- **Supplemental Discharge Permit for Closure, DP-1340, Chino Mines Company**, issued by the NMED on February 24, 2003 (NMED, 2003);
- **Revision 01-1 to Permit GR009RE**, issued by the Director of the MMD of the New Mexico Energy, Minerals and Natural Resources Department on December 18, 2003 (MMD, 2003); and
- Applicable conditions of the **Copper Mine Rules (Section 20.6.7 NMAC)**, respectively.

Respectfully submitted,

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TABLES

Table 2-1: Vegetation Map Units in the Chino Survey Area

Name	Acreage	Elevation Range (ft amsl)
Mixed-Grama Herbaceous Alliance	6,717	5,200-5,750
Mesquite/Mixed Grama Shrubland Alliance	8,858	5,200-5,800
Fluvial Forest and Shrubland Alliance	1,585	5,200-5,600
Alligator juniper-Oak/Grama Woodland Alliance	10,257	5,800-7,700
Alligator juniper-Oak Woodland Alliance	4,456	5,800-7,400
Mountain mahogany Shrubland Alliance	10,038	5,600-7,600
Ponderosa pine-Oak Forest Alliance	1,552	6,000-7,600
Mine Facilities/Urban	10,122	NA

Notes: NA = Not applicable

Table 2-2: Summary of Chino Closure/Closeout-Related Permits Pertinent to the North Lampbright Waste Rock Stockpile Extension

Permit or Requirement	Agency	ID Number	Area Covered
Mining Act Permit	New Mexico Mining & Minerals Division	GR009RE	Chino Mine
Groundwater Discharge Plans	NMED Ground Water Quality Bureau	DP-376, DP-1340	Operational DP for the Lampbright Leach System Supplemental DP for Closure
National Pollutant Discharge Elimination System (NPDES)	U.S. EPA (Region 6)	NMR053259 MSGP-2008	Multi-Sector General Storm Water Permit
Water Rights	New Mexico Office of State Engineer	M-3527, M-4425, M- 5010 through 5019, M-6724	Chino Mine Areas
Air Quality	U.S. EPA (Region 6)	P066R1 0298M7	Title V Mine-wide Cobre and Chino Mines
Hazardous Waste Generator / Hazardous Materials Inventory	U.S. EPA/New Mexico Department of Public Safety State and County Emergency Response Commission	NMD007396930	Chino Mine

Notes:
SX/EW = Solution extraction/electrowinning
U.S. EPA = United States Environmental Protection Agency
NMED = New Mexico Environment Department
NA = Not applicable

Table 4-1: Summary of Key Design Criteria for Closure of the North Lampbright Waste Rock Stockpile Extension

Stockpile Regrading:

- Outslope to be graded to inter-bench slopes of between 3.0H:1V and 3.3H:1V
- Maximum uninterrupted slope length of 200 feet for outslopes
- Terrace benches will have maximum bench width 50 feet (conceptual designs at 15 feet wide)
- Bench longitudinal slopes at maximum of 5 percent
- Bench cross slopes and channels between 1 and 5 percent
- Top surface graded at a minimum final grade of 1 percent
- Regrading to be done in such a manner that orients surface water conveyances to the exterior perimeter of the stockpile
- Slope channels will be located where possible in natural junctions or drainage chutes, but all channels will contain riprap and energy dissipation structures as appropriate
- Top surface and outslope to be covered with 36 inches of suitable cover material
- Top surface and outslope to be revegetated in accordance with Appendix C of the MMD Permit and applicable modifications
- A moderate maintenance program will be acceptable until cover vegetation establishes

Haul Roads (all haul roads except those located within PMLU access roads)

- Where located on acid-generating material, surface to be covered with 36 inches of suitable cover material
- Cover surfaces to be revegetated in accordance with Appendix C of the MMD Permit and applicable modifications
- Where located on non-acid-generating material, surface to be ripped and revegetated in accordance with Appendix C of the MMD Permit and applicable modifications
- A moderate maintenance program will be acceptable until cover vegetation establishes

Notes:
MMD = Mining and Minerals Department
PMLU = Post Mining Land Use
OPSDA = Open Pit Surface Drainage Area

Table 6-1: Proposed Interim Seed Mix and Rates for the North Lampbright Waste Rock Stockpile Extension Site

Species[a]	Life-Form	Duration[b]	Seasonality	Rate[a,c]
Primary				
Blue grama (*Bouteloua gracilis*)	Grass	Per	Warm	0.25
Side-oats grama (*Bouteloua curtipendula*)	Grass	Per	Warm	1.25
Black grama (*Bouteloua eriopoda*)	Grass	Per	Warm	0.10
Green sprangletop (*Leptochloa dubia*)	Grass	Per	Warm	0.15
Plains lovegrass (*Eragrostis intermedia*)	Grass	Per	Intermediate	0.05
Bottlebrush squiretail (*Sitanion hystrix*)	Grass	Per	Cool	1.25
New Mexico needlegrass (*Stipa neomexicana*)	Grass	Per	Cool	1.75
Streambank wheatgrass (*Agropyron dastachyum v. riparium*)	Grass	Per	Cool	1.50
Apache plume (*Fallugia pardoxa*)	Shrub	Per	NA	0.10
Mountain mahogany (*Cercocarpus montanus*)	Shrub	Per	NA	1.00
Winterfat (*Eurotia lanata*)	Shrub	Per	NA	0.60
White prairie clover (*Dalea candida*)	Shrub	Per	NA	0.15
Globe mallow (*Sphaeralcea sp.*)	Forb	Per	NA	0.10
Blue flax (*Linum lewisii*)	Forb	Per	NA	0.15
Total PLS (lb/ac)				**8.40**
Alternate				
Needle-and-thread (*Stipa comata*)	Grass	Per	Cool	ND
Thickspike wheatgrass (*Agropyron dastachyum*)	Grass	Per	Cool	ND
Smooth brome (*Bromus inermis*)	Grass	Per	Cool	ND
Sand dropseed (*Sporobolus cryptandrus*)	Grass	Per	Intermediate	ND
Tobosa (*Hilaria mutica*)	Grass	Per	Warm	ND
Bush muhly (*Mohlenbergia porteri*)	Grass	Per	Warm	ND
Squawberry (*Rhus trilobata*)	Shrub	Per	NA	ND
Fourwing saltbush (*Atriplex canescens*)	Shrub	Per	NA	ND
Prairie coneflower (*Ratibida columnaris*)	Forb	Per	NA	ND
White sweet clover (*Melilotus alba*)	Forb	Ann	NA	ND

Notes:
[a] Seed mix and rates are subject to change based on future investigations
[b] Per – Perennial; Ann = Annual
[c] Rate is in pounds of pure live seed per acre; substitutions may change seeding rates
lb/ac = pounds per acre
NA = Not applicable
ND = Not determined
PLS = Pure live seed

Table 6-2: Functions and Attributes of the Primary Plant Species Proposed for the North Lampbright Waste Rock Stockpile Extension Site

Species	Character[a]	Attributes and Function
Blue grama (*Bouteloua gracilis*)	N,P,W,G	Sod and bunch grass providing ground cover and forage
Side-oats grama (*Bouteloua curtipendula*)	N,P,W,G	Bunch grass providing ground cover and forage
Black grama (*Bouteloua eriopoda*)	N,P,W,G	Bunch grass providing ground cover and forage
Green sprangletop (*Leptochloa dubia*)	N,P,W,G	Erect bunch grass; aggressive short-lived nurse plant with forage value
Plains lovegrass (*Eragrostis intermedia*)	N,P,C,G	Bunch grass providing ground cover and early spring forage
Bottlebrush squiretail (*Sitanion hystrix*)	N,P,C,G	Persistent (moderately palatable) bunch grass providing ground cover
New Mexico needlegrass (*Stipa neomexicana*)	N,P,C,G	Persistent bunch grass providing ground cover and forage
Streambank wheatgrass (*Agropyron dastachyum v. riparium*)	N,P,C,G	Sod-forming grass providing ground cover and forage
Apache plume (*Fallugia pardoxa*)	N,P,S	Mid-height shrub providing browse, cover, and erosion control
Mountain mahogany (*Cercocarpus montanus*)	N,P,S	Mid-height to tall shrub providing browse and cover
Winterfat (*Eurotia lanata*)	N,P,HS	Low shrub providing winter browse
White prairie clover (*Dalea candida*)	N,P,S	Early season legume providing ground cover and forage
Globe mallow (*Sphaeralcea sp.*)	N,P,F	Persistent mid-height forb providing browse
Rubber rabbitbush (*Chrysothamnus nauseosus*)	N,P,S	Mid-height shrub providing cover and erosion control
Blue flax (*Linum lewisii*)	N,P,F	Persistent forb with a pretty blue flower

Notes:

[a] N = Native
I = Introduced
P = Perennial
A/B = Annual or biannual
W = Warm season
C = Cool season
G = Grass
S = Shrub HS = Half shrub
F = Forb

Table 6-3: Proposed Diversity Guidelines for the North Lampbright Waste Rock Stockpile Extension Site

Class	Seasonality	Number	Minimum Occurrence (% cover)
Perennial grass	Warm	3	1
Perennial grass	Cool	1	0.5
Perennial shrub	NA	2	1
Forbs	NA	2	0.1

Note:
NA = NOT APP

FIGURES

STATE OF NEW MEXICO

NOT TO SCALE

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	TS

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
MINE LOCATION MAP

PROJECT No.	PHASE	Rev.	FIGURE
153-7066	1	0	1-1

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

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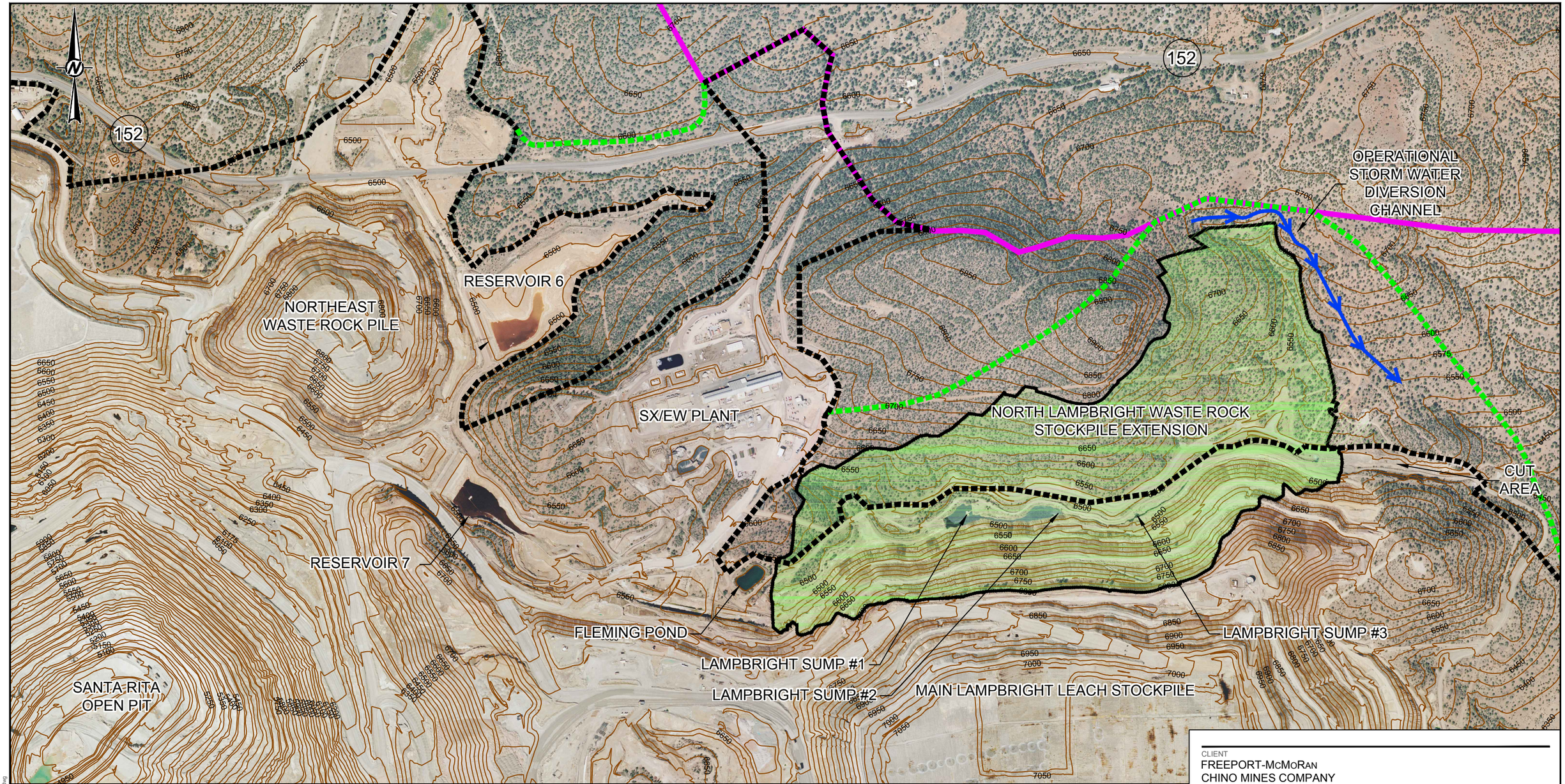

LEGEND

- PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- EXISTING DESIGN LIMIT BOUNDARY
- EXISTING DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- MINE PERMIT BOUNDARY

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.

0 400 800 1200
SCALE FEET

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE
EXTENSION AREA

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
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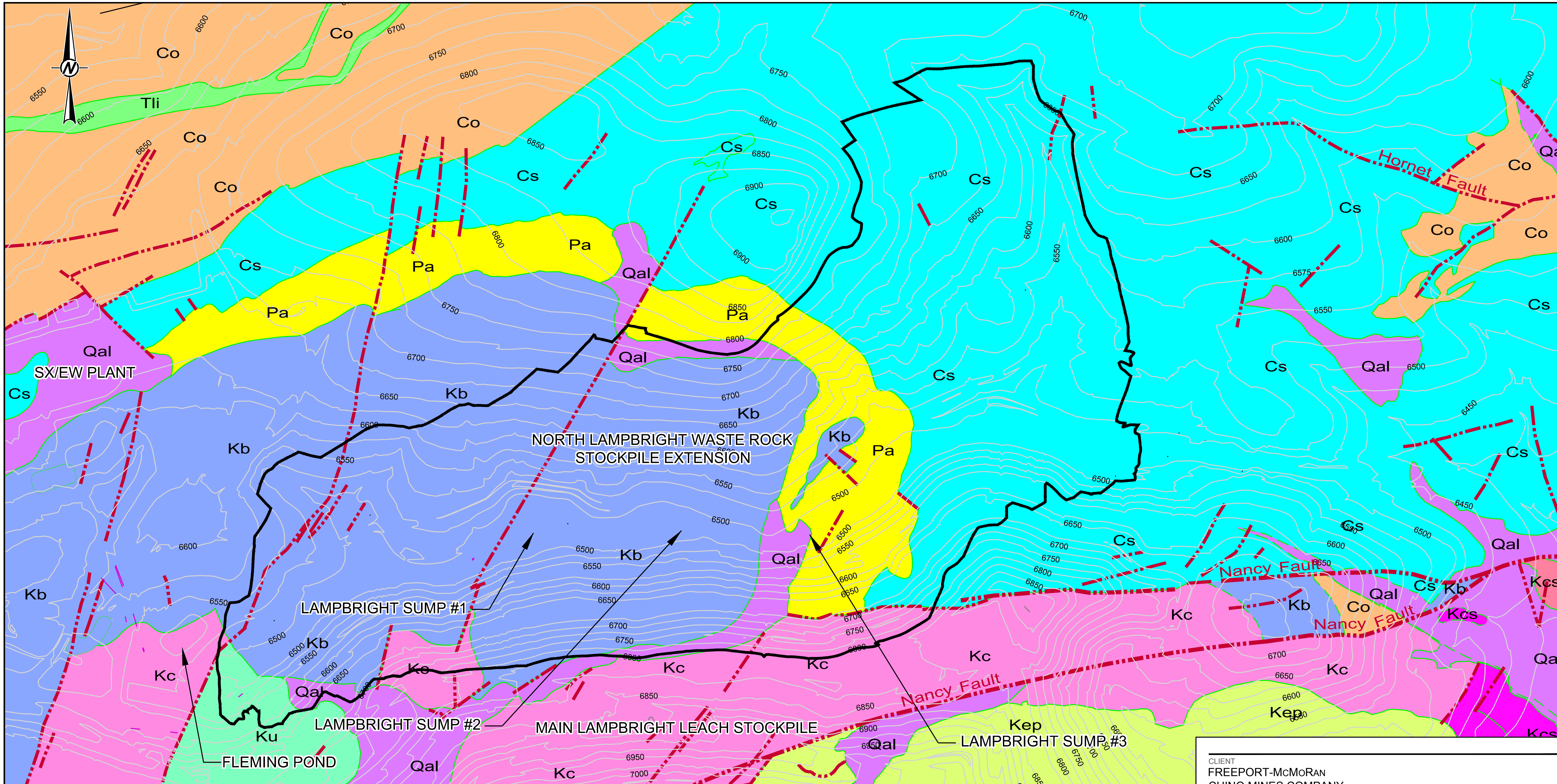

LEGEND

PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.
4. GEOLOGIC MAP FROM FIGURE 6 OF CHINO MINES - NORTH LAMPBRIGHT STAGE 1 ABATEMENT PLAN (GOLDER, 2003)

GEOLOGIC LEGEND

Symbol	Description
Qal	YOUNGER ALLUVIUM
Tli	RHYODACITE PORPHYRY
Kb	BEARTOOTH QUARTZITE
Kcs	COLORADO FORMATION SANDSTONE MEMBER
Ku	UNDIFFERENTIATED
Kc	COLORADO FORMATION
Kcsh	COLORADO FORMATION SHALE MEMBER
Kep	QUARTZ DIORITE PORPHYRY
Pa	ABO FORMATION
Cs	SYRENE FORMATION
Co	OSWALDO FORMATION
	GEOLOGIC CONTACT
	FAULT

SCALE 0 250 500 750 FEET

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
AREA SURFACE GEOLOGY AND TOPOGRAPHIC MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
153-7066	1	0	2-1

LEGEND

- APPROXIMATE GROUNDWATER FLOW DIRECTION
- 100 FT GROUNDWATER ELEVATION CONTOUR (FT MSL)
- 376-97-01 — EXISTING WELL NEAR THE NORTH LAMPBRIGHT STOCKPILE EXTENSION WITH WELL ID

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.
4. GROUNDWATER CONTOURS AND FLOW DIRECTIONS FROM DP-1340 CLOSURE ACTIVITY REPORT FOURTH QUARTER 2015.
5. GROUNDWATER ELEVATIONS FROM FOURTH QUARTER 2015 WATER LEVEL MEASUREMENT.

0 400 800 1200
SCALE FEET

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
HYDROLOGIC SETTING IN THE NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION AREA

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
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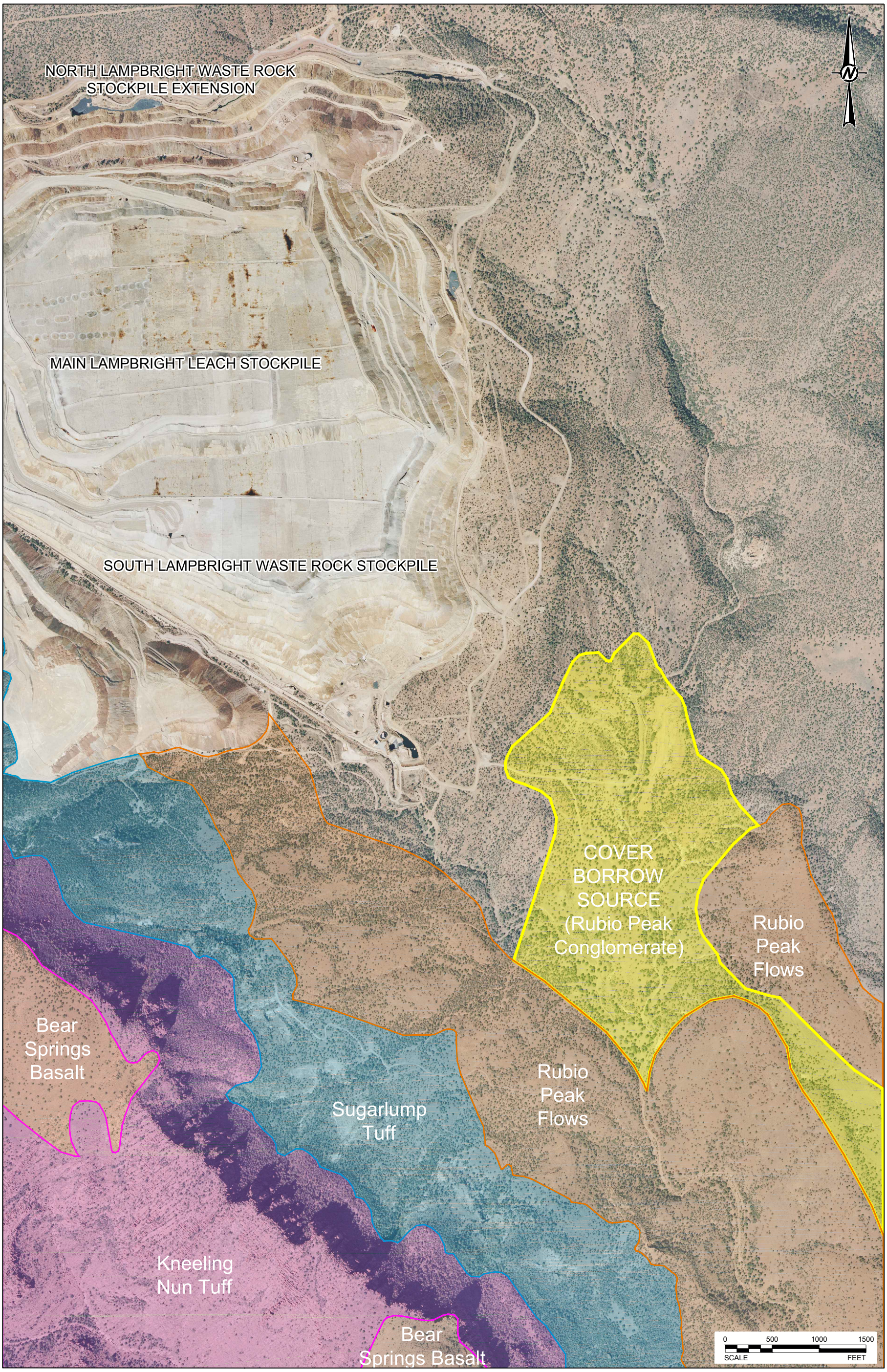

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.

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BAYARD, NEW MEXICO

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-01-13
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DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
COVER BORROW SOURCE AREA AND VOLCANIC FORMATIONS LOCATED SOUTHEAST OF THE MAIN LAMPBRIGHT LEACH STOCKPILE

PROJECT No.	PHASE	Rev.	FIGURE
153-7066	1	0	2-3

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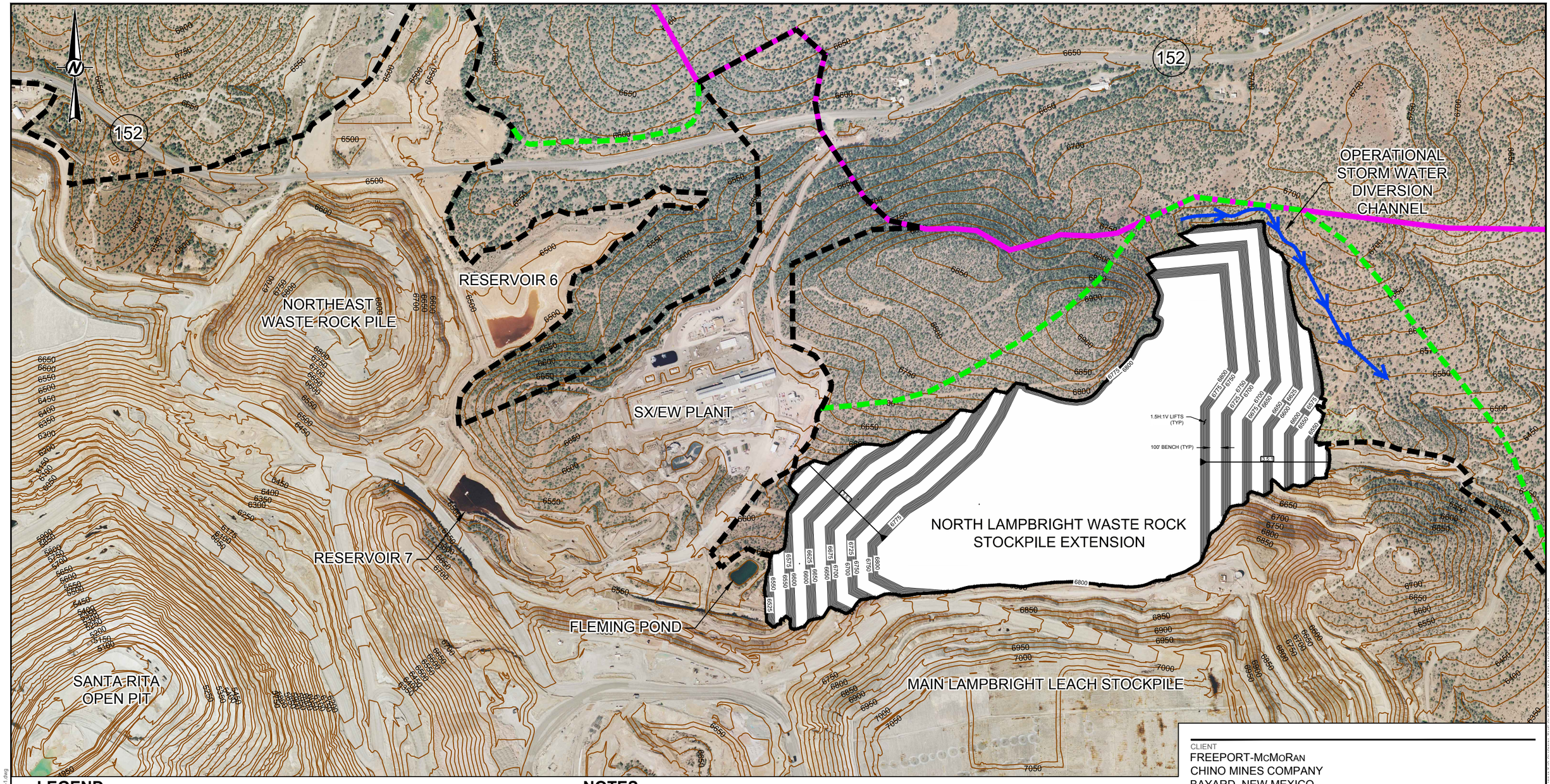

LEGEND

- PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- EXISTING DESIGN LIMIT BOUNDARY
- EXISTING DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- MINE PERMIT BOUNDARY
- 6725 PLANNED FINAL TOPOGRAPHY FROM CHINO MINE PLANNING

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.
4. PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION BUILD-OUT TOPOGRAPHY FROM CHINO MINE PLANNING ON 1/11/2016.

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SCALE FEET

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION AT FINAL BUILD-OUT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
153-7066	1	0	3-1

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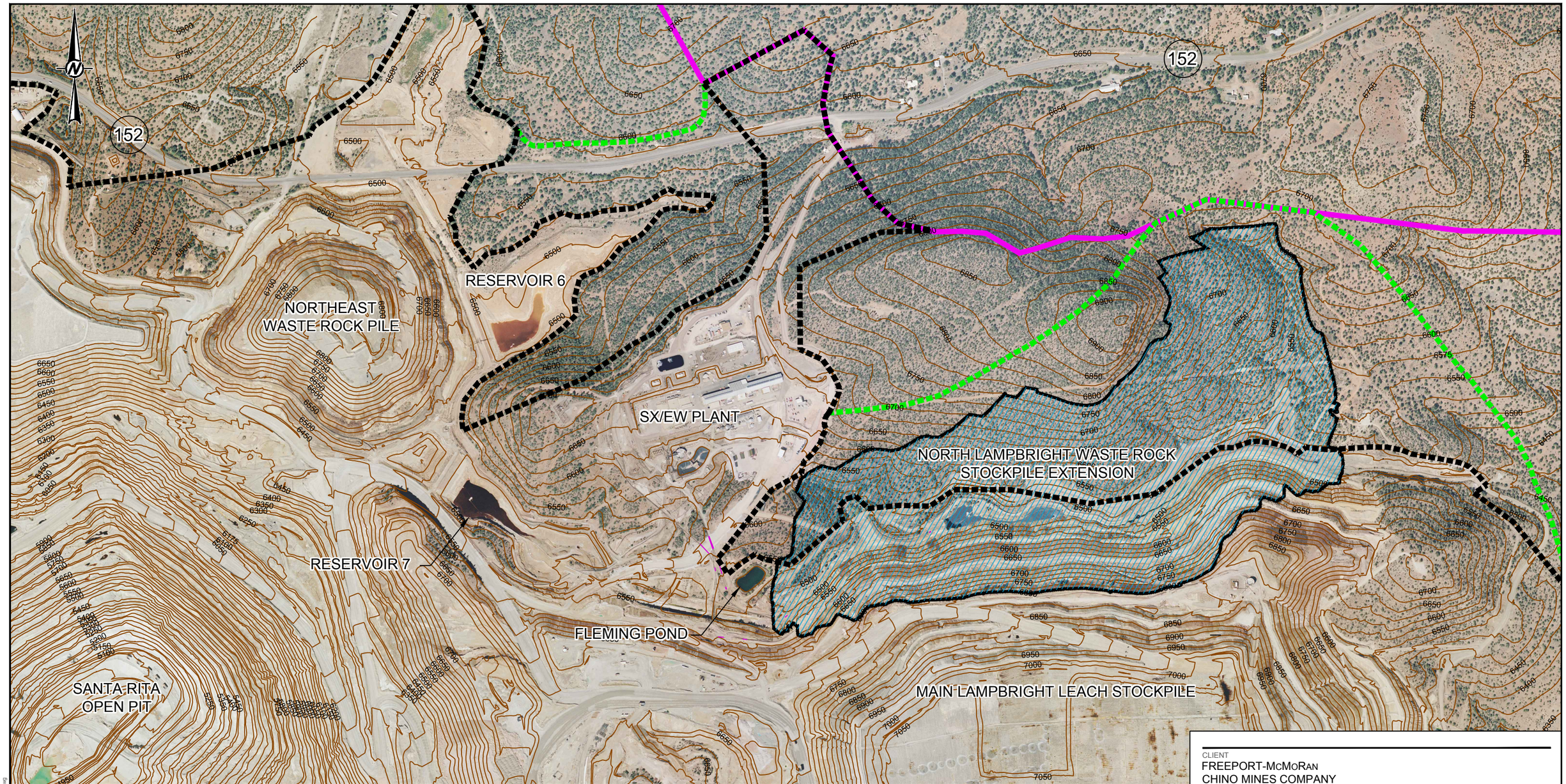

LEGEND

- PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- EXISTING DESIGN LIMIT BOUNDARY
- EXISTING DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- MINE PERMIT BOUNDARY
- PROPOSED WILDLIFE HABITAT POST MINING LAND USE AREA

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.

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SCALE FEET

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FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
PROPOSED WILDLIFE HABITAT PMLU AREA FOR THE NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION AREA

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
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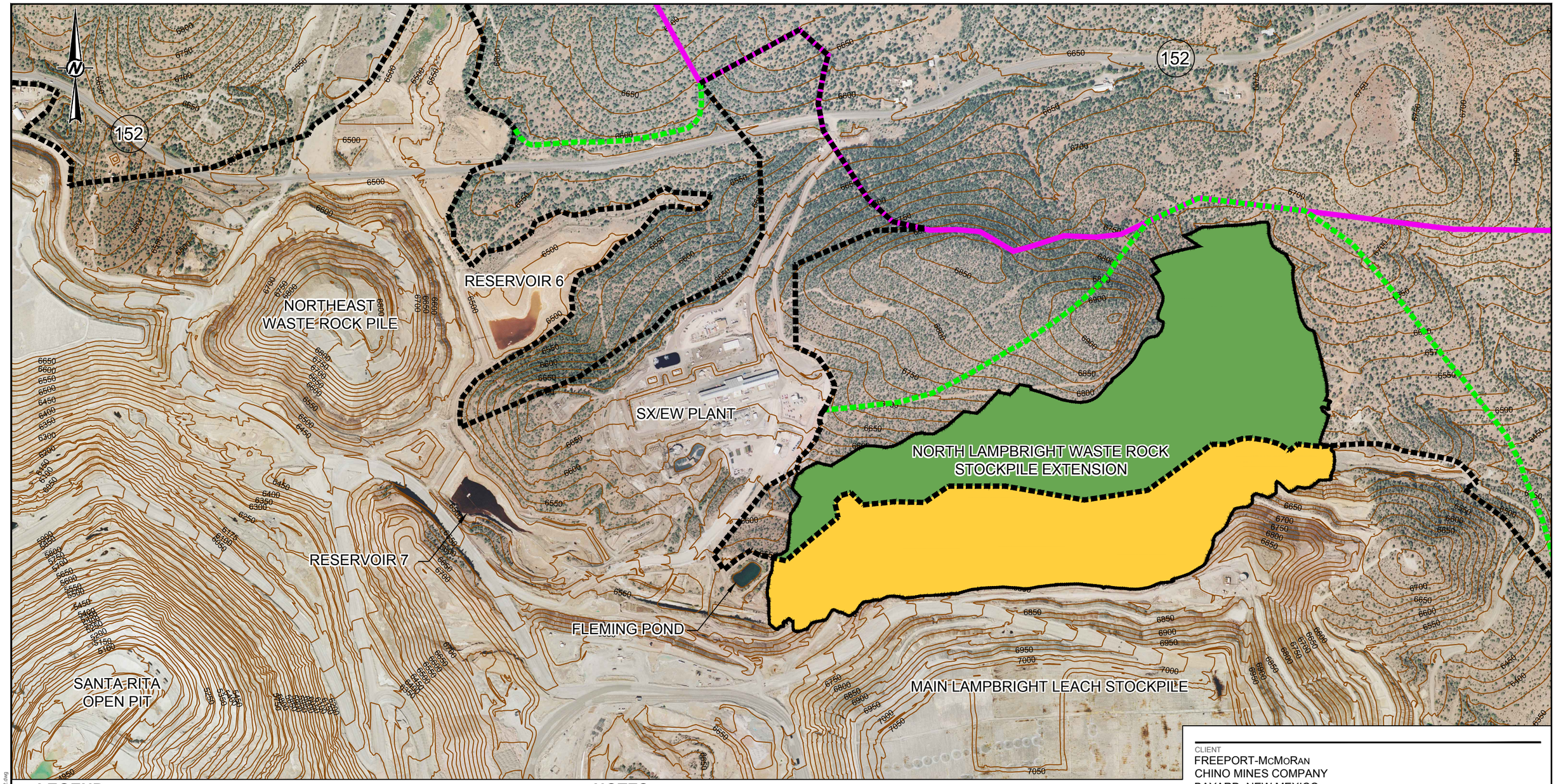

LEGEND

- PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY
- PROPOSED MODIFIED DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- EXISTING DESIGN LIMIT BOUNDARY
- EXISTING DESIGN LIMIT BOUNDARY (OVERLAPS MINE PERMIT BOUNDARY)
- MINE PERMIT BOUNDARY
- EXISTING UNIT (EARLIER, EXISTING AND APPROVED DISTURBANCE)
- NEW UNIT (INCLUDES NEW DISTURBANCES OUTSIDE THE CURRENT DESIGN LIMIT)

NOTES

1. MAP COORDINATES ARE BASED ON THE NEW MEXICO STATE PLANE (NMSP) NAD 83, WEST ZONE
2. SOURCE: SEPTEMBER 2014 AERIAL IMAGE FROM CHINO MINE COMPANY.
3. TOPOGRAPHY IS BASED ON 2014 DATA FROM CHINO MINES COMPANY.

0 400 800 1200
SCALE FEET

CLIENT
FREEPORT-McMoRan
CHINO MINES COMPANY
BAYARD, NEW MEXICO

PROJECT
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION
CLOSURE/CLOSEOUT PLAN

TITLE
DISTURBED AREAS ASSOCIATED WITH PROPOSED NORTH LAMPBRIGHT WASTE ROCK STOCKPILE EXTENSION AREA

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-16
PREPARED	CM
DESIGN	TS
REVIEW	TS
APPROVED	LM

PROJECT No.	PHASE	Rev.	FIGURE
153-7066	1	0	6-2

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APPENDIX A
EARTHWORK COST ESTIMATE PROCESS REPORT AND RECLAMATION DESIGN DRAWINGS

North Lampbright Waste Rock Stockpile Extension
Earthwork Cost Estimate
Process Report

Prepared for

Freeport-McMoRan
Chino Mines Company
99 Santa Rita Mine Road
Vanadium, New Mexico 88023

Prepared by

Telesto Solutions, Inc.
3801 Automation Way, Suite 201
Fort Collins, CO 80525

January 2016

TELESTO
SOLUTIONS • INCORPORATED

Signature Page

North Lampbright Waste Rock Stockpile Extension Earthwork Cost Estimate Process Report

January 2016

Report Authors and Contributors

Telesto Solutions, Inc.

_____

April Tischer P.E. – Primary Author

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LIST OF TABLES

LIST OF DRAWINGS

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Purpose & Summary

Freeport-McMoRan Chino Mines Company (Chino) is expanding the main Lambright Stockpile to the north. This expansion area will be called the North Lampbright Waste Rock Stockpile (NLS). The process and associated cost factors that will be used in the earthwork reclamation cost estimate has been prepared by Telesto Solutions Inc. (Telesto). The earthwork reclamation process is based on a template originally created by the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division (MMD, 1996). The process addresses reclamation earthwork and site operations and maintenance costs.

Reclamation cost estimates are developed by first selecting an appropriate fleet of equipment and associated productivity factors, unit rates, and quantities. Equipment selection is done based on the type of operation and availability. Equipment is optimized based on capacity, productivity, size and shape, and type of operation. The amount of time a reclamation operation takes is based on volume of material, haul distance, change in elevation, and factors called productivity factors. Productivity factors are selected based on the latest Caterpillar equipment publications, and site specific conditions such as slope angle. Unit rates are referenceable current 3rd party rates for labor, equipment, fuel, and materials. Indirect rates are later added to the total direct costs. Conceptual reclamation quantities are based on the mine plan and timing considerations required by financial assurance and established reclamation criteria. The equipment, productivity factors, unit rates, and quantities are put together using the template originally created by MMD to develop the reclamation cost estimate.

1.2 Cost Estimate Assumptions

Assumptions used throughout the cost estimate include:

- **Cost estimate calculations:** Are based on the caterpillar performance handbook and the 1996 MMD cost template. Appendix A.1 provides the calculations that will be used on each calculation sheet of the cost estimate spreadsheet.
- **Labor Rates**: With the exception of the truck driver rate, all labor rates are developed based on the New Mexico Department of Labor (DOL) Type H (Heavy Engineering) labor rates effective January 1, 2015. These rates include the base, fringe benefit, and apprenticeship contribution rates. The following FICA, Medicare, Federal un-employment, State un-employment, and Workman's Compensation Insurance are added to the labor rates to obtain the total per hour labor rate.
- **Truck Driver Labor Rate**: The base truck driver labor rate will be 90% of the New Mexico DOL base operator labor rate. Added to the base rate are fringe benefits, apprenticeship contributions, taxes, and Workman's Compensation Insurance.
- **Equipment Rates**: The earth-moving equipment used in the estimate would commonly be available to a contractor. The equipment unit operating costs are taken from EquipmentWatch Custom Cost Evaluator (Penton Media, Inc., 2015).
- **Fuel Costs**: The off-road diesel fuel cost will be a vendor quote for delivery of dyed ultra-low sulfur diesel to Silver City, NM.
- **Revegetation Unit Costs**: The revegetation unit cost will be a vendor quote including: scarifying, discing, rangeland drill seeding, mulching, crimping, and daily per diem.
- **Miscellaneous Unit Costs**: Miscellaneous unit costs are taken from several sources including R.S. Means Heavy Construction Cost Data Edition 29 (R.S. Means, 2015). All costs taken from R.S. Means are adjusted using the location factor for Las Cruces (84.4%).
- **RipRap Production**: The riprap unit cost will be developed based on experience gained producing riprap at the McCain Springs Quarry.
- **Equipment Production Factors**: Production factors from Caterpillar (2014) for each type of equipment are presented in Table 1. Productivity curves are developed from Caterpillar (2014) and are described in Appendix A.2 and A.3.
- **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. A maximum of three segments is typically used for each haul route.
- **Borrow Areas**: Two cover sources will be utilized: 1) A borrow area located southeast of NLS consisting of Rubio Peak Formation material and 2) a nearby topsoil stockpile consisting of suitable material stripped from

within the footprint of the NLS. Revegetation for the topsoil stockpile will be included with the NLS reclamation costs. After cover operations, borrow areas are left in a condition such that they can be directly revegetated.

- **Dozer Push Distances**: Dozer push distances represent the distance from the centroid of the cut block to the centroid of the fill block.
- **Dust Suppression and Site Maintenance:** A full time water truck and a motor grader are included as part of the fleet during reclamation. The water truck and grader time are set equal to loader time.
- **Capital Indirect Costs**: Total indirect costs of 22.5% per MMD (1996) and Office of Surface Mining (OSM, 2000) guidance based on total capital reclamation costs for Chino. The indirect costs are comprised of: Mobilization and Demobilization (1.0%), Contingencies (2.0%), Engineering Redesign Fee (2.5%), Contractor Profit and Overhead (15.0%), and Project Management Fee (2.0%). Indirect cost percentages are identical to the percentages presented to MMD and the New Mexico Environment Department (NMED) in meetings with Tyrone on September 20, 2012, and on November 2, 2012 (Table 2).
- **Operations and Maintenance Indirect Costs**: Total indirect costs of 17.5% for long term operations and maintenance per MMD (1996) and OSM (2000) guidance and comprise the same values and factors as the capital indirect costs with exception of Contractor Profit and Overhead. Contractor Profit and Overhead for long term operations and maintenance is 10.0%, to account for the long term contract and repetitive annual work. Indirect cost percentages are identical to the percentages presented to MMD and the NMED in meetings with Tyrone on September 20, 2012, and on November 2, 2012 (Table 2).

2.0 RECLAMATION DESIGN

During operations, the NLS will be constructed at an overall slope that will result in 3:1 (horizontal: vertical) slope after reclamation benches are cut in. The top surface constructed at a 1% minimum slope, sloping to the east. The conceptual pre-reclamation and reclaimed NLS, including details are shown in the Drawings Sheets 1 through 7. The main reclamation activities that will occur include:

- Minor top surface grading to achieve a smooth slope following the minimum 1% top surface sloping to the east.
- Pushing down operational stockpile benches to achieve a smooth slope.
- Hauling and grading cover material for the top surfaces.
- Completing surface water channels and benches to collect and convey storm water from the stockpile surfaces.
- Scarification and revegetation of covered areas.

The major assumptions for this cost estimate would include:

- **Regrading**: Slopes: 200-foot maximum inter-bench slope length, maximum 3H:1V inter-bench slopes, 1% minimum top surface slope.
- **Outslope Channels and Benches:** 15-foot bench width, 1% to 5% cross-bench slope, <5.0% longitudinal bench slope and 3-feet of cover; channel 6-inches of gravel underlain by 3-feet of cover.
- **Channels:** maximum 2,500 feet in length, maximum 2% longitudinal slope, 1-foot of riprap over 6-inches of filter material (gravel) underlain by 3-feet of cover.
- **Downdrains:** 2.5-feet of riprap over 6-inches of filter material underlain by 3-feet of cover.
- **Cover**: 36-inch cover thickness – tops and outslopes. 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 Maintenance**: 2% failure every year for a total of 12 years, starting the year reclamation is completed.

3.0 REFERENCES

Caterpillar, Inc. 2011. Caterpillar Performance Handbook, Edition 41. Caterpillar Inc. Peoria, Illinois. January 2011.

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MMD. 1996. [New Mexico Energy, Minerals and Natural Resources, Department, Mining and Minerals Division]. 1996. Closeout Plan Guidelines for Existing Mines, Natural Resources Department. April 30, 1996.

OSM. 2000. U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement Handbook for Calculation of Reclamation Bond Amounts. April 5, 2000.

Penton Media, Inc. 2015. Equipment Watch Custom Cost Evaluator Version 6.17.13A.

R.S. Means. 2015. Heavy Construction Cost Data. 29th Annual Edition. R.S. Means Company, Inc.

TABLES

Table 1 Equipment Production Factors

Parameter	Value	Comment/Reference
Swell Factor Stockpiles and Tailings(1)	0% Pushdown, load & haul cover	Cover material volumes are calculated based on the reclaimed area and the cover depth. Thus, a swell factor is not needed to calculate this cost. No virgin materials are being regraded as part of reclamation. Thus a swell factor is not applied when regrading material.
Grading (D11T CD, D11T, D9T, 16M, D6T)		
Operator Factor (1)	1.0 Stockpile coarse grading 0.75 Cover & channel fine grading	Due to large job size assume excellent operator (CPH 44, 19-55, excellent) (CPH 44, 19-55, average)
Material Factor	1.2 - Stockpile 1.2 - Cover	CPH 44, 19-55, Loose stockpile
Work Hour	50 min	(CPH 44, 19-55)
Grade Factor – Tops	1.0	(CPH 44, 19-55) 1-5% Slope
Grade Factor - Outslopes(1)	1.6	(CPH 44, 19-55) 1.6 – 3H:1V Slopes
Soil Weight	3,300 lb./cy Stockpile 2,900 lb/cy Cover	-
Production Method/ Blade Factor	1.2 – Slot 1 – Channels/Down drains/Benches	(CPH 44, 19-55, slot dozing) No correction applied for channels/ downdrains/benches
Effective Blade Width (feet)	22 D11T CD Universal Blade 14.25 D9T Semi Universal Blade 16 16M 17.5 D6T XL SU	(CPH 44, 19-49) (CPH 44, 19-47) (CPH 44, 11-17) (CPH 44, 19-43)
Speed (miles/hr)	2.5 mph D11T CD and 16M 1.0 mph D9T and D6T	-
Visibility Factor	1.0	(CPH 44, 19-55) Clear
Elevation Factor	1.0	(CPH 44, 30-5)
Transmission Factor	1.0	-
Loader (992K)		
Heaped Bucket Capacity (cy)	16.0	(CPH 44, 23-288, Standard, 3000 lb./yd3)
Loader Cycle Time (load, dump, and	0.65	(CPH 44, 23-223) Avg 0.6-0.7

Parameter	Value	Comment/Reference
maneuver; min)		
Bucket Fill Factor	0.875	(CPH 44, 30-1) Avg 0.85-0.90 Loose Material 1" and over
Work Hour (min/hr)	50	(CPH 44, 19-55)
Trucks (CAT 777F)		
Struck Capacity (cy)	54.8	Equipment Watch Specification Sheet
Heaped Capacity(cy)	78.8	(CPH 41, 9-6)
Rolling Resistance (%)	2.5%	(CPH 44, 30-1) Radial tires, dirt road maintained fairly regularly, watered, flexing slightly
Truck Exchange Time (min)	0.7	(CPH 44, 10-20) Avg. 0.6-0.8
Dump/Maneuver Time (min)	1.1	(CPH 44, 10-20) Avg 1.0-1.2
Work Hour (min/hr)	50	(CPH 44, 19-55)

CPH = Caterpillar Performance Handbook Edition 35, 44(Caterpillar, Inc. 2007, 2014)

(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.

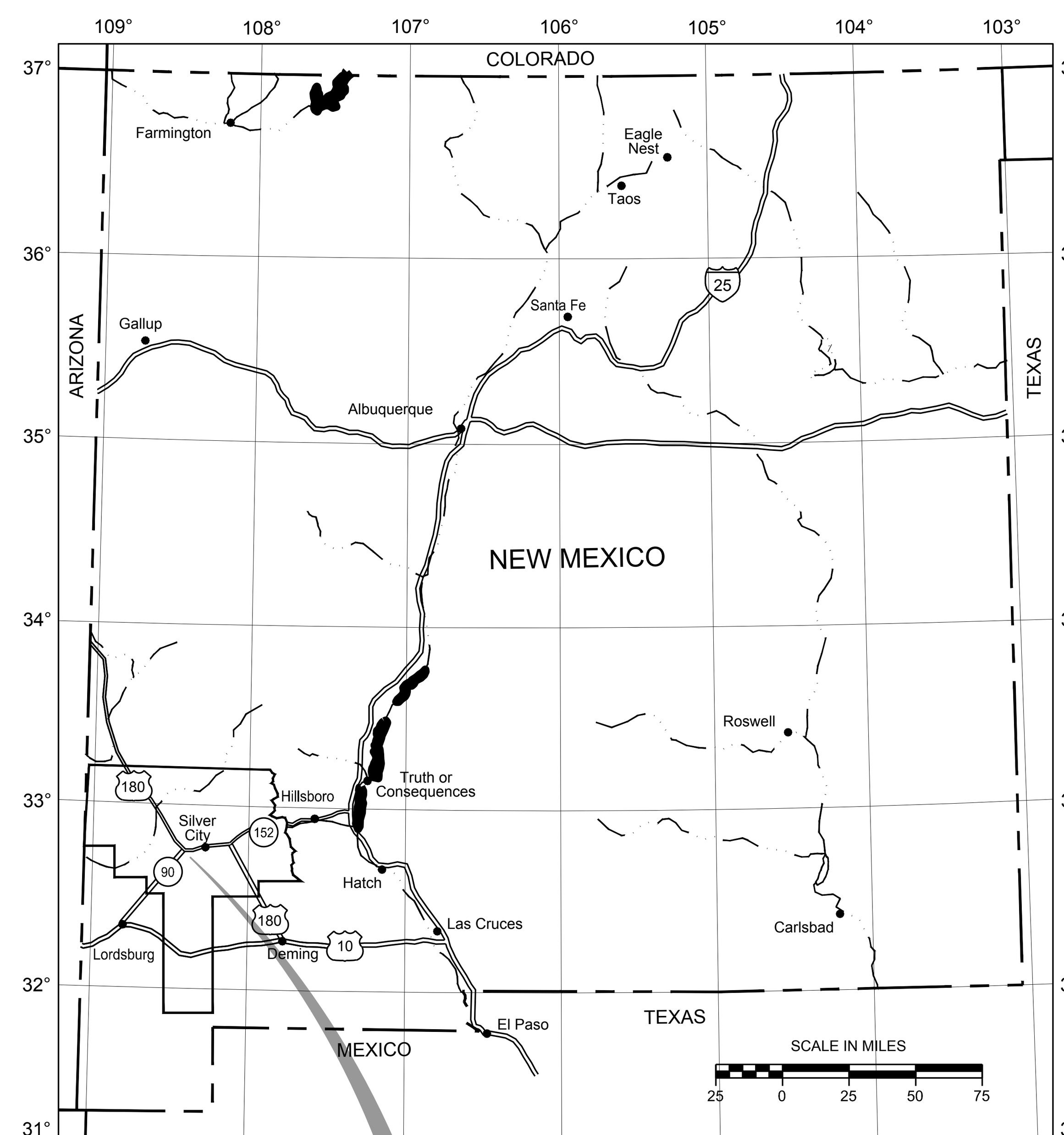
Table 2 Indirect Cost Summary

				Little Rock $1 M Direct Costs Presented to NMED/MMD in 2013 Little Rock CCP		Tyrone $400 M Direct Costs Presented to NMED/MMD in 2012 Tyrone CCP			Chino $400-$500 M Direct Costs Internal, proposed same as Tyrone CCP			Cobre $30-40M Direct Costs Presented to NMED/MMD in 2014 Continental Mine CCP			
Direct Cost ($)	**MMD (1996)**	**OSM (2000)**	**Prior Indirect Percentages**	**Capital**	**O&M**	**Capital**	**Earthwork O&M**	**Water Treatment O&M**	**Capital**	**Earthwork O&M**	**Water Treatment O&M**	**Capital**	**Earthwork O&M**	**Water Management O&M**	**Notes**
Mobilization & Demobilization	1%-5%	<10%	1.1%	5%	5%	1%	1%	0%	1%	1%	0%	3.8%	3.8%	0%	Mobilization and Demobilization not needed for water treatment plant operations and maintenance
Contingencies	-	3% - 5%	2%	-	-	-	-	-	-	-	-	-	-	-	
0 - 500,000	10%		-	-	-	-	-	-	-	-	-	-	-	-	
500,000 - 5 million	7%		-	7%	7%	-	-	-	-	-	-	-	-	-	
5 million - 50 million	4%		-	-	-	-	-	-	-	-	-	4%	4%	4%	
Greater than 50 million	2%		-	-	-	2%	2%	2%	2%	2%	2%				
Engineering Redesign	-	2.5% - 6%	4.5%	6%	6%	2.5%	2.5%	0%	2.5%	2.5%	0%	2.5%	2.5%	0%	Engineering Redesign not needed for water treatment plant operations and maintenance
Profit & Overhead (OSM)	-	10% - 30%	25%	-	-	-	-	-	-	-	-	-	-	-	
0 - 100,000	-	30%	-	-	-	-	-	-	-	-	-	-	-	-	
100,000 - 500,000	-	25%	-	-	-	-	-	-	-	-	-	-	-	-	Contractor Profit and overhead decreased by 5% for operations and maintenance since not new construction
500,000 - 2,000,000	-	20%	-	20.0%	10.0%	-	-	-	-	-	-	-	-	-	
>10,000,000	-	15%	-	-	-	15%	10%	10%	15%	10%	10%	15%	10%	10%	
Reclamation or closeout plan management	-	-	5%	-	-	-	-	-	-	-	-	-	-	-	
10,000	-	7%	-	-	-	-	-	-	-	-	-	-	-	-	
500,000		5%		-	-	-	-	-	-	-	-	-	-	-	
1,000,000	-	4.5%	-	4.5%	4.5%	-	-	-	-	-	-	-	-	-	
10,000,000	-	3.25%	-	-	-	-	-	-	-	-	-	-	-	-	
100,000,000	-	2%	-	-	-	2%	2%	2%	2%	2%	2%	3%	3%	3%	
State Procurement Cost	-	-	2%	-	-	-	-	-	-	-	-	-	-	-	Included in Engineering Re-Design and Reclamation Management Fee
Contract Administration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Included in Reclamation Management Fee, Procurement Cost and Engineering Re-Design
			39.6%	42.5%	32.5%	22.5%	17.5%	14.0%	**22.5%**	**17.5%**	**14.0%**	28.3%	23.3%	17.0%	

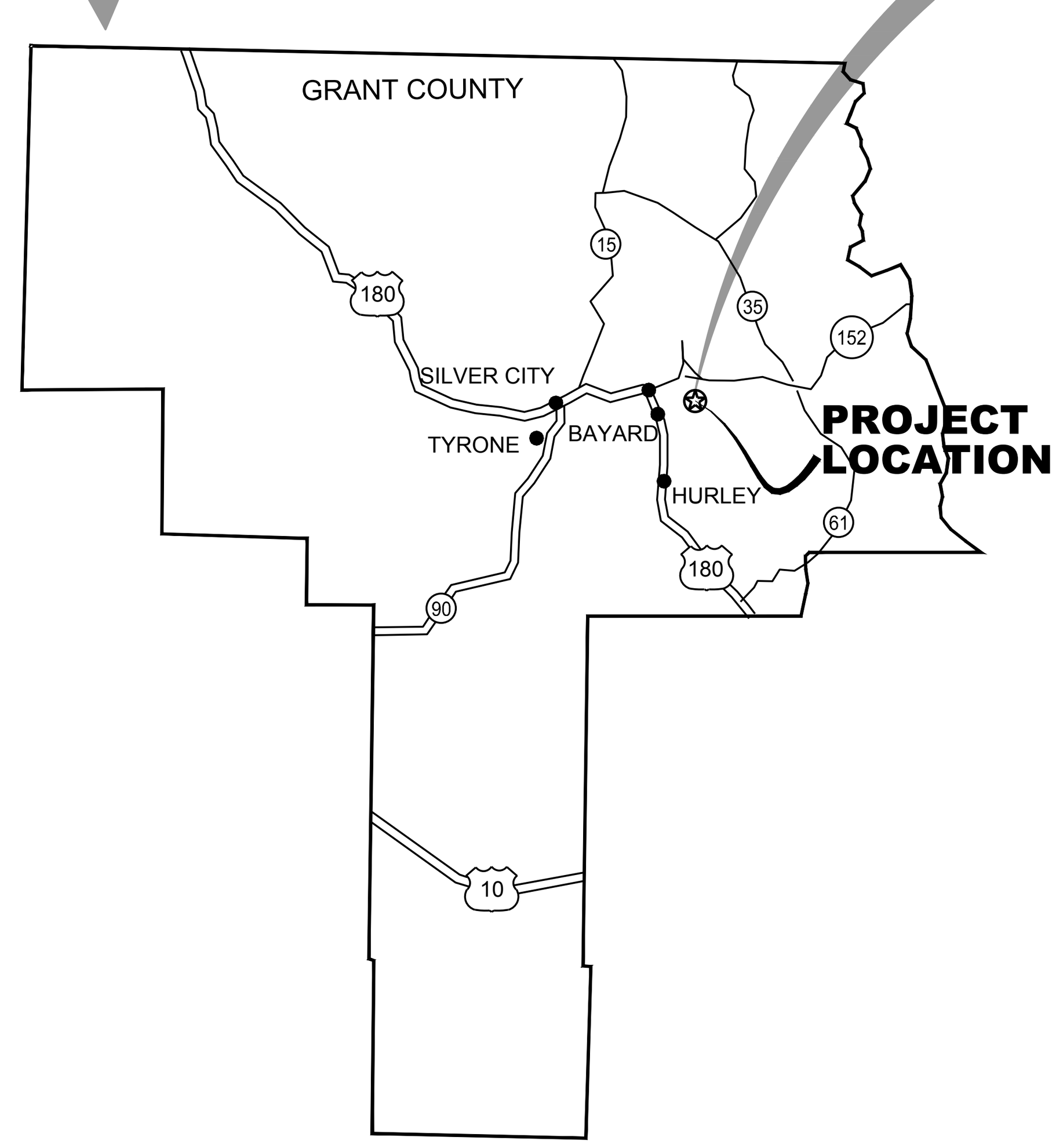
DRAWINGS

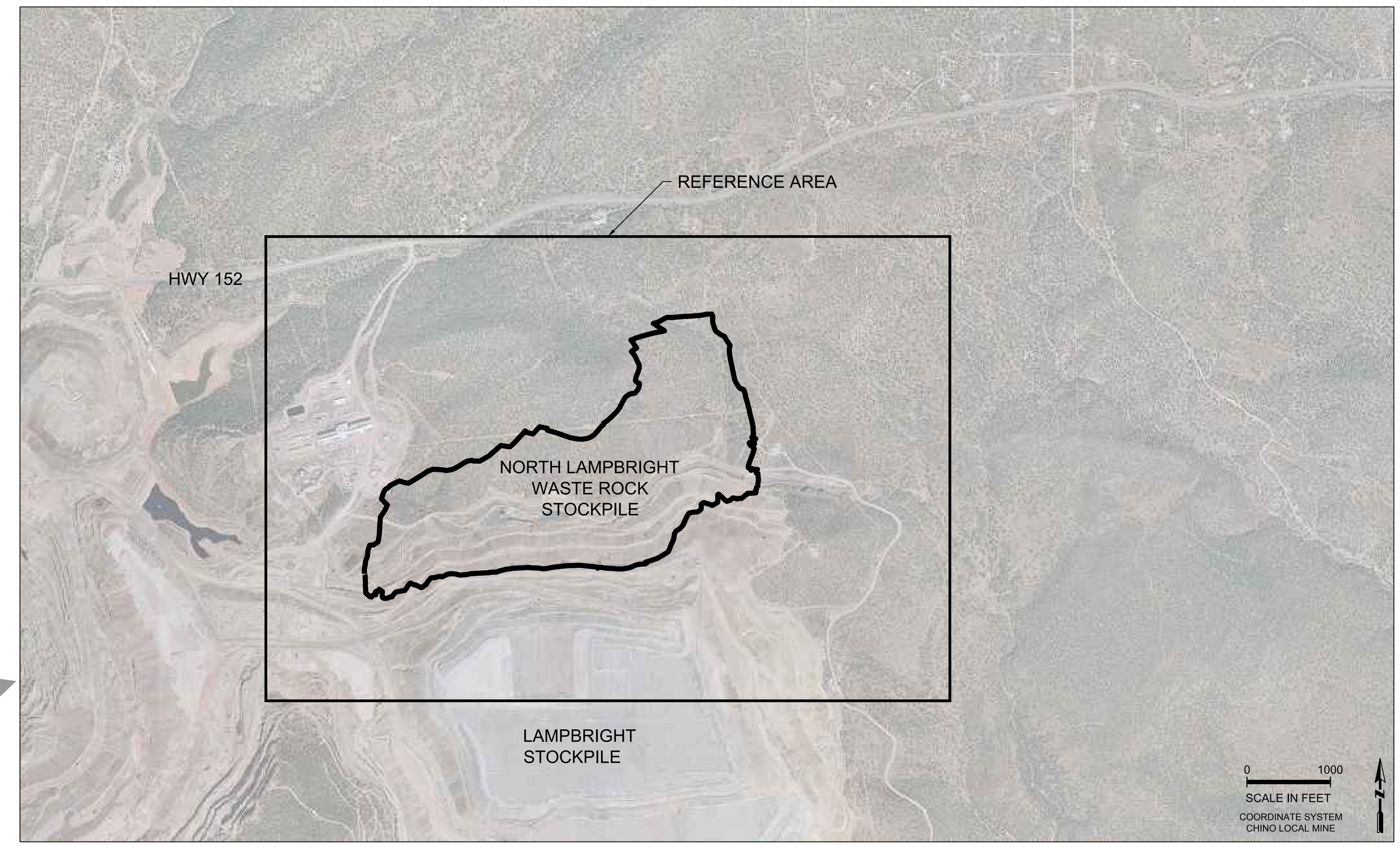
PROPOSED RECLAMATION PLAN FOR THE NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

ISSUED FOR FINANCIAL ASSURANCE RECLAMATION COST ESTIMATE



NORTH





Sheet List Table	
Sheet Number	Sheet Title
1	COVER SHEET
2	EXISTING TOPOGRAPHY
3	CONCEPTUAL PRE-RECLAMATION STOCKPILE
4	CONCEPTUAL RECLAIMED STOCKPILE
5	CROSS SECTIONS
6	DETAILS
7	CONCEPTUAL HAUL PATHS

DETAIL REFERENCE
(1) DETAIL IDENTIFICATION NUMBER OR LETTER

SECTION REFERENCE
(A) SECTION IDENTIFICATION NUMBER OR LETTER

LEGEND / NOTES

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR AGENCY REVIEW	1/18/2016	DO	AT

DATE	1/18/2016
PROJECT	200399
TASK NUMBER	
DRAWN BY	DO
PROJECT ENGINEER	AT
CHECKED BY	

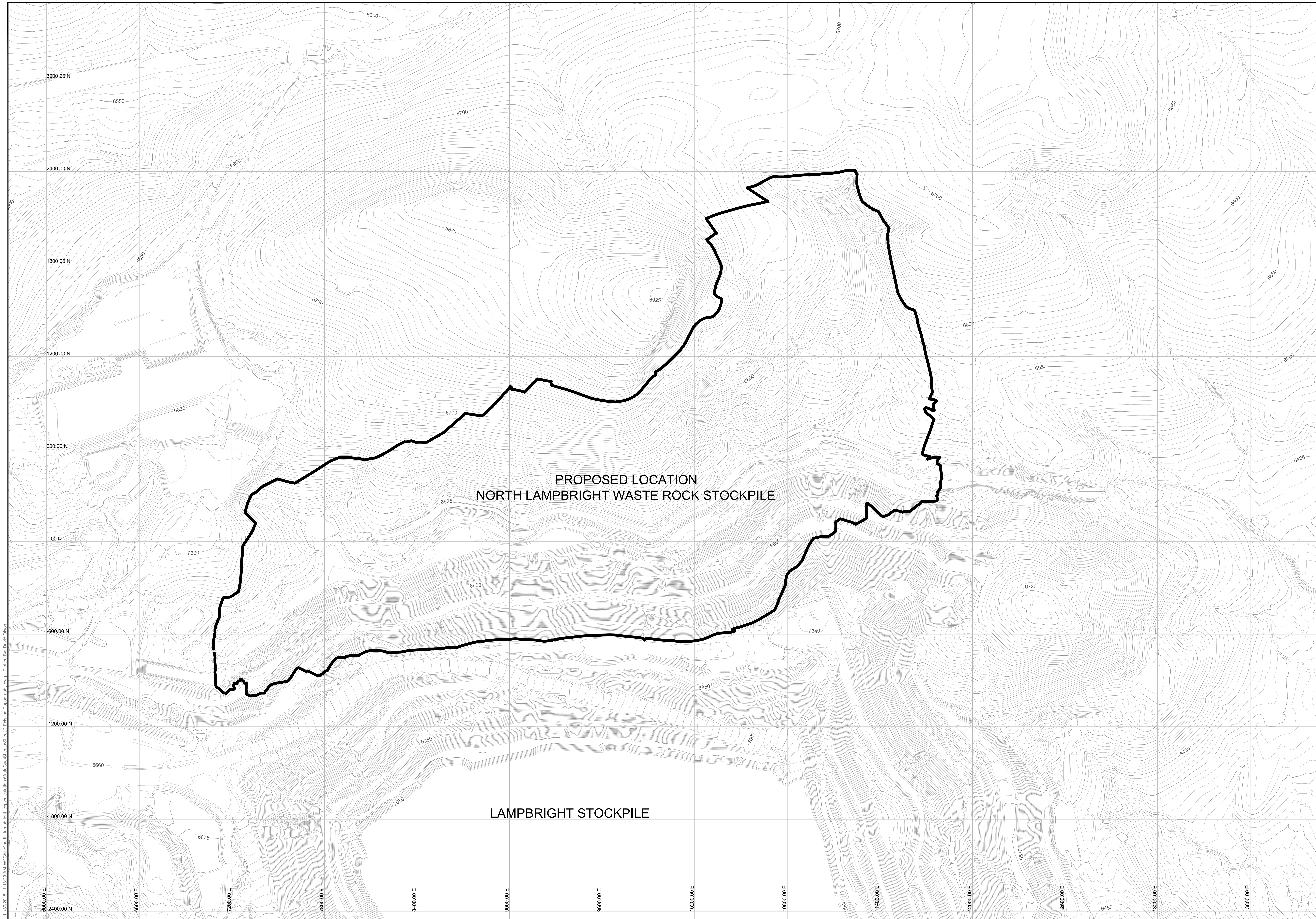
NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

COVER SHEET

SHEET NUMBER: 1
REVISION NUMBER: 0

PREPARED BY:
TELESTO SOLUTIONS INCORPORATED

PREPARED FOR:
FREEPORT-McMoRAN



LEGEND / NOTES

EXISTING CONTOURS
(5' CONTOUR INTERVAL)

0 300
SCALE IN FEET

COORDINATE SYSTEM
CHINO LOCAL MINE

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR AGENCY REVIEW	1/18/2016	DO	AT

DATE	1/18/2016
PROJECT	200399
TASK NUMBER	
DRAWN BY	DO
PROJECT ENGINEER	AT
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

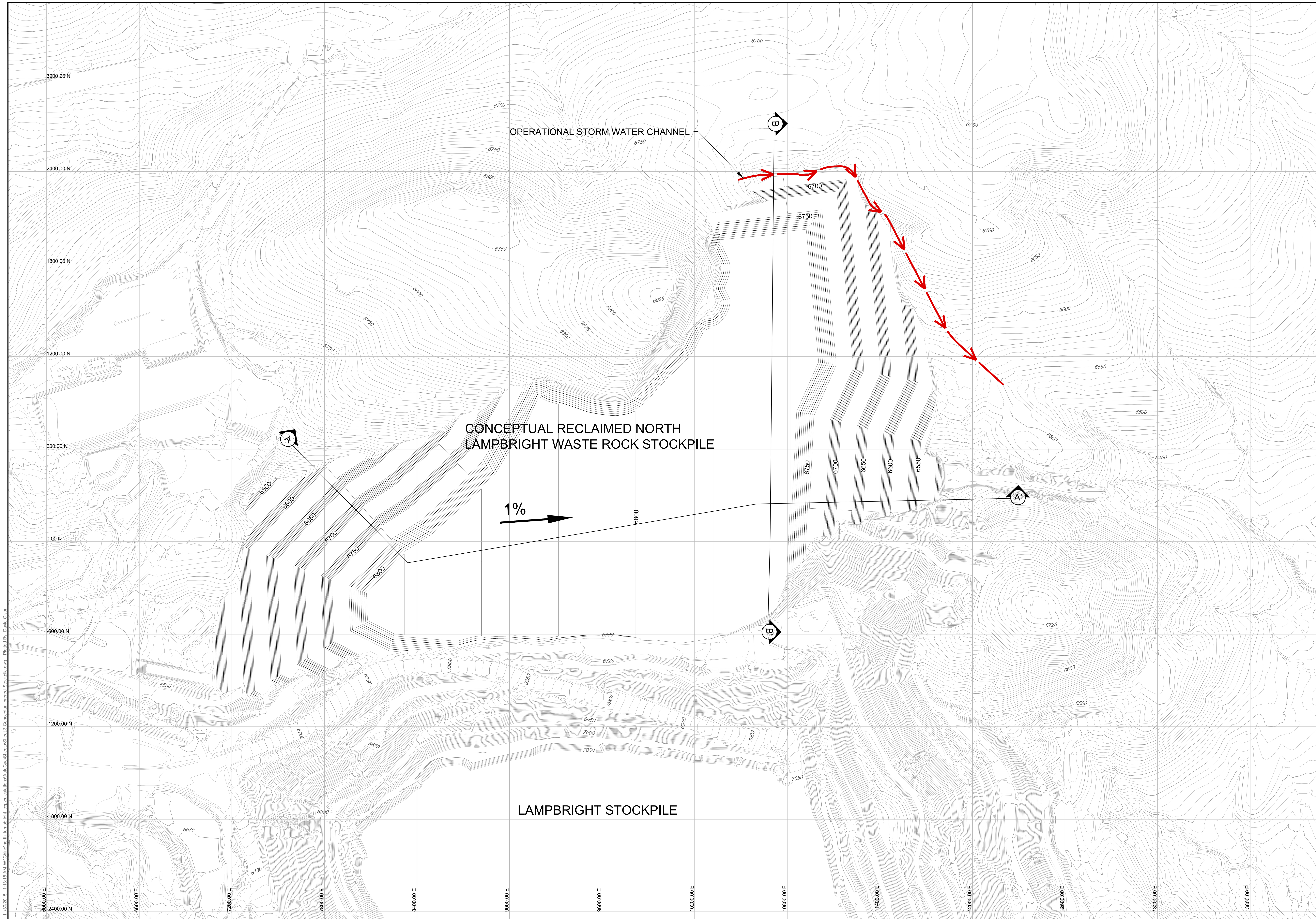
EXISTING TOPOGRAPHY

SHEET NUMBER: 2

REVISION NUMBER: 0

PREPARED BY: TELESTO

PREPARED FOR: FREEPORT-McMoRAN



LEGEND / NOTES

EXISTING CONTOURS (5' CONTOUR INTERVAL)

PRE-RECLAMATION CONTOURS (5' CONTOUR INTERVAL)

NOTE: SEE SHEET 5 DETAIL 1 FOR TYPICAL OPERATIONAL BENCH REGRADE

0 300 SCALE IN FEET

COORDINATE SYSTEM CHINO LOCAL MINE

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	*FOR AGENCY REVIEW*	1/18/2016	DO	AT

DATE	*1/18/2016*
PROJECT	*200399*
TASK NUMBER	
DRAWN BY	*DO*
PROJECT ENGINEER	*AT*
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

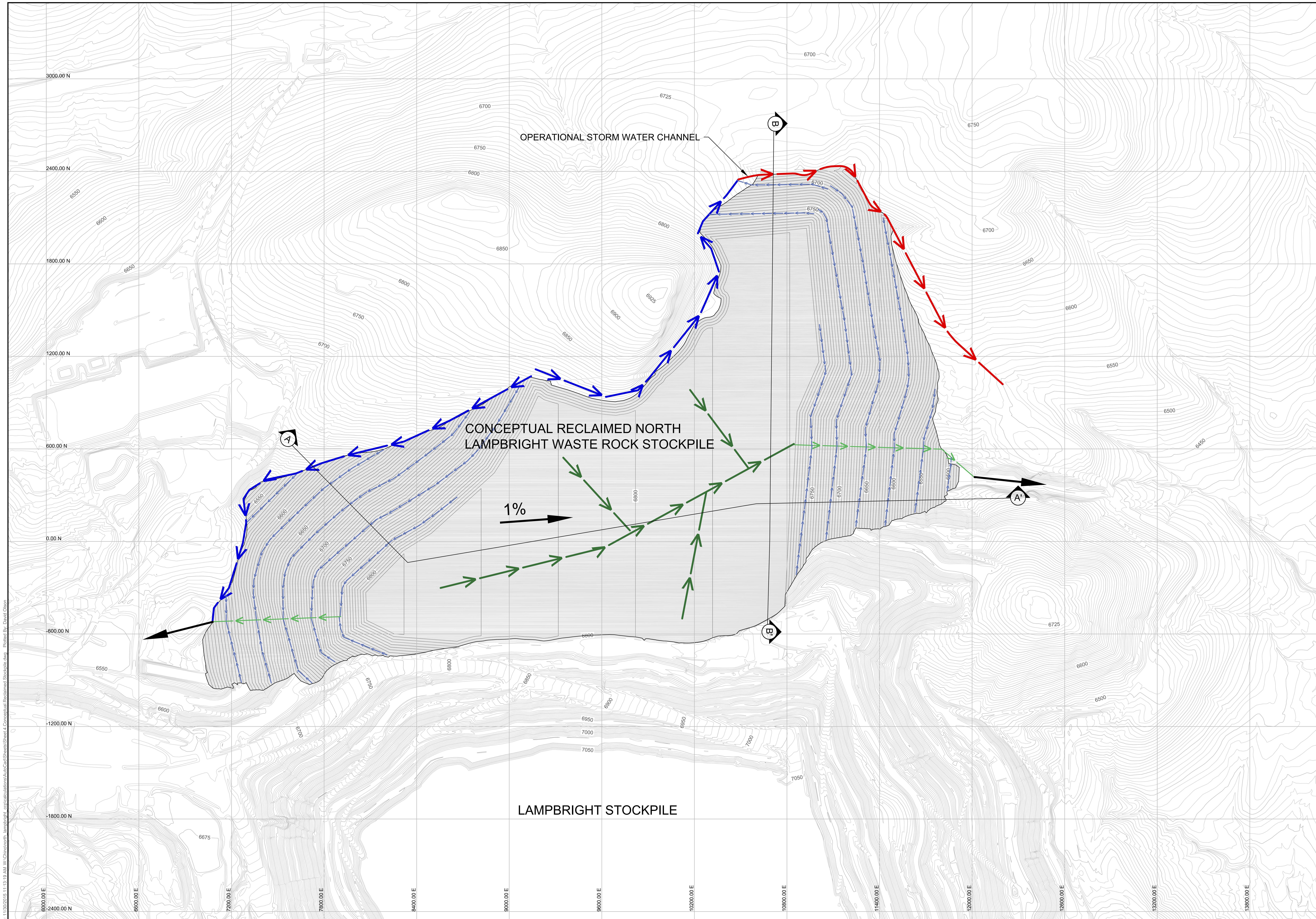
CONCEPTUAL PRE-RECLAMATION STOCKPILE

SHEET NUMBER: 3

REVISION NUMBER: 0

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

PREPARED FOR: FREEPORT-MCMORAN



LEGEND / NOTES

- EXISTING CONTOURS (5' CONTOUR INTERVAL)
- CONCEPTUAL RECLAIMED CONTOURS (5' CONTOUR INTERVAL)
- TOP CHANNELS (DETAIL 2 SHEET 5)
- OFF SITE CHANNEL (DETAIL 2 SHEET 5)
- DOWNDRAINS (DETAIL 3 SHEET 5)
- BENCHES (DETAIL 4 SHEET 5)
- REVEGETATED AREA

0 300
SCALE IN FEET

COORDINATE SYSTEM
CHINO LOCAL MINE

N

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR AGENCY REVIEW	1/18/2016	DO	AT

DATE	1/18/2016
PROJECT	200399
TASK NUMBER	
DRAWN BY	DO
PROJECT ENGINEER	AT
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

CONCEPTUAL RECLAIMED STOCKPILE

SHEET NUMBER: 4

REVISION NUMBER: 0

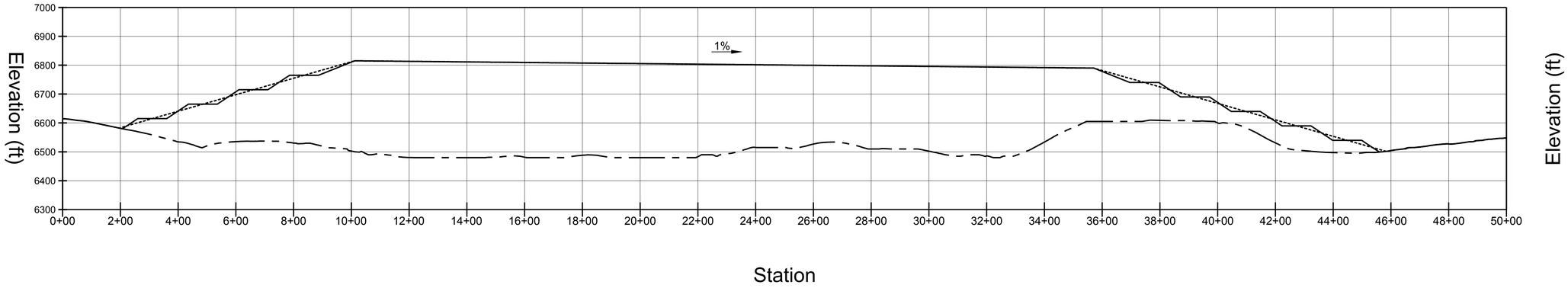
PREPARED BY: TELESTO SOLUTIONS INCORPORATED

PREPARED FOR: FREEPORT-MCMORAN

A

CROSS SECTION ALIGNMENT A - A'

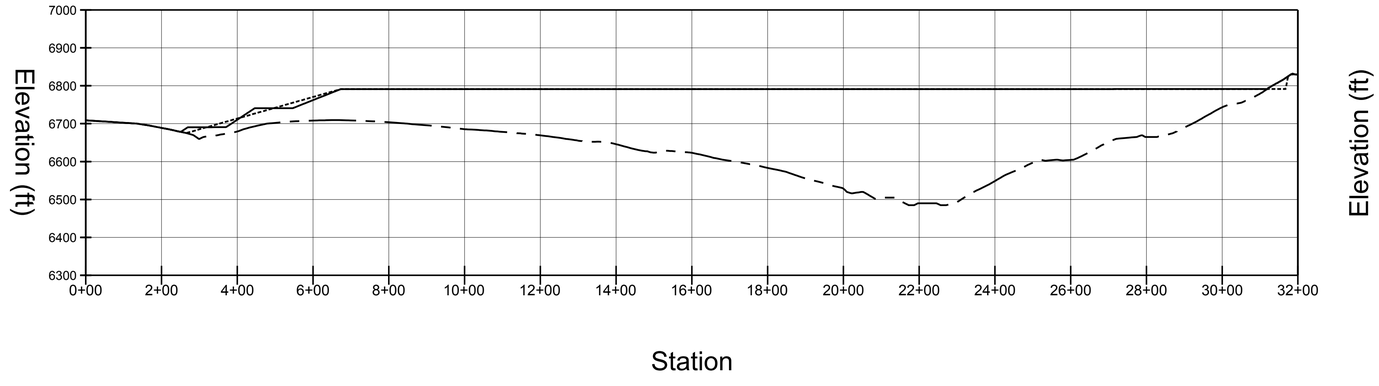
A'



B

CROSS SECTION ALIGNMENT B - B'

B'



LEGEND / NOTES

PRE-RECLAMATION STOCKPILE

CONCEPTUAL RECLAIMED STOCKPILE

EXISTING GROUND

NOTE: RECLAIMED BENCHES NOT SHOWN

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	*FOR AGENCY REVIEW*	1/18/2016	*DO*	*AT*

DATE	*1/18/2016*
PROJECT	*200399*
TASK NUMBER	
DRAWN BY	*DO*
PROJECT ENGINEER	*AT*
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

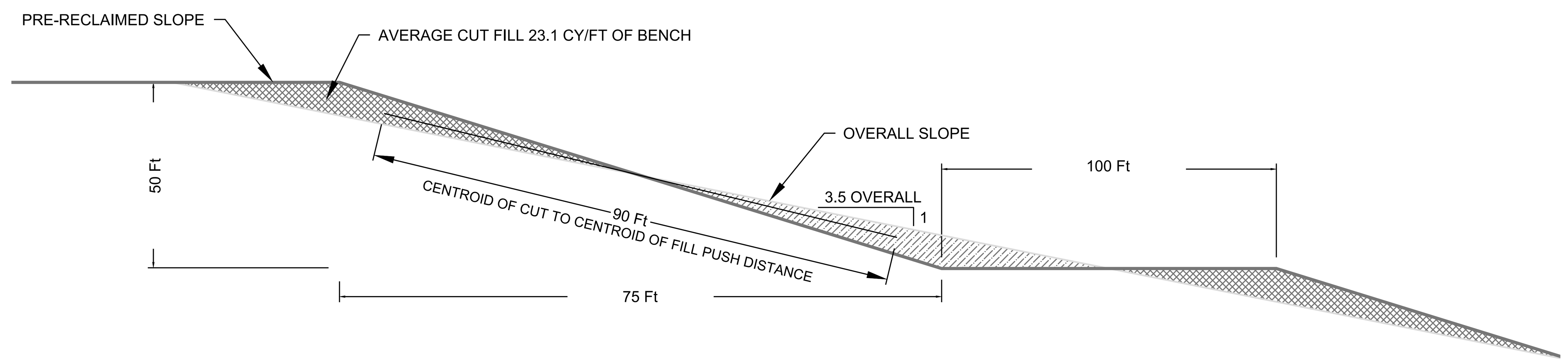
CROSS SECTIONS

SHEET NUMBER: 5

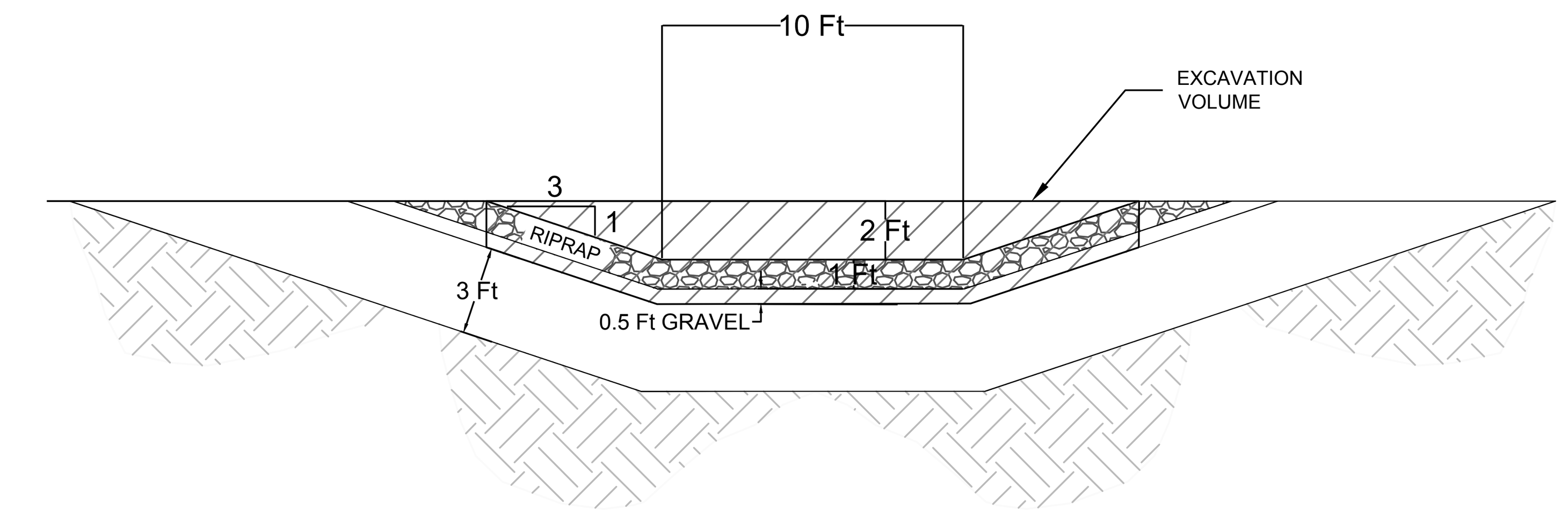
REVISION NUMBER: 0

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

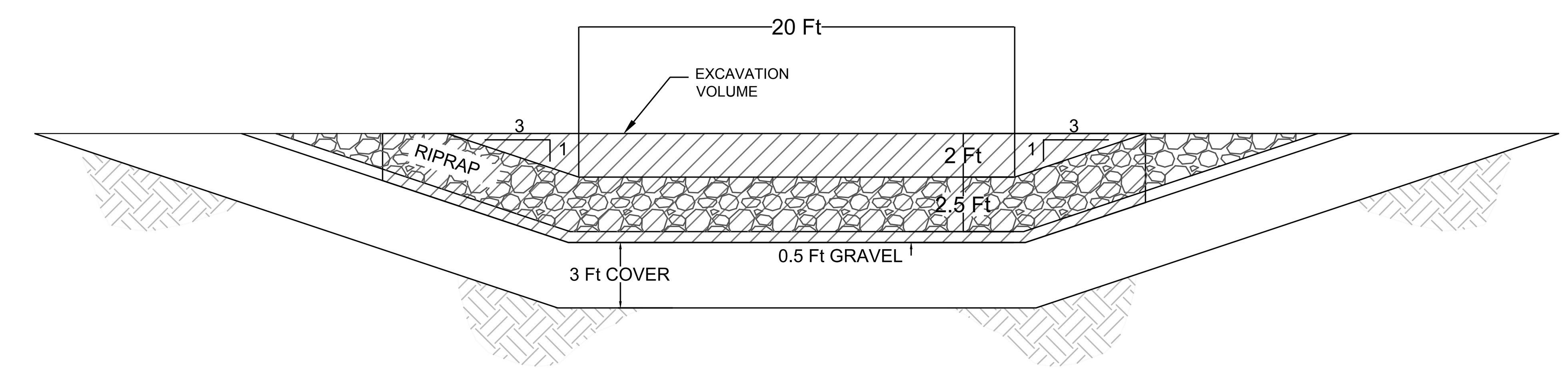
PREPARED FOR: FREEPORT-MCMORAN



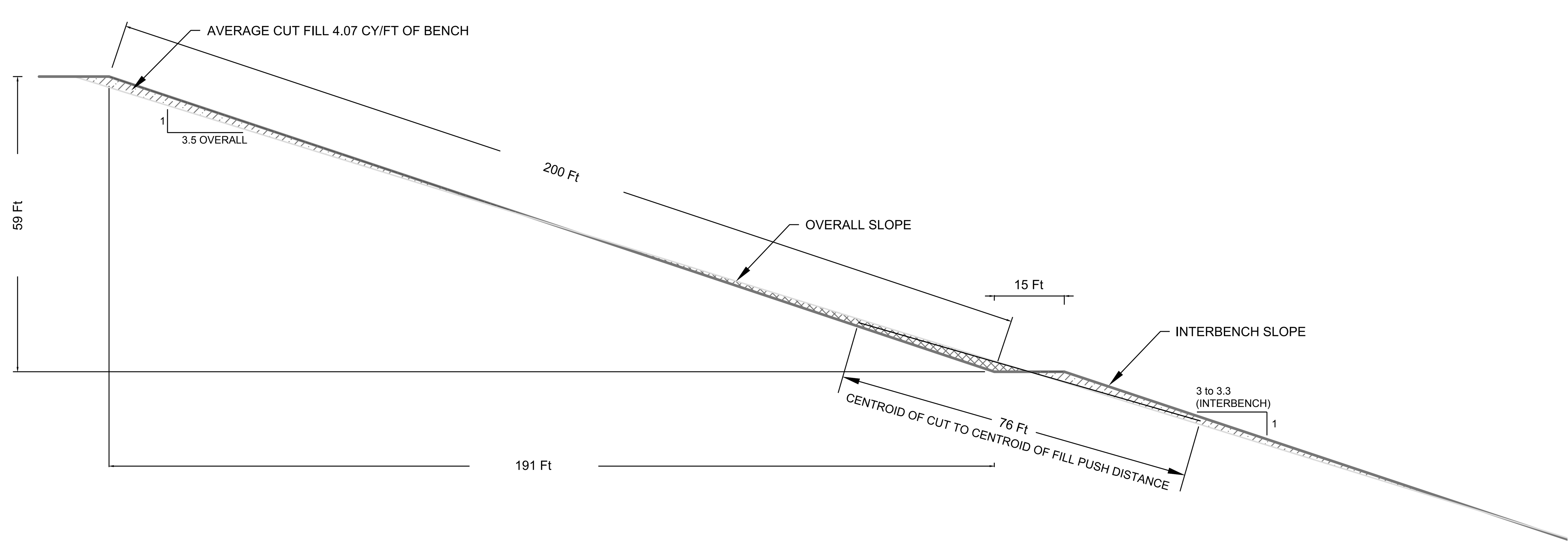
1 TYPICAL OPERATIONAL BENCH REGRADE
(NOT TO SCALE)



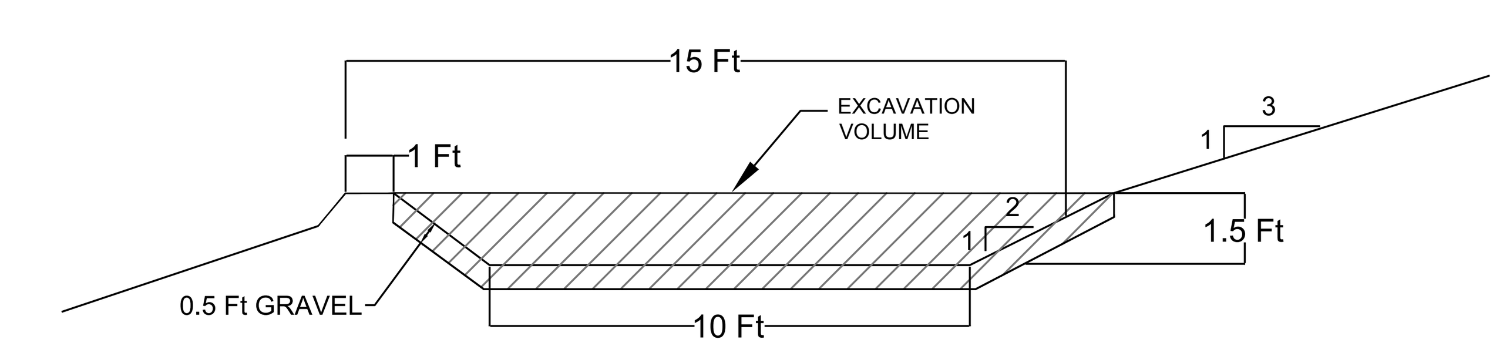
2 TYPICAL TOP AND OFF SITE CHANNELS
(NOT TO SCALE)



3 TYPICAL DOWNDRAINS
(NOT TO SCALE)



5 TYPICAL RECLAIMED OUTSLOPE BENCH
(NOT TO SCALE)



4 TYPICAL BENCH
(NOT TO SCALE)

LEGEND / NOTES

- RIPRAP
- EXCAVATION VOLUME

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVED
0	FOR AGENCY REVIEW	1/18/2016	DO	AT

DATE	1/18/2016
PROJECT	200399
TASK NUMBER	
DRAWN BY	DO
PROJECT ENGINEER	AT
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

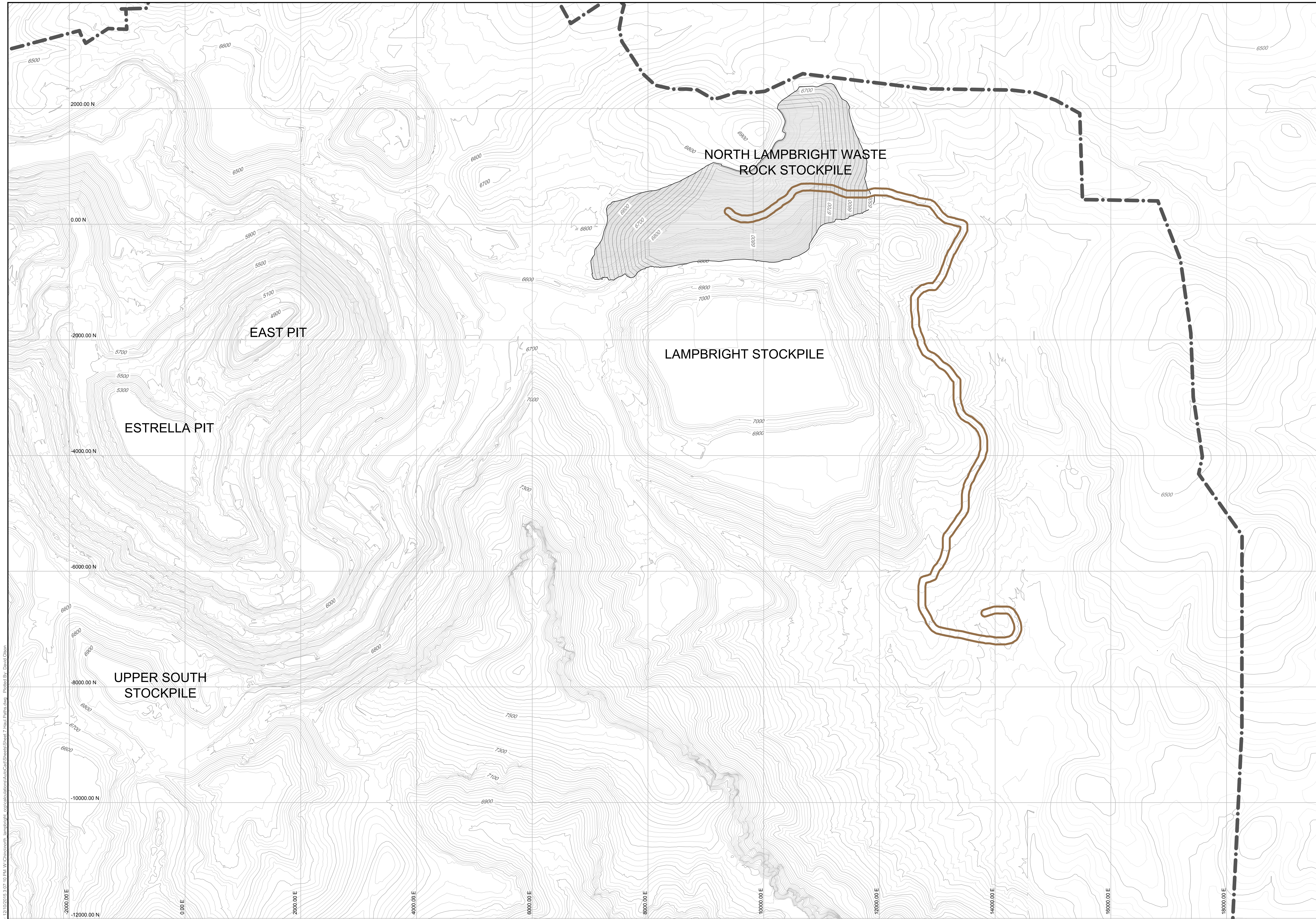
DETAILS

SHEET NUMBER: 6

REVISION NUMBER: 0

PREPARED BY: TELESTO SOLUTIONS INCORPORATED

PREPARED FOR: FREEPORT-McMoRAN



LEGEND / NOTES

CHINO MMD PERMIT BOUNDARY

EXISTING CONTOURS (20' CONTOUR INTERVAL)

CONCEPTUAL RECLAIMED CONTOURS (20' CONTOUR INTERVAL)

REVEGETATED AREA

CONCEPTUAL HAUL ROAD

0 800
SCALE IN FEET

COORDINATE SYSTEM
CHINO LOCAL MINE

N

REVISIONS

#	DESCRIPTION	DATE	BY	APPROVAL
0	FOR AGENCY REVIEW	1/18/2016	DO	AT

DATE	1/18/2016
PROJECT	200399
TASK NUMBER	
DRAWN BY	DO
PROJECT ENGINEER	AT
CHECKED BY	

NORTH LAMPBRIGHT WASTE ROCK STOCKPILE

CONCEPTUAL HAUL PATHS

SHEET NUMBER: 7
REVISION NUMBER: 0

PREPARED BY:
TELESTO SOLUTIONS INCORPORATED

PREPARED FOR:
FREEPORT-McMoRAN

APPENDIX A
SUPPORTING DOCUMENTATION

APPENDIX A.1
CALCULATION DOCUMENTATION

EQUATIONS USED IN CAPITAL COST SPREADSHEET

Sheet #4 Earthwork:

$$\text{Bank Volume (bcy)} = \text{Area (acre)} * \text{Cover Depth (in)} * \frac{43560(\text{ft}^2/\text{acre})}{12(\text{in/ft}) * 27(\text{ft}^3/\text{cy})}$$

$$\text{Loose or Stockpile Volume (lcy)} = \text{Bank or stockpile Volume (cy)} * [1 + \text{Swell Factor}]$$

Sheet #5 Dozer:

$$\text{Normal Production (cy/hr)} = 159372.008958 * \text{Maximum Push Distance (ft)}^{-0.862481}$$

(Caterpillar Performance Handbook Edition 41 D11T CD 1 - 53)

$$\text{Productivity (cy/hr)} = \text{Normal Production (cy/hr)} * \text{Operator} * \text{Material} * \frac{\text{Work Hour (min/hr)}}{60\ \text{(min/hr)}}$$

$$* \text{Grade Factor} * \frac{2300(\text{lbs/cy})}{\text{Soil Weight (lbs/cy)}} * \text{Prod. Method} * \text{Visibility} * \text{Elev.} * \text{Drive Trans.}$$

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

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

(*Curve Fit Cat Handbook Ed* 44 19 – 55)

Sheet #6 Grading:

Grade Surface:

$$\text{Grade Factor} = -0.02 * \text{Grade (\%)} + 1$$

(Curve Fit Cat Handbook Ed 44 19 – 55)

$$\text{Productivity (acre/hr)} = \text{Speed (mi/hr)} * \frac{5280\ \text{(ft/mi)} * \text{Effective Blade Width (ft)}}{43560\ (\text{ft}^2/\text{acre})} * \frac{\text{Work Hour (min/hr)}}{60\ \text{(min/hr)}}$$

$$* \text{Operator} * \text{Material} * \text{Grade Factor} * \frac{2300(\text{lbs/cy})}{\text{Soil Weight (lbs/cy)}} * \text{Prod. Method} * \text{Visibility} * \text{Elev.} * \text{Drive Trans.}$$

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

Grade
Cover:

$$\text{D11T CD Normal Production } (cy/hr) = 159372.008958 * \text{Maximum Push Distance } (ft)^{-0.862481}$$

(*Curve Fit Cat Handbook Ed* 41 1 – 53)

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

(*Curve Fit Cat Handbook Ed* 44 19 – 55)

$$\text{Productivity } (cy/hr) = Normal\ \text{Production } (cy/hr) * \frac{Work\ Hour\ (\text{min}/hr)}{60\ (\text{min}/hr)} * Operator * Material * Grade\ Factor$$

$$* \frac{2300\ (lbs/cy)}{Soil\ Weight\ (lbs/cy)} * \text{Production } Method * Visibility * Elevation * DirectDriveTrans$$

$$Task\ Time(hr) = \frac{\text{Area or Volume}}{\text{Productivity}}$$

Sheet #7 Ripper NOT USED

Sheet #8 Excavator NOT USED

Sheet #9 Trucks:

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

$$Haul\ \text{Distance}\ Segment\ (m) = Haul\ \text{Distance}\ (ft) * 0.3048\ (m/ft)$$

$$Haul\ Effective\ Grade\ (\%) = \left(Haul\ Grade\ (\%) + Rolling\text{Resistance}\ (\%)\right)(unless < 0\ then\ 0)$$

$$\text{Return}\ Effective\ Grade\ (\%) = \left(Rolling\text{Resistance}\ (\%) - Haul\ Grade\ (\%)\right)(unless < 0\ then\ 0)$$

$$777F\ Segment\ Travel\ Time\ Loaded\ (\text{min}/m) =$$
$$-1.6825 * Haul\ Effective\ Grade\ Segment\ (\%)^{3} + 0.4592 * Haul\ Effective\ Grade\ Segement\ (\%)^{2}$$
$$+ 0.0079 * Haul\ Effective\ Grade\ Segment\ (\%) + 0.0009$$

$$777F\ Segment\ Travel\ Time\ Empty\ (\text{min}/m) =$$
$$-6.2135 * \text{Return}\ Effective\ Grade\ Segment\ (\%)^{4} + 1.0448 * \text{Return}\ Effective\ Grade\ Segment\ (\%)^{3} + 0.1016 * \text{Return}\ Effe$$
$$-0.0035 * \text{Return}\ Effective\ Grade\ Segement\ (\%) + 0.0009$$

(*Curve Fit Cat Handbook Ed* 41 9 – 42)

$$Loader\ (cycles/truck) = Maximum\left[\frac{Struck\ Capacity\ (cy)}{Loader\ Net\ Bucket\ Capacity\ (cy)}, \frac{Heaped\ Capacity\ (cy)}{Loader\ Net\ Bucket\ Capacity\ (cy)}\right]$$

$$Haul\ Time\ (\text{min}) = \sum\left(Segment\ Travel\ Time\ Loaded\ (\text{min}/m) * Segment\ Haul\ Dist\ (m)\right)$$

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

$$Loading\ Time\ (\text{min}) = Loader\ Cycle\ Time\ (\text{min}) * Loader\ (cycles/truck)$$

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

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

$$\text{Productivity}\ (cy/hr) =$$
$$Work\ Hour\ (\text{min}/hr) * Loader\ (cycles/truck) * Loader\ Net\ Bucket\ Capcity\ (cy) * \frac{Optimum\ Number\ of\ Trucks}{Truck\ Cycle\ Time\ (\text{min})}$$

Sheet #10 Loader:

992K Truck Loader

$$Net\ Bucket\ Capcity\ (cy) = Heaped\ Bucket\ Capacity\ (cy) * Bucket\ Fill\ Factor$$

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

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

Sheet #11 Scraper NOT USED

Sheet #13 Earth Sum:

$$Direct\ Cost\ (\$) = \left[Owning\ \&\ Operating\ Cost\ (\$/hr) + Labor\ Cost\ (\$/hr)\right] * \text{TimeRequired}\ (hr) * \text{Number of Units of Equipment}$$

$$Unit\ Cost\ (\$/unit) = \frac{Direct\ Cost\ (\$)}{Total\ \text{Production}\ (unit)}$$

$$Earthwork\ Total\ Direct\ Cost\ (\$) = \sum Total\ Cost\ (\$)$$

Sheet #14 Reveg:

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

$$\text{Reveg Total Direct Cost}\ (\$) = \sum\ Direct\ Costs\ (\$)$$

Sheet #15 Other:

$$Unit\ Cost\ (\$/unit) = Unadjusted\ Cost\ (\$/unit) * \frac{Location\ Adjustment\ (\%)}{100}$$

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

$$Other\ Total\ Direct\ Cost\ (\$) = \sum Direct\ Cost\ (\$)$$

Sheet #16 & 17 Sum:

$$Subtotal\ Direct\ Cost\ (\$) = \text{Earthwork Total Direct Cost}\ (\$) + \text{Reveg Total Direct Cost}(\$) + \text{Other Total DirectCost}\ (\$)$$

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

$$Total\ Cost\ (\$) = Subtotal\ Direct\ Cost\ (\$) + Subtotal\ Indirect\ Cost\ (\$)$$

OPTIMIZATION EQUATIONS:

Each Equation for number of trucks (n) from 2 to 25.

Productivity Sheet:

$$\text{Productivity}\ (cy/hr) = Work\ Hour\ (\min/hr) * Loader\ (cycle/truck) * Loader\ Net\ Buckter\ Cap\ (cy) * \frac{Number\ of\ Trucks[n]}{Truck\ Cycle\ Time\ (\min)}$$

Time Sheet:

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

Truck Cost Sheet:

$$Truck\ Cost\ (\$) =$$
$$Time\ (hr) * Number\ of\ Trucks[n] * \left(Owning\ \&\ Operating\ Cost\ (\$/hr) + Labor\ Cost\ (\$/hr)\right)$$

Loader Cost Sheet:

$$Loader\ Cost\ \ for\ Number\ of\ Trucks[n]\ (\$) =$$
$$Time\ (hr) * \left(Owning\ \&\ Operating\ Cost\ (\$/hr) + Labor\ Cost\ (\$/hr)\right)$$

Total Cost Sheet:

$$Total\ Cost\ \ Number\ of\ \ Trucks[n]\ (\$) = Truck\ Cost\ (\$) + Loader\ Cost\ (\$)$$

$$Minimum\ Cost = Minimum\ (Total\ Cost\ \ for\ Number\ of\ \ Trucks[n](\$))$$

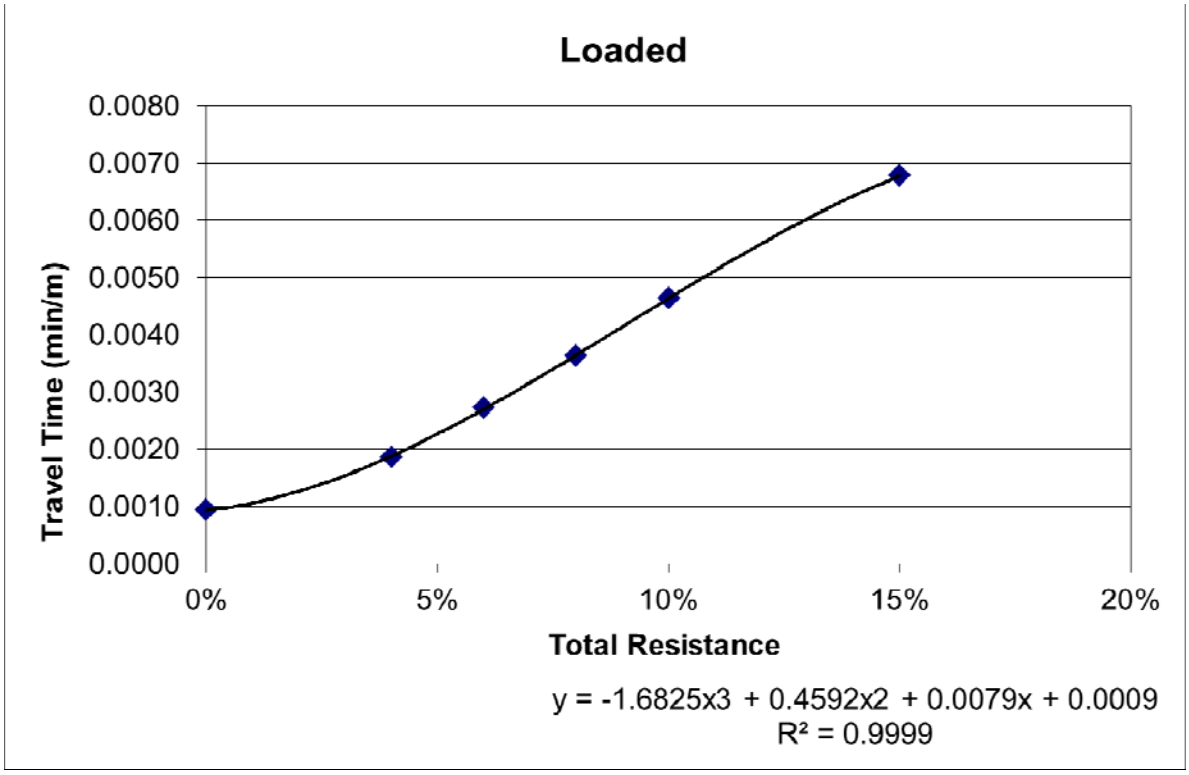
Optimum Number of Trucks:

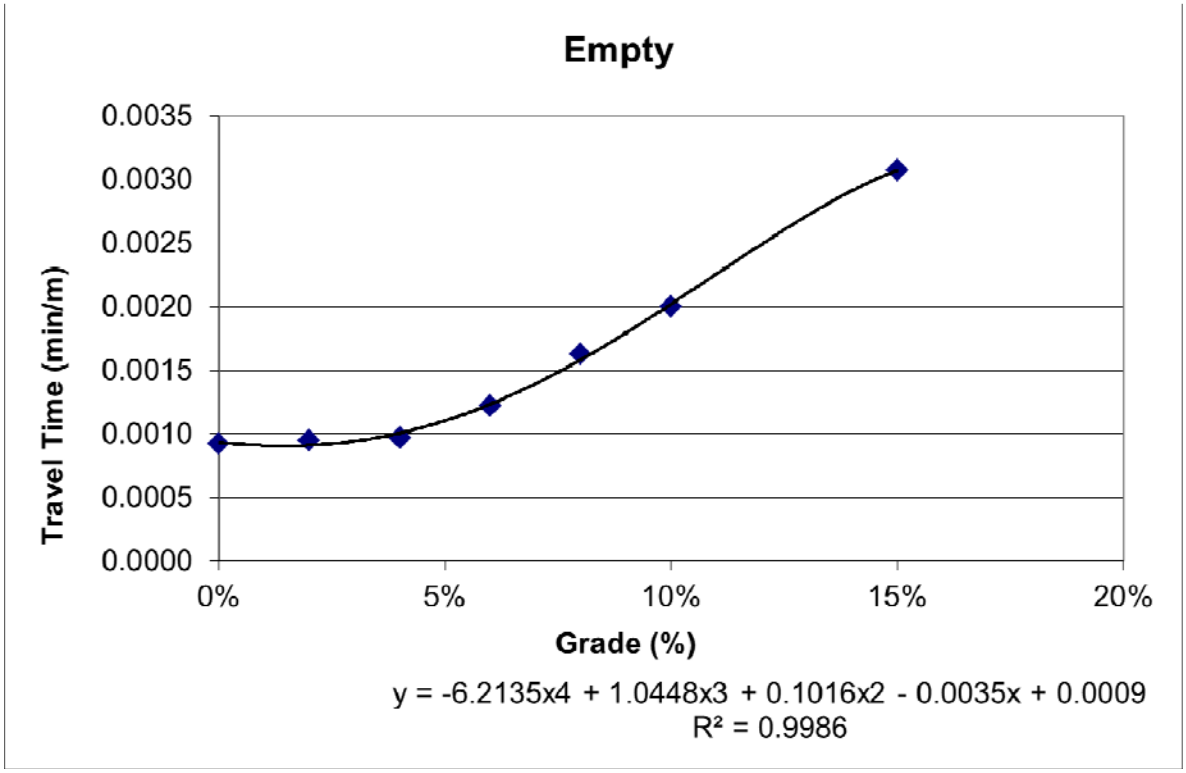
$$Number\ of\ \ Trucks[n] =$$
$$when\ \left(Minimum\ Cost\ (\$) > or = Total\ Cost\ \ for\ Number\ of\ \ Trucks[n]\right)$$
$$then\ use Number\ of\ \ Trucks[n];\ if\ \ not, use\ 0$$

$$Optimum\ Number\ of\ \ Trucks = \sum_{n=2}^{25} Number\ of\ \ Trucks[n]$$

APPENDIX A.2
EQUIPMENT PRODUCTIVITY CURVE FITS

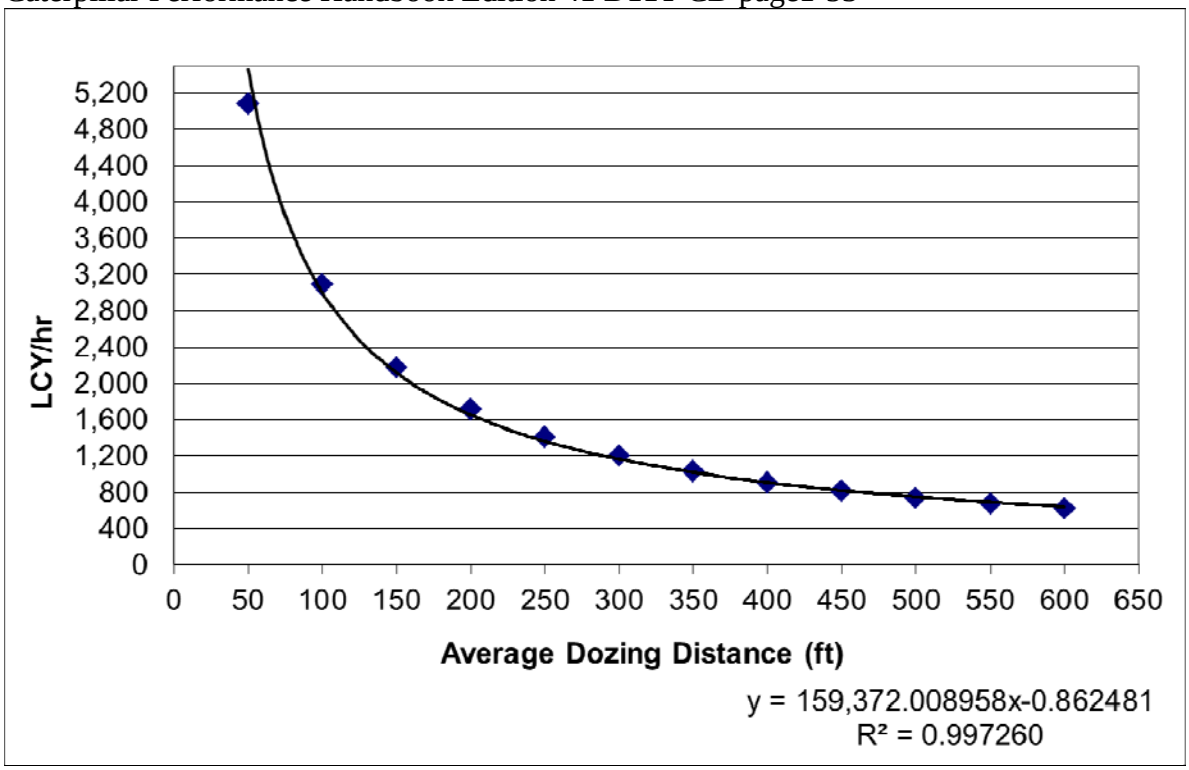
777F
Caterpillar Performance Handbook Edition 41 9-42





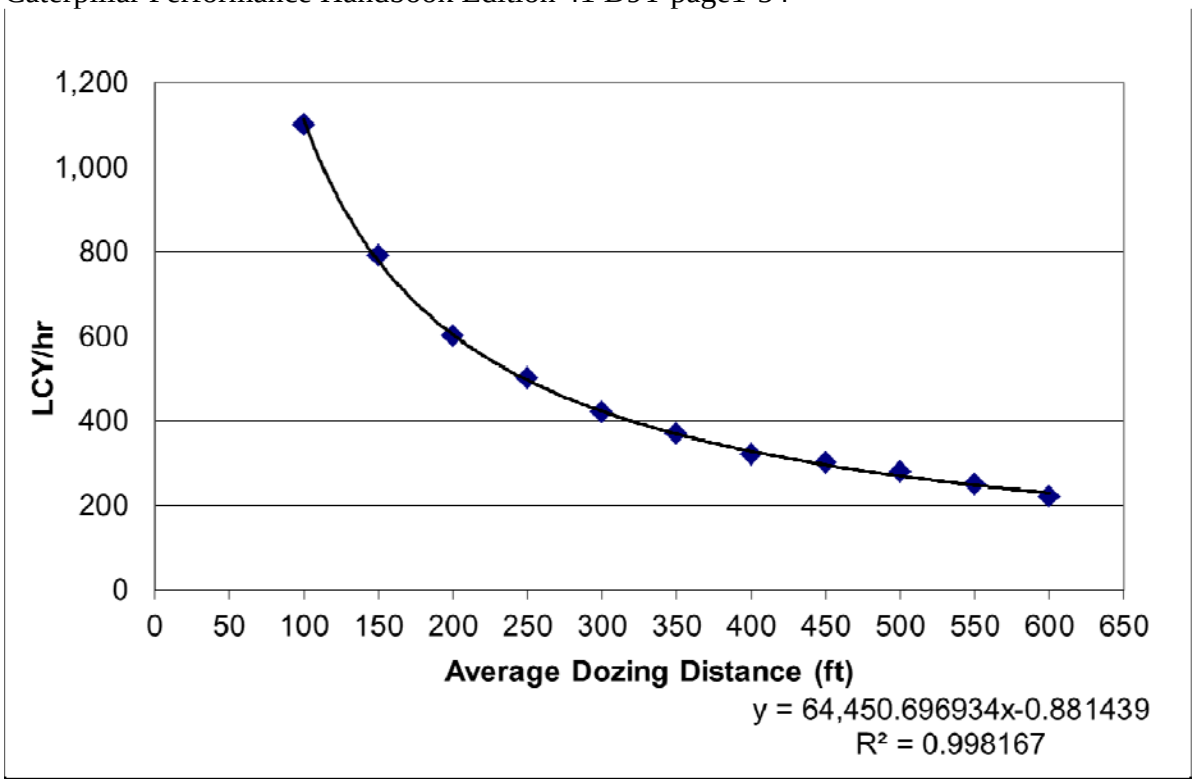
D11T CD

Caterpillar Performance Handbook Edition 41 D11T CD page1-53

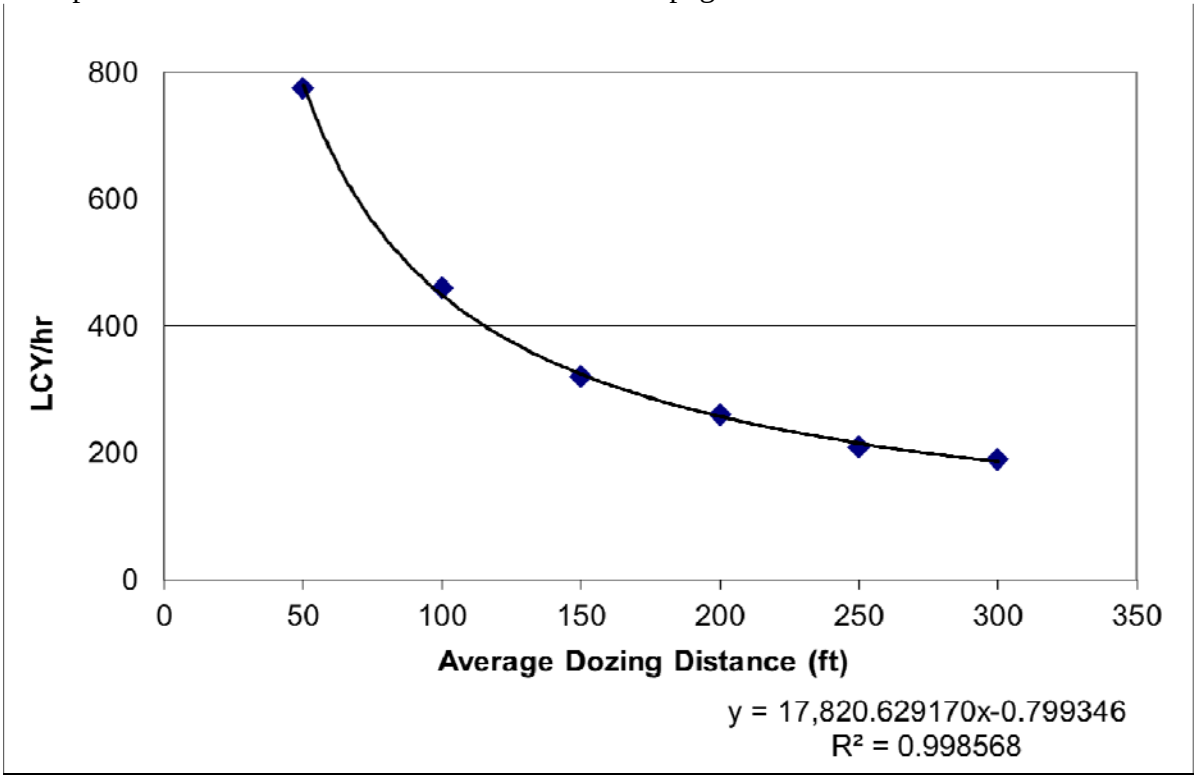


D9T

Caterpillar Performance Handbook Edition 41 D9T page1-54



D6T
Caterpillar Performance Handbook Edition 41 D6T page1-55



Dozing Factor
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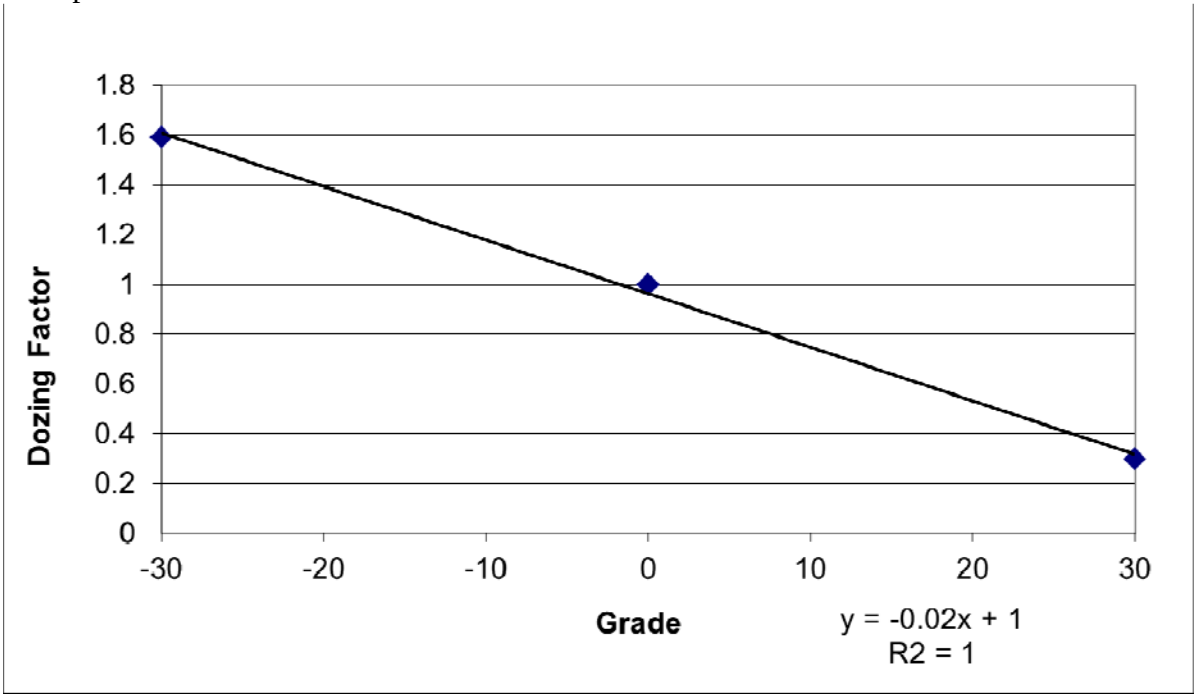

APPENDIX A.3
CATERPILLAR PERFORMANCE HANDBOOK
REFERENCES

CATERPILLAR PERFORMANCE HANDBOOK

a publication by Caterpillar Inc., Peoria, Illinois, U.S.A.

JANUARY 2011

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Performance information in this booklet is intended for estimating purposes only. Because of the many variables peculiar to individual jobs (including material characteristics, operator efficiency, underfoot conditions, altitude, etc.), neither Caterpillar Inc. nor its dealers warrant that the machines described will perform as estimated.

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

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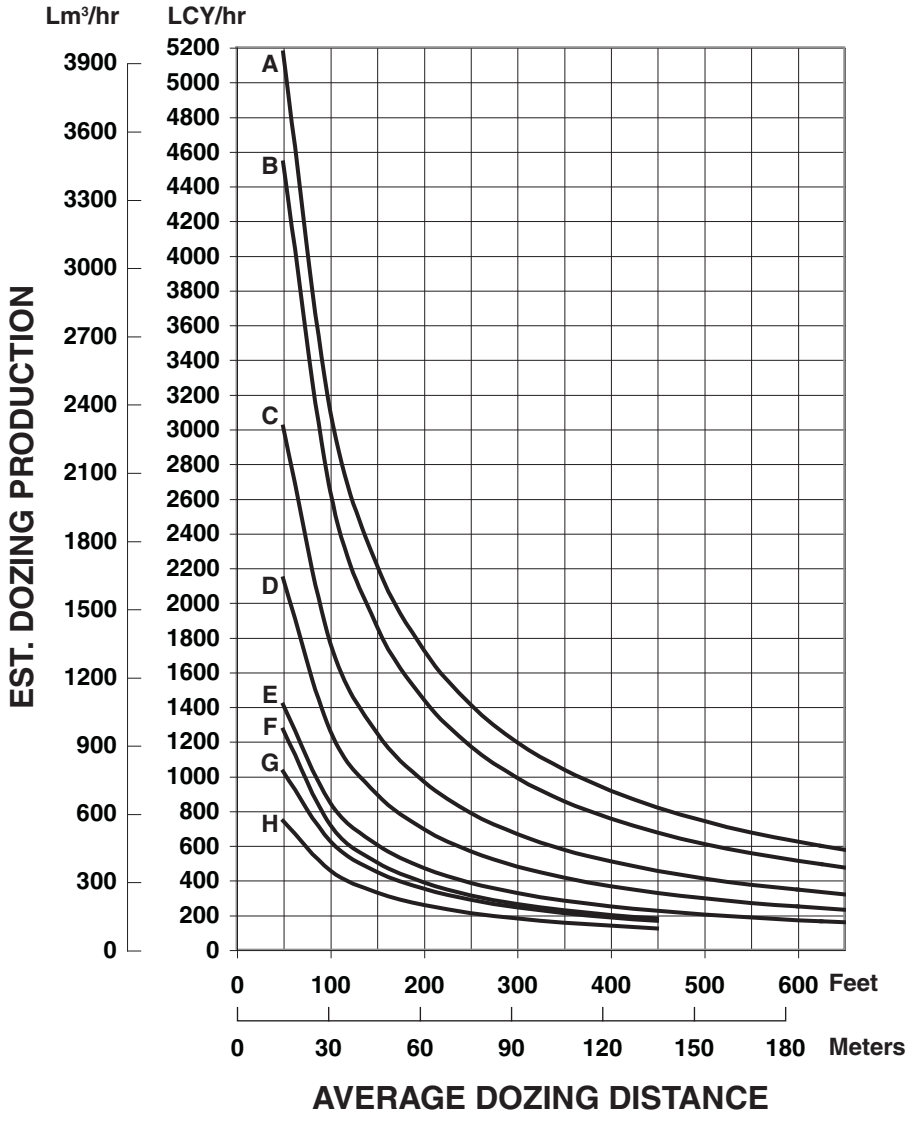
ESTIMATED DOZING PRODUCTION ● Universal Blades ● D7G through D11T CD

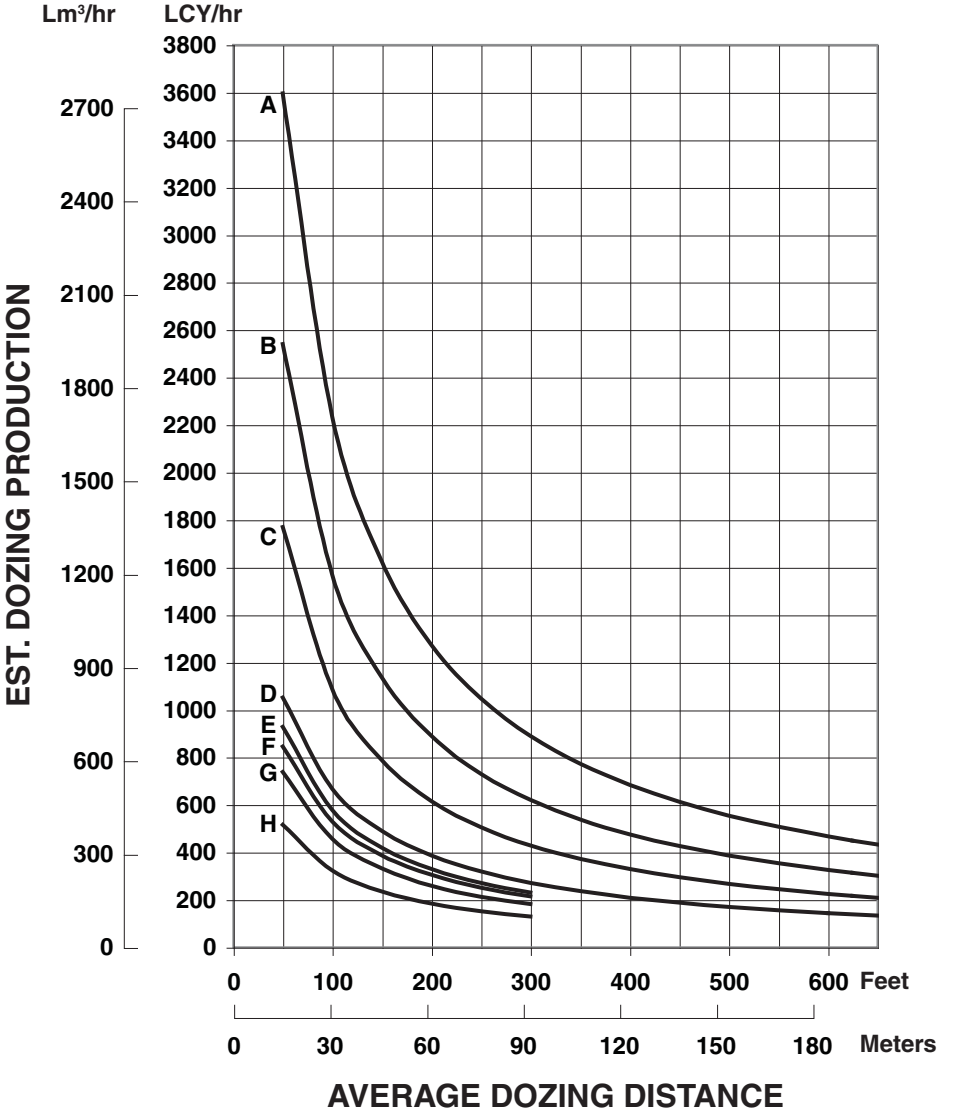


KEY

A — D11T CD
B — D11T
C — D10T
D — D9T
E — D8T
F — D7E
G — D7R Series 2
H — D7G

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 ● D6N through D11T

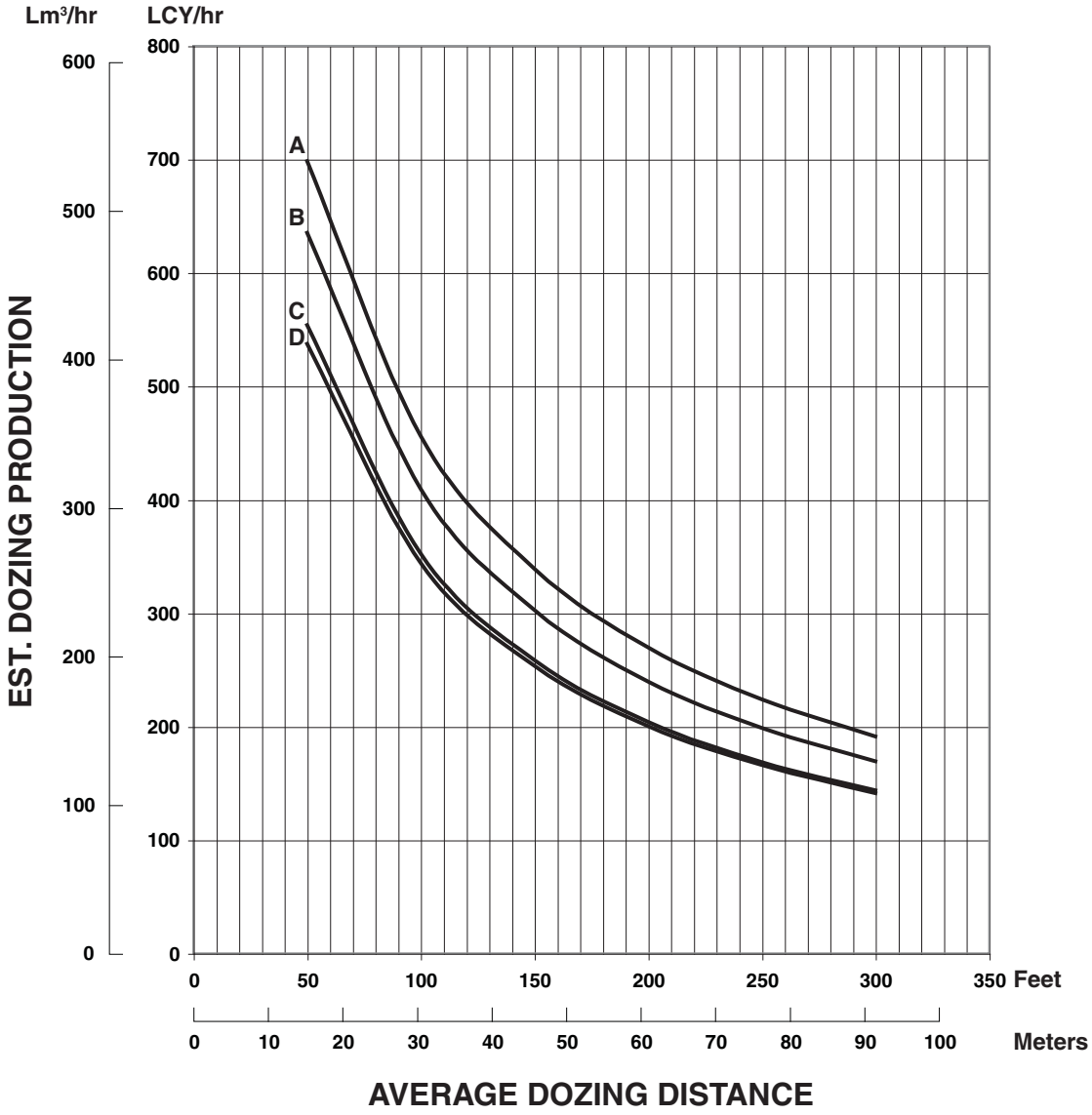


KEY

A — D11T
B — D10T
C — D9T
D — D8T
E — D7E
F — D7R Series 2
G — D6T
H — 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 D7R Series 2



KEY

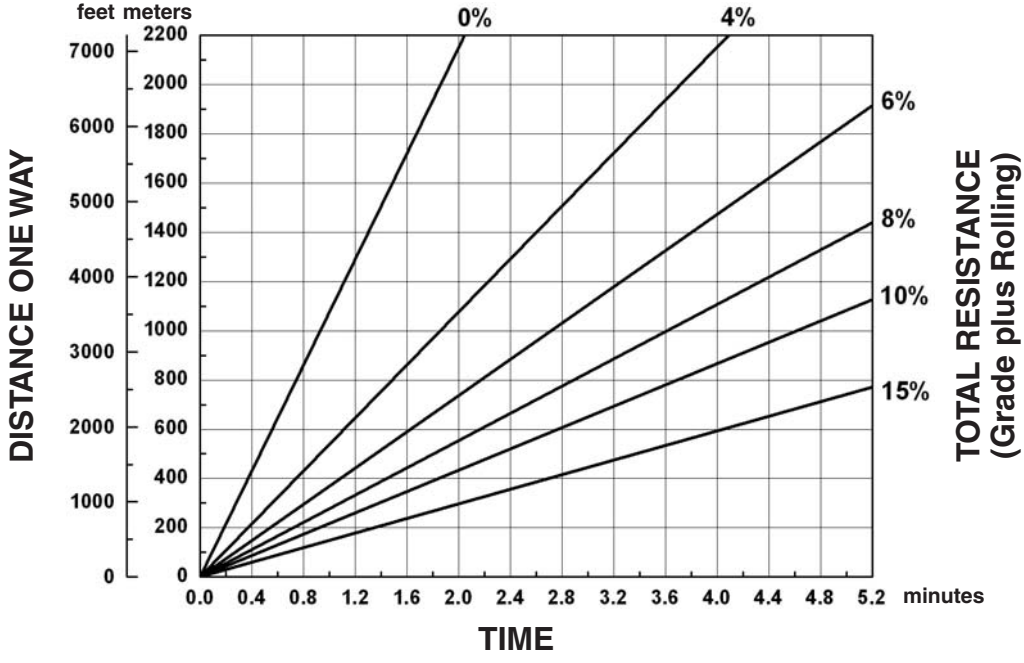
A — D7E
B — D7R Series 2
C — D6T
D — D7G

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

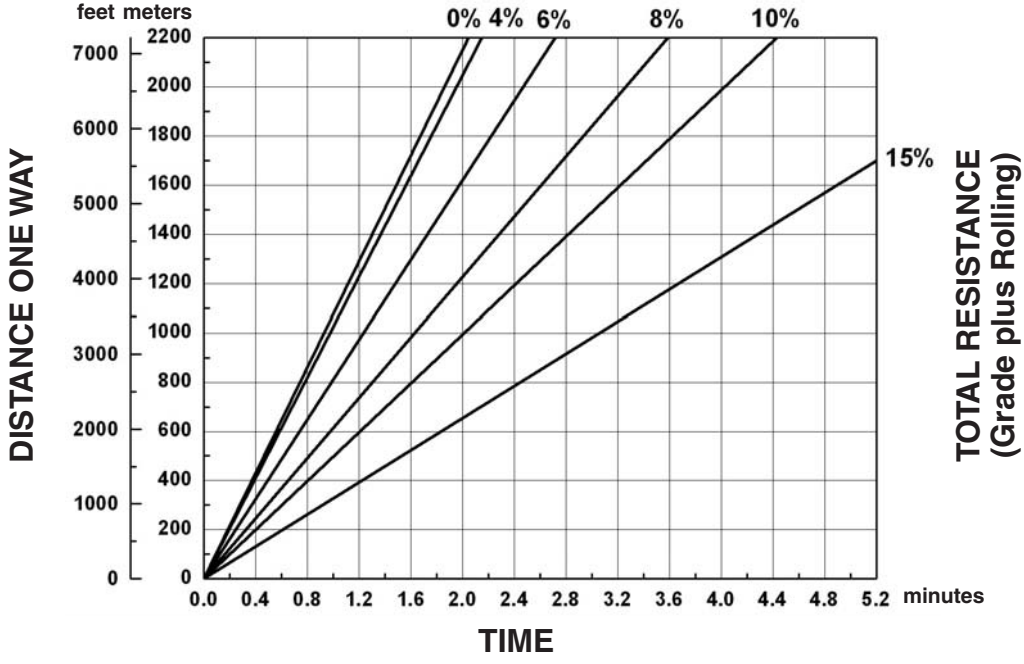
MODEL	777D†		777F	
Body Type	**Dual Slope Lined**		**Dual Slope Lined**	
Target Gross Machine Weight §	163 360 kg	**360,143 lb**	163 293 kg	**360,000 lb**
Basic Machine Weight*	33 951 kg	**74,849 lb**	33 438 kg	**73,718 lb**
Attachments**	17 377 kg	**38,310 lb**	17 114 kg	**37,730 lb**
Body Weight without Liners***	16 070 kg	**35,428 lb**	16 420 kg	**36,200 lb**
Full Liner	5432 kg	**11,975 lb**	5767 kg	**12,714 lb**
Operating Machine Weight	72 830 kg	**160,562 lb**	72 739 kg	**160,360 lb**
Debris (2% of Operating Machine Weight)	1457 kg	**3211 lb**	1455 kg	**3207 lb**
Empty Operating Weight	74 287 kg	**163,774 lb**	74 194 kg	**163,568 lb**
Target Payload §	90.9 m tons	**100 tons**	90.7 m tons	**100 tons**
Capacity:				
Heaped (2:1) (SAE) Base Body	60.1 m^3	**78.6 yd^3**	60.2 m^3	**78.8 yd^3**
Distribution Empty:				
Front	**47%**		**45%**	
Rear	**53%**		**55%**	
Distribution Loaded:				
Front	**33%**		**33%**	
Rear	**67%**		**67%**	
Engine Model	**3508B EUI**		**C32 ACERT**	
Number of Cylinders	**8**		**12**	
Bore	170 mm	**6.7"**	145 mm	**5.7"**
Stroke	190 mm	**7.5"**	162 mm	**6.4"**
Displacement	34.5 L	**2105 in^3**	32.1 L	**1959 in^3**
Net Power	699 kW	**938 hp**	700 kW	**938 hp**
Gross Power	746 kW	**1000 hp**	758 kW	**1016 hp**
Standard Tires	**27.00-R49 (E4)**		**27.00R49 (E4)**	
Machine Clearance Turning Circle	28.4 m	**93'2"**	28.4 m	**93'2"**
Fuel Tank Refill Capacity	1137 L	**300 U.S. gal**	1136 L	**300 U.S. gal**
Top Speed (Loaded)	60.4 km/h	**39.9 mph**	64.5 km/h	**40.1 mph**
GENERAL DIMENSIONS (Empty):				
Height to Canopy Rock Guard Rail	5.14 m	**16'10"**	5.17 m	**17'0"**
Wheelbase	4.57 m	**15'0"**	4.56 m	**15'0"**
Overall Length (Base Body)	9.78 m	**32'1"**	10.54 m	**34'7"**
Loading Height (Base Body)	4.38 m	**14'4"**	4.38 m	**14'4"**
Height at Full Dump	10.06 m	**33'0"**	10.33 m	**33'11"**
Body Length (Target Length)	7.23 m	**23'9"**	9.83 m	**32'3"**
Width (Operating)	6.11 m	**20'0"**	6.49 m	**21'4"**
Width (Shipping)***	3.51 m	**11'5"**	3.51 m	**11'5"**
Front Tire Tread	4.17 m	**13'8"**	4.17 m	**13'8"**

*See Weight Definitions and Relations on 9-11. Note: No mandatory or optional attachments or fuel.
**Typical selection of mandatory and optional attachments.
***Data provided is for a representative body and liner package. Several dual slope, flat floor, and mine specific design (MSD) bodies and liner packages are available. All weights, capacities, and dimensions are dependent on the machine configuration (body type, attachments, tires, and optional equipment selected).
§ Reference Caterpillar's latest 10/10/20 Payload Policy for information on gross machine operating weight and target payload.
† India sourced, only available in Asia Pacific.

LOADED



EMPTY



CATERPILLAR PERFORMANCE HANDBOOK

a publication by Caterpillar, Peoria, Illinois, U.S.A.

JANUARY 2014

Please direct any inquiries about the Performance Handbook to the Caterpillar Performance Handbook Coordinator at *Sherman_Ashley_E@cat.com*.

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SEBD0351-44

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.

MODEL	14M		16M		24M	
Base Power — Net	193 kW	**259 hp**	221 kW	**297 hp**	397 kW	**533 hp**
VHP Range — Net	193-204 kW	**259-274 hp**	221-233 kW	**297-312 hp**		—
VHP Plus Range — Net	193-219 kW	**259-294 hp**	221-248 kW	**297-332 hp**		—
Operating Weight*	21 423 kg	**47,229 lb**	27 531 kg	**60,695 lb**	62 726 kg	**138,287 lb**
Engine Model	**C11 ACERT**		**C13 ACERT**		**C18 ACERT**	
Rated Engine RPM	**1800**		**2000**		**1800**	
No. of Cylinders	**6**		**6**		**6**	
Displacement	11.1 L	**677 in³**	12.5 L	**763 in³**	18.1 L	**1104.5 in³**
Max. Torque	1422 N·m	**1049 lb-ft**	1712 N·m	**1263 lb-ft**	2713 N·m	**2001 lb-ft**
No. of Speeds Forward/Reverse	**8/6**		**8/6**		**6/3**	
Top Speed: Forward	50.4 km/h	**31.3 mph**	51.7 km/h	**32.1 mph**	43.4 km/h	**27.0 mph**
Reverse	39.8 km/h	**24.7 mph**	40.8 km/h	**25.3 mph**	41.6 kmh	**25.8 mph**
Std. Tires — Front and Rear	**16R24**		**23.5R25**		**29.5R29**	
Front Axle/Steering:						
Oscillation Angle	**32°**		**32°**		**32°**	
Wheel Lean Angle	**17.1°**		**18.2°**		**18.0°**	
Steering Angle	**47.5°**		**47.5°**		**47.5°**	
Articulation Angle	**20°**		**20°**		**25°**	
Minimum Turning Radius**	7.9 m	**25'11"**	8.9 m	**29'3"**	12.4 m	**40'9"**
No. Circle Support Shoes	**6**		**6**		**6**	
Hydraulics:						
Pump Type	**Variable Piston**		**Variable Piston**		**Variable Piston**	
Max. Pump Flow	280 L/min	**74 gpm**	280 L/min	**74 gpm**	550 L/min	**145 gpm**
Tank Capacity	60 L	**15.9 U.S. gal**	65 L	**17.2 U.S. gal**	135 L	**36 U.S. gal**
Implement Pressure: Max.	24 150 kPa	**3500 psi**	24 150 kPa	**3500 psi**	24 150 kPa	**3500 psi**
Min.	3100 kPa	**450 psi**	3100 kPa	**450 psi**	3100 kPa	**450 psi**
Interior Sound Level/SAE J919	**70 dB(A)**		**72 dB(A)**		**74 dB(A)**	
Electrical:						
System Size	**24V**		**24V**		**24V**	
Std. Battery CCA @ 0° F	**1125**		**1400**		**1500**	
Std. Alternator	**80**		**150**		**150**	
GENERAL DIMENSIONS:						
Height (to top of ROPS)	3535 mm	**139.2"**	3718 mm	**146.4"**	4452 mm	**175.3"**
Overall Length	9349 mm	**368.1"**	9963 mm	**392.2"**	14 194 mm	**558.8"**
With Ripper and Pushplate	10 896 mm	**429"**	11 672 mm	**459.5"**	16 102 mm	**633.9"**
Wheelbase	6559 mm	**258"**	6985 mm	**275"**	10 278 mm	**404.6"**
Blade Base	2840 mm	**111.8"**	3069 mm	**120.8"**	4048 mm	**159.4"**
Overall Width (at top of front tires)	2801 mm	**110.3"**	3096 mm	**121.9"**	4280 mm	**168.5"**
Standard Blade: Length	4267 mm	**14'0"**	4877 mm	**16'0"**	7315 mm	**24'0"**
Height	686 mm	**27"**	787 mm	**31"**	1025 mm	**40"**
Thickness	25 mm	**1"**	25 mm	**1"**	50 mm	**2"**
Lift Above Ground	419 mm	**16.5"**	395 mm	**15.6"**	634 mm	**25"**
Max. Shoulder Reach:***						
Frame Straight — left	2169 mm	**85.4"**	2282 mm	**90"**	3222 mm	**126.9"**
Frame Straight — right	2279 mm	**89.7"**	2587 mm	**101.9"**	3228 mm	**127.1"**
Fuel Tank Capacity	492 L	**130 U.S. gal**	534 L	**141 U.S. gal**	1326 L	**350 U.S. gal**

*__Operating Weight__ — based on standard machine configuration with full fuel tank, coolant, lubricants and operator. 24M includes ripper.
**__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.

MODEL	D6R 6S		D6R 6SU		D6R 6SU XL		D6R 6S LGP	
Gauge	—		1880 mm	**74"**	1880 mm	**74"**	2.23 m	**90"**
Type	**Straight**		**Semi-Universal**		**Semi-Universal**		**Straight**	
Blade Capacities*	3.27 m^3	**4.27 yd^3**	5.35 m^3	**6.99 yd^3**	5.35 m^3	**6.99 yd^3**	5.50 m^3	**7.20 yd^3**
Weight, Shipping** (Dozer)	2599 kg	**5717 lb**	2973 kg	**6540 lb**	2973 kg	**6540 lb**	3054 kg	**6733 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	5.12 m	**16'9"**	5.08 m	**16'8"**	5.33 m	**17'6"**	5.48 m	**18'0"**
Blade Dimensions:								
B Width (including std. end bits)	3.36 m	**11'0"**	3.26 m	**10'8"**	3.26 m	**10'8"**	4.08 m	**13'4"**
C Height	1257 mm	**4'1.5"**	1411 mm	**4'8"**	1411 mm	**4'8"**	1104 mm	**3'7"**
D Max. Digging Depth	473 mm	**18.6"**	453 mm	**1'6"**	453 mm	**1'6"**	658 mm	**2'2"**
E Ground Clearance @ Full Lift	1104 mm	**3'7.5"**	1204 mm	**3'11"**	1204 mm	**3'11"**	1088 mm	**3'7"**
F Manual Tilt	689 mm	**2'3.1"**	—		—		—	
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	764 mm	**2'6.1"**	811 mm	**2'8"**	811 mm	**2'8"**	747 mm	**2'5"**
J Hydraulic Tilt (Manual Brace Centered)	420 mm	**16.5"**	455 mm	**1'6"**	455 mm	**1'6"**	421 mm	**1'5"**
K Push Arm Trunnion Width (to Ball Centers)	—		2.58 m	**8'6"**	2.58 m	**8'6"**	3.42 m	**11'5"**

MODEL	D6T 6A		D6T 6SU		D6T 6A XL		D6T 6SU XL	
Gauge	1880 mm	**74"**	1880 mm	**74"**	1.88 m	**74"**	1.88 m	**74"**
Type	**Angling**		**Semi-Universal**		**Angling**		**Semi-Universal**	
Blade Capacities*	3.64 m^3	**4.75 yd^3**	5.35 m^3	**6.99 yd^3**	3.94 m^3	**5.15 yd^3**	5.35 m^3	**6.99 yd^3**
Weight, Shipping** (Dozer)	3138 kg	**6904 lb**	2973 kg	**6540 lb**	3195 kg	**7044 lb**	2973 kg	**6540 lb**
Tractor and Dozer Dimensions:								
A Length (Blade Straight)	5.00 m	**16'5"**	5.08 m	**17'6"**	5.21 m	**17'1"**	5.33 m	**17'6"**
Length (Blade Angled)	5.83 m	**19'2"**	—		6.05 m	**19'10"**	—	
Width (Blade Angled)	3.78 m	**12'5"**	—		3.77 m	**12'5"**	—	
Width (with C-Frame only)	2.93 m	**9'8"**	—		2.99 m	**9'10"**	—	
Blade Dimensions:								
B Width (including std. end bits)	4.16 m	**13'8"**	3.26 m	**10'8"**	4.16 m	**13'8"**	3.26 m	**10'8"**
C Height	1154 mm	**3'10"**	1411 mm	**4'8"**	1154 mm	**3'10"**	1411 mm	**4'8"**
D Max. Digging Depth	506 mm	**1'8"**	453 mm	**1'6"**	511 mm	**1'8"**	453 mm	**1'6"**
E Ground Clearance @ Full Lift	1144 mm	**3'9"**	1204 mm	**3'11"**	1217 mm	**4'0"**	1204 mm	**3'11"**
G Max. Pitch Adjustment	—		**+5.6° to –5.2°**		—		**+5.6° to –5.2°**	
H Max. Hydraulic Tilt	519 mm	**1'8"**	811 mm	**2'8"**	485 mm	**1'4"**	811 mm	**2'8"**
Blade Angle	**25°**		—		**25°**		—	
J Hydraulic Tilt (Manual Brace Centered)	—		455 mm	**1'6"**	—		455 mm	**1'6"**
K Push Arm Trunnion Width (to Ball Centers)	2.58 m	**8'6"**	2.58 m	**8'6"**	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	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)	6543 kg	**14,425 lb**	7134 kg	**15,727 lb**
Tractor and Dozer Dimensions:				
A Length (Blade Straight)	6.84 m	**22'5"**	7.18 m	**23'7"**
Blade Dimensions:				
B Width (including std. end bits)	4.35 m	**14'3"**	4.68 m	**15'4"**
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)	3.17 m	**10'3"**	3.17 m	**10'3"**
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	8.38 m	**27'6"**	8.83 m	**28'11"**	8.34 m	**26'8"**
Width	5.60 m	**18'4"**	6.35 m	**20'10"**	6.71 m	**22'0"**
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	2.77 m	**9'1"**	2.77 m	**9'1"**	2.74 m***	**9'0"*** **
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°.

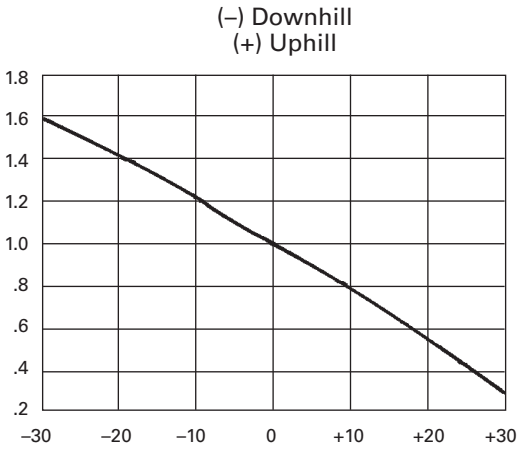
All dimensions are approximate.

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

	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

914G2-962H	0.45-0.50 min
966H-980H	0.50-0.55 min
988H-990H	0.55-0.60 min
992K-994H	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

992K — Standard

Up to specified density for 100% fill factor

Bucket Volume		Material Density	
m^3	yd^3	kg/m^3	lb/yd^3
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	
m^3	yd^3	kg/m^3	lb/yd^3
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	
m^3	yd^3	kg/m^3	lb/yd^3
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	
m^3	yd^3	kg/m^3	lb/yd^3
14.5	**19**	1720	**2890**
13.8	**18**	1810	**3060**
13.0	**17**	1920	**3240**

TABLES

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

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, rackback 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.

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.

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

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
D5N XL & LGP	100	100	100	100	100	100
D6K XL & LGP	100	100	100	100	N/A	N/A
D6N XL & LGP	100	100	100	100	N/A	N/A
D6N XL & LGP**	100	100	100	100	100	100
D6G	100	100	100	100	94	87
D6G Series 2 XL	100	100	100	94	87	80
D6G Series 2 LGP	100	100	100	94	87	80
D6R	100	100	100	100	92	84
D6R Series 3 (All)	100	100	100	100	92	84
D6T (Tier 4 Interim/Stage IIIB)	100	100	100	100	100	88
D7E	100	100	100	98	95	88
D7G	100*	100*	100*	94	86	80
D7G Series 2	100	100	100	100	100	94
D7R Series 2 (All)	100	100	100	100	100	96
D8R	100	100	100	93	85	77
D8T	100	100	100	100	100	93
D9R	100	100	100	93	85	77
D9T U.S. EPA Tier 4 Final	100	100	100	100	100	100
D9T Tier 3 equivalent NACD Std. Altitude	100	100	100	99	92	83
D9T Tier 3 equivalent NACD High Altitude	100	100	100	100	100	100
D9T EU Stage IIIA equivalent	100	100	100	98	91	80
D9T Tier 2 equivalent	100	100	100	100	99	88
D10T2 Tier 2 equivalent ***	100	100	100	100	100	100
D10T2 Tier 4 Final***	100	100	100	100	100	100
D11T/D11T CD Tier 2 equivalent****	100	100	100	100	100	86
D11T/D11T CD Tier 4 Final****	100	100	100	100	83	67
120H STD	100	100	100	100	100	100
120M	100	100	100	100	95	88
135H STD	100	100	100	100	100	98
12H STD	100	89	83	77	71	65
12M	100	100	100	100	95	88

*Refer to "Captive Vehicle Engine Fuel Specifications" microfiche at your local dealer.
**Information not available at time of printing.
***In forward gears.
****D11T — High altitude arrangement available.

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