CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT






REPORT ON FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY

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EXECUTIVE SUMMARY

The Casino Copper-Gold Project is a large copper-gold deposit located in the Dawson Range Mountains of the Yukon Territory, approximately 300 km northwest of Whitehorse. The deposit will be mined using open pit methods with a nominal mill throughput of approximately 125,000 tonnes/day of ore over a 22 year operating life. Knight Piésold Ltd. has been engaged to prepare a Feasibility design of the Tailings Management Facility (TMF) to accommodate all tailings and potentially reactive mine waste rock and overburden materials. The total mined ore reporting to the mill is approximately 965 million tonnes. Approximately 157.5 Mt of additional mined ore will be processed at a Heap Leach Facility (HLF) located south of the open pit.

The TMF will be used for safe, secure and environmentally secure disposal of mine tailings and all potentially acid generating and metal leaching waste rock and overburden. The TMF is located within Casino Creek valley. The embankments that confine the TMF are the Main Embankment to the south and the West Saddle Embankment to the west. The embankments have been designed in accordance to the Canadian Dam Association (CDA) “Dam Safety Guidelines” (2007).

Since the completion of the revised Pre-Feasibility design in 2011, additional geotechnical site investigations and laboratory testing have been completed in 2011 and 2012 to obtain additional geotechnical and hydrogeological information in the area of the TMF embankments. The information collected has been reviewed and incorporated into this Feasibility design. The findings of previous site investigation programs at the site in 1993, 1994, 2010 and 2011 were also used to support the Feasibility design.

The TMF has been sized to provide sufficient capacity to store approximately 956 million tonnes of tailings (including cyclone sand tailings used as embankment fill) and co-disposal of up to 658 million tonnes of potentially reactive waste rock and overburden materials. Potentially reactive waste rock and overburden will be hauled to the TMF for co-disposal with tailings and submergence by tailings and the supernatant pond. A Waste Storage Area (WSA) will be developed in the northern section of the TMF impoundment area.

Approximately 80% of the total tailings will be geochemically innocuous NAG material, following the removal of the pyrite component. These tailings will be used for the production of cyclone sand for construction of the Main Embankment. It is assumed that the NAG tailings will be passed through the cyclone plant for approximately nine months of each year. Cyclone operations will likely not be possible for a portion of the year due to freezing temperatures in the winter months. In addition to cyclone sand the cyclone plant will produce a high volume low solids content stream, containing the fines fraction of the tailings (cyclone overflow). This material will be discharged into the TMF. The discharge of bulk NAG tailings and cyclone overflow will be from valved offtakes located along the Main Embankment and from the West Saddle Embankment.

Approximately 20% of the total tailings will be PAG tailings which are delivered to the TMF in a separate pipeline. The PAG tailings deposit will be developed in a separate central region of the TMF by discharging the tailings from the north-western side of the TMF, close to the WSA. Deposition in this area will keep the PAG tailings remote from the confining embankments. This will minimise seepage from the PAG tailings and ensure that they remain in a subaqueous state.

The TMF embankments will be constructed as water-retaining zoned structures with a low permeability core zone and appropriate filter and transition zones to prevent downstream migration of fines. The core zone will include a seepage cut-off into competent rock in the foundation. The Main Embankment Starter dam is designed to store runoff as a source for mill start-up water and accommodate tailings and potentially reactive waste rock and overburden production for approximately one year of initial operations. The embankment shell zones for the Starter dam will be constructed with random fill comprising suitable rockfill from local borrow sources, supplemented by available non-reactive (leach cap) waste rock material from pre-production stripping. Cyclone sand production in Year 1 of operations will be used to extend the downstream shell of the Main Embankment, allowing the dam crest and core zone to be raised after about 1 year. Ongoing raises will comprise centreline raises with a vertical low permeability core zone and adjacent downstream filter zones. Cyclone sand will be produced from bulk NAG tailings at the Cyclone Plant and discharged into the cyclone sand shell zones (upstream and downstream of the core zone) where it will be spread in cells and compacted using bulldozers. Bulk tailings that bypass the Cyclone Plant and cyclone overflow (fines) produced during cycloning operations will be discharged into the impoundment. The final Main Embankment will be approximately 286 meters high at the deepest section of Casino Creek valley.

The West Saddle Embankment will be constructed at the south-western corner of the TMF and is required at the start of operations to provide a pipeline corridor at a suitable grade for tailings delivery to the cyclone sand plant and TMF. The embankment will comprise an earth-rockfill dam, constructed from local borrow materials to a maximum height of approximately 21 metres.

The TMF will be used to assist with site water management. The supernatant pond within the TMF will provide a large water storage capacity that will be used to both store water for later use and to attenuate inflows. The TMF supernatant pond will provide a water source for milling operations. The supply of reclaim water to the mill will be by a reclaim barge equipped with a pumping system and a reclaim water pipeline to connect the barge and mill.

A revised seepage assessment for the TMF has also been completed and the results incorporated into the Feasibility design. A detailed monthly operational water balance model has been developed for the TMF to assess the various flows to and from the facility, to predict the variation in supernatant pond volume during operations and to estimate makeup water requirements. The water balance includes consideration of Heap Leach Facility operations, cyclone sand operations, tailings consolidation and the co-disposal of potentially reactive waste materials within the TMF. The water balance indicates that the mine site will likely be in a deficit condition over the operating life of the TMF, except for the last 1 to 2 years.

A spillway and downstream channel will be required at closure to facilitate control and discharge of excess water accumulation within the TMF and to provide safe passage of storm water volumes from the TMF. The water balance model developed for the TMF indicates that there will be a water surplus at closure. The closure spillway will be located close to the right abutment of the West Saddle Embankment to provide long term protection against overtopping of the TMF during the post closure years.

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1 – INTRODUCTION

1.1 PROJECT DESCRIPTION

The Casino Copper-Gold Project is a venture by Casino Mining Corporation (CMC) to develop an open pit copper-gold-molybdenum mine in the Yukon Territory. The project is located in the Dawson Range Mountains of the Klondike Plateau approximately 300 km northwest of Whitehorse, Yukon, Canada, as shown on Figure 1.1. This area is somewhat unique in that the region was not glaciated during the Wisconsin Advance. The deposit is hosted by the Prospector Mountain Suite, a suite of igneous intrusive rocks with an intense hydrothermal alteration overprint. The deposit will be mined using open pit methods with a nominal mill throughput of approximately 125,000 tonnes/day (tpd) of ore over a 22 year operating life.

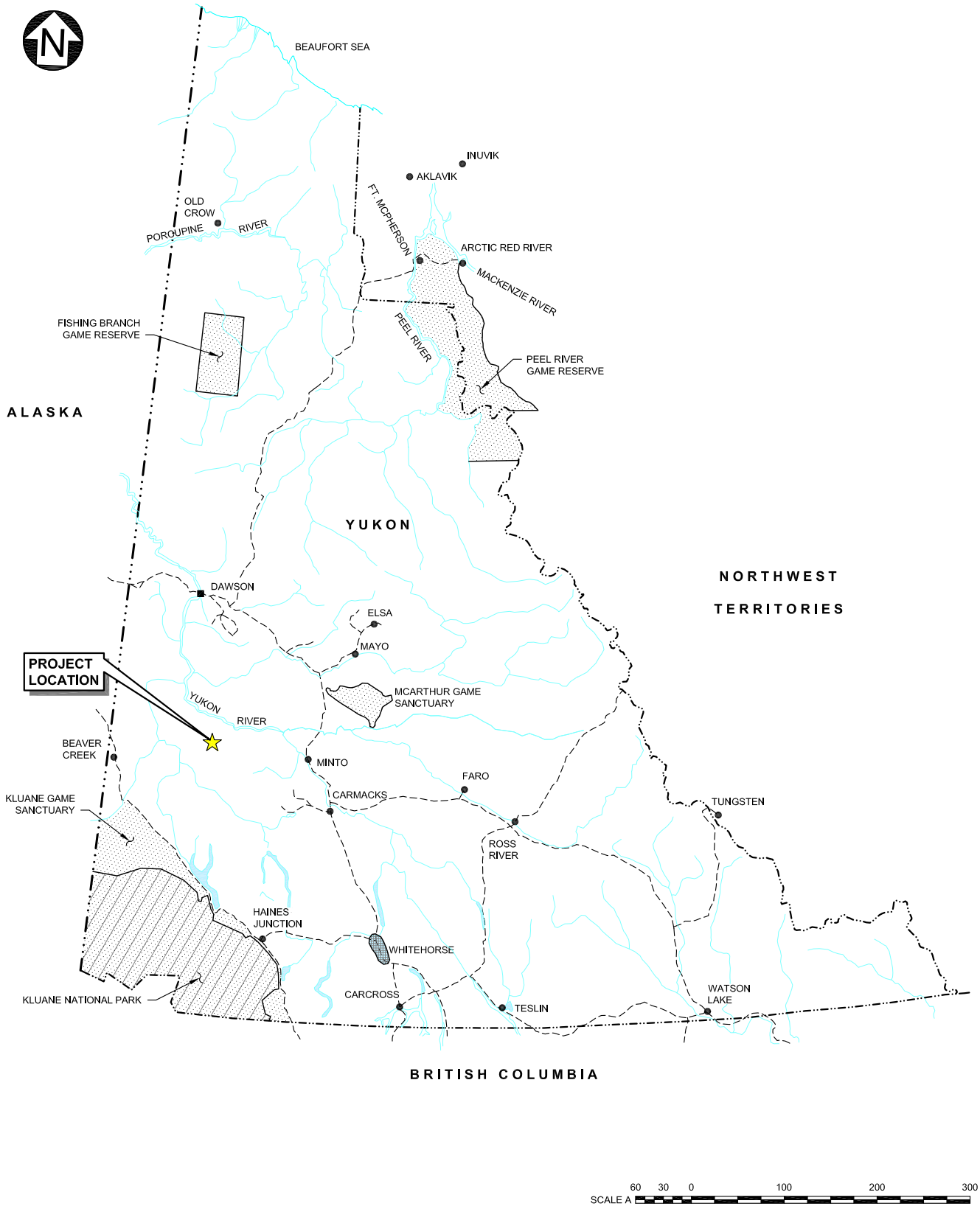
A general layout of the project site is shown on Figure 1.2. The proposed components of the project facilities include an open pit up to 600 meters deep containing a mineable reserve of approximately 965 million tonnes of mill ore. The Tailings Management Facility (TMF) has been sized to provide sufficient capacity to store approximately 956 million tonnes of tailings (including cyclone sand tailings used as embankment fill) and co-disposal of up to 658 million tonnes of potentially reactive waste rock and overburden materials.

Approximately 157.5 Mt of additional mined ore will be processed at a Heap Leach Facility (HLF) located south of the open pit. Details of the Feasibility design of the HLF are presented in Knight Piésold Ltd. (KPL) report “Feasibility Design of the Heap Leach Facility” (Ref. No. VA101-325/8-9, December, 2012). HLF operations will commence during pre-production stripping of the open pit.

Since the completion of the revised Pre-Feasibility design in 2011, additional geotechnical site investigations and laboratory testing have been completed at the TMF, HLF, plant site, ore stockpile areas and open pit. The information collected has been reviewed and incorporated into the applicable project design components. A revised seepage assessment for the TMF has also been completed in 2012. The results of the seepage assessment have been incorporated into the Feasibility design. A detailed operational water balance model has been developed for the TMF and includes consideration of HLF operations, cyclone sand operations and the co-disposal of potentially reactive waste rock within the TMF.

Approximately 80% of the total tailings will be Non-Acid Generating (NAG) material, following the removal of the pyrite component. The NAG tailings will be passed through a cyclone station to produce suitable cycloned sand for embankment construction. The quantity of cyclone sand used in embankment construction is approximately 221 million tonnes. It is estimated that 50% of the NAG tailings can be recovered as cyclone sand when the cyclone station is operating. This amounts to approximately 7.2 to 7.5 million m^3 (12 to 12.5 million tonnes) of cyclone sand fill material produced annually, except for Years 1 and 22. Approximately 20% of the total tailings will be Potentially Acid Generating (PAG) tailings which are delivered to a central region of the TMF in a separate pipeline.

Any non-reactive waste rock and overburden materials produced from mining activities can be used in embankment construction. It is anticipated that approximately 2 to 3 million tonnes of non-reactive leach cap material will be available during pre-production and will be used to provide some of the fill requirements for the Stage IA (starter) embankment.



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CASINO COPPER-GOLD PROJECT

PROJECT LOCATION MAP

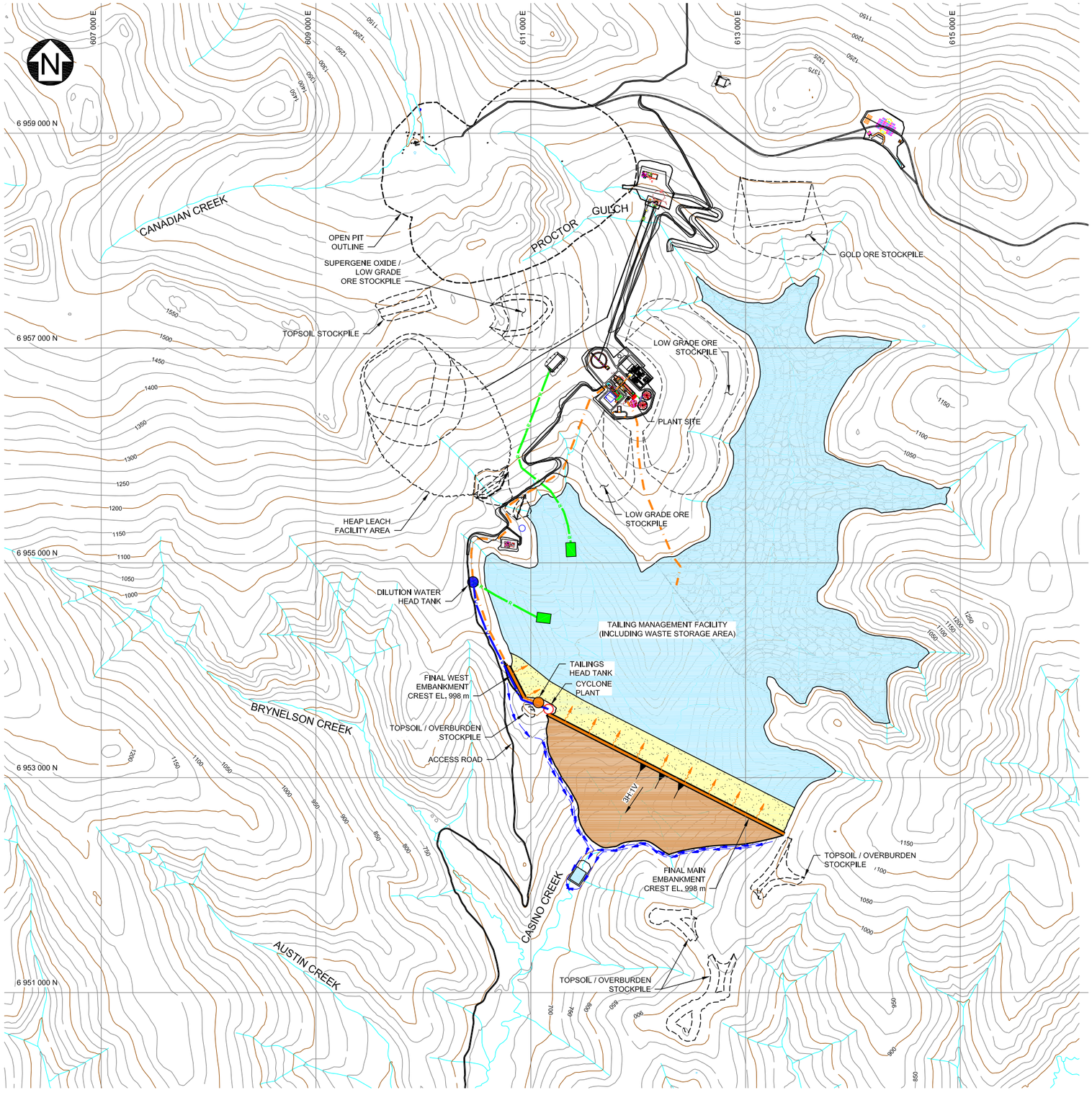
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FIGURE 1.1 | REV 0

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LEGEND:

- TAILINGS
- EMBANKMENT (CYCLONE SAND)
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT AT ITS FINAL OUTLINE AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

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PROJECT GENERAL ARRANGEMENT

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FIGURE 1.2

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1.2 PREVIOUS STUDIES

Knight Piésold Ltd. (KPL) was retained in 1993 by Pacific Sentinel Gold Corp. to prepare a scoping level study of the open pit, heap leach facility, mine tailings and waste rock management options for the proposed Casino open pit mine development. A number of engineering and environmental reports have been submitted by KPL and Hallam Knight Piésold since the beginning of the project. A list of the reports to date is included in Appendix A.

Several geotechnical site investigation programs were conducted by KPL in the Casino Project area from 1993 to 1994. Preliminary surficial geotechnical investigations were carried out at the site over the period of June 4 to October 1, 1993. The investigations were carried out as part of the Placer Lease Agreement Program to provide a preliminary overview of the surficial materials and foundation conditions for the various potential mine site components (including the open pit, plant site, heap leach facility, waste rock storage and potential tailings impoundment sites). The site investigation program included the excavation of geotechnical trenches for visual description and characterization of surficial materials, and for the collection of representative samples for laboratory testing. The laboratory testwork was carried out on site by KPL and included particle size analyses, natural moisture contents, Atterberg limits (plasticity), compaction tests and permeability tests. The results of the investigations are included in the KPL report "Report on Preliminary Surficial Geotechnical Investigations" (Ref. No. 1831/1, March, 1994).

Geotechnical and hydrogeological investigations conducted in 1994 resulted in fifteen drillholes throughout the Casino Project area. The investigation program also included the excavation of test pits for visual inspection and characterization of surficial materials. Representative rock core and test pit samples were collected for laboratory testwork. The laboratory testwork included particle size analyses, natural moisture contents, Atterberg limits, and compaction tests. In situ packer and falling head permeability tests and shut-in pressure tests were conducted within the drillholes and groundwater monitoring wells and thermistors were installed. Point load testing was conducted on site by KPL for select rock core samples. The results of the investigations are included in KPL report "Data Compilation Report on 1994 Geotechnical and Hydrogeotechnical Investigations" (Ref. No. 1832/2, February 22, 1995).

Alternative waste management sites were short listed for consideration during these previous studies. Preliminary studies identified Site No. 2 as the preferred option, and a scoping level conceptual design of the tailings facility was completed, and presented in the KPL letter report "230 Million Tonne Tailings Storage Facility Study" (Ref. No. 5/2115, September 14, 1995).

Initial scoping studies for a mine production rate of 100,000 tpd were completed in January 2008. This included a preliminary mine waste management alternatives assessment, comprising the following:

- Evaluation of potential TMF options, taking into consideration the recommendations of the previous studies on the conceptual layout for a 230 million tonne tailings storage facility completed by KPL in September 1995
- Determination of storage and embankment volume requirements for each potential TMF
- Consideration of the incorporation of potentially reactive waste rock within the tailings impoundment for flooded co-disposal with the tailings, and
- Selection of the most appropriate TMF option, considering a number of factors.

The TMF options were assessed using a number of criteria including:

- Ability to meet storage capacity requirements
- Minimal footprint and catchment area
- Water management, and
- Minimal infrastructure requirements, including consideration of tailings and reclaim pipelines, ease of road construction, embankment fill volume and construction requirements and location relative to the plant site and open pit.

Consideration was given to minimizing the overall project footprint, placing mine site facilities within one catchment, reducing the contributing catchment areas (simplifying site water management) and mitigating environmental impact.

This study also included a preliminary review and assessment of the potential use of dewatered (thickened/paste) tailings for surface disposal and an initial review of operating considerations for tailings and reclaim systems in freezing conditions. The results of the study were presented in the KPL letter report "Mine Waste Management Assessment" (Ref. No. VA07-01593, January 18, 2008).

The conceptual design for the selected TMF (Option 2) was used as a basis for development of the Pre-Feasibility level design completed in May 2008 and presented in KPL report "Report on the Pre-Feasibility Design of the Tailings Management Facility" (Ref. No. VA101-325/1, May 30, 2008).

Pre-Feasibility design studies completed in 2008 for the TMF utilized Non-Acid Generating (NAG) mine waste rock for embankment construction. However, subsequent geochemical characterization of the mine waste indicated that almost all of the mine waste material may have acid generating or metal (copper) leaching potential, and therefore not suitable for embankment construction. Consequently, a study was carried out to evaluate alternative embankment construction options and alternative tailings disposal technologies for the TMF. The findings of the study indicated that the use of cyclone sand for embankment construction is the preferred option and provides the most efficient and cost effective design concept for the TMF.

Consequently a revised Pre-feasibility design for the TMF completed in early 2011 incorporated the use of cycloned sand in embankment construction. A site investigation program was carried out between May and August of 2010 to obtain geotechnical and hydrogeological information in the TMF embankment area. This information was used to support the revised Pre-Feasibility Study. Geotechnical conditions were also investigated at the current locations of the Plant Site and Open Pit to assess the geotechnical factors affecting design. The results of the investigations are included in KPL report "2010 Geotechnical Site Investigation Data Report" (Ref. No. VA101-325/3-4, November 2, 2010).

1.3 FEASIBILITY DESIGN SCOPE OF WORK

This report presents the Feasibility design of the TMF. Specific design items which are addressed in the report include:

- Review of site characteristics including hydrometeorology, regional geology, hydrogeology and seismicity.
- Tailings physical characteristics.
- Review and evaluation of the results of previous geotechnical investigations carried out at the project site.

- Development of a suitable TMF layout and operating strategy.
- Evaluation of the TMF foundations and preliminary identification of potential borrow sources for construction materials.
- Development of a filling schedule for the TMF to determine initial and on-going staged embankment construction requirements.
- Design of TMF embankments, including static and seismic stability assessment.
- Development of a monthly operational water balance for the TMF to provide a running total of the inputs and outputs from the facility and water availability for reclaim.
- Examination of surface drainage and diversion requirements.
- Seepage analyses and consideration of seepage recovery and control systems.
- Consideration of the operating requirements for the tailings delivery, cyclone sand production and water reclaim systems.
- Preliminary consideration for TMF closure and reclamation requirements, including a closure spillway, and
- Estimation of TMF construction quantities (costing to be carried out by Others).

Additional site investigations to support the Feasibility design of the TMF and other project facilities (including the Waste Storage Area (WSA), stockpile areas and HLF) have been carried out in 2011 and 2012. A primary focus of the 2011 and 2012 site investigation programs was to confirm foundation conditions (including permeability of overburden and rock), refine the characterisation of geotechnical and hydrogeological conditions and to delineate and characterize the low permeability soil materials required for construction of the TMF and HLF. Thermistors were installed in the TMF and HLF areas to provide additional information on the subsurface thermal regime.

A summary of the geotechnical information provided by the site investigations is included in Section 4.0. Details and findings of the 2011 and 2012 site investigation programs for the waste management facilities are provided in KPL reports “2011 Geotechnical Site Investigation Data Report – Waste Management Facilities” (Ref. No., VA101-325/8-5, December, 2012), and “2012 Geotechnical Site Investigation Data Report” (Ref. No., VA101-325/8-14, December, 2012).

2 – TAILINGS CHARACTERISTICS

2.1 GENERAL

The tailings from the Casino Project operation will be produced from the conventional milling of copper and gold ore. The anticipated tailings stream from the mill will be at a typical solids throughput of approximately 45 to 46 million tonnes per year (approximately 34.5 million tonnes in Year 1 and 22.9 million tonnes in Year 22 of operations). The tailings will be transported from the mill at a thickened slurry solids content of about 55 percent by weight.

The tailings stream will be split into a PAG stream (20% by mass) and NAG tailings (80% by mass). Bulk NAG tailings will be passed through a cyclone station for approximately nine months of the year. The sand fraction (underflow) will be recovered and made available for embankment construction. The cyclone overflow (fine tailings) will report to the TMF for disposal. Bulk tailings will also report to the TMF when cycloning operations are suspended (assumed to be for approximately three months of the year) when freezing climatic conditions likely preclude sand placement in the embankments, and when the cyclone station is unavailable due to maintenance or downtime.

2.2 PHYSICAL CHARACTERISTICS

A laboratory testing program has been conducted in 2012 to determine the geotechnical characteristics of the Casino tailings materials. A tailings sample representing Non Acid Generating (NAG) Whole Tailings was provided by Casino Mining Corporation for testing. This sample was used to generate representative samples of tailings Cyclone Overflow (fine tailings) and Cyclone Underflow (sand) materials. A sample of Potentially Acid Generating (PAG) tailings was not available for testing at this time.

The test program included index testing to enable geotechnical classification of each of the materials. The Whole Tailings material can generally be described as non-plastic sand and silt with trace clay. The particle size distribution of the Whole Tailings sample comprises approximately 58% fine sand, 35% silt and 7% clay. The Cyclone Overflow sample was generated to a target particle size distribution with approximately 75% fines (silt and clay fractions). Similarly, the Cyclone Underflow sample was generated for a target particle size distribution with a maximum of 15% fines.

The specific gravity of the tailings solids was determined to be 2.70 for the Whole Tailings sample, 2.71 for the Cyclone Overflow sample, and 2.80 for the Cyclone Underflow sample.

A particle size distribution and specific gravity value for the PAG tailings material was provided by Casino Mining Corporation (based on test results conducted for laboratory metallurgical testing). The particle size distribution for the PAG tailings is included on Figure 2.1. The specific gravity of solids for the PAG tailings sample is 3.0. It is recommended that laboratory testing is also carried out on a representative sample of PAG tailings for future design studies.

Slurry settling (undrained and drained), air drying, consolidation and permeability tests were conducted to determine the characteristics of the Whole Tailings and Cyclone Overflow following deposition and for a range of conditions (representative of expected field conditions). Compaction, strength and permeability tests were carried out on the Cyclone Underflow sample to provide

information on the characteristics of the material as sand fill material over a range of stress conditions.

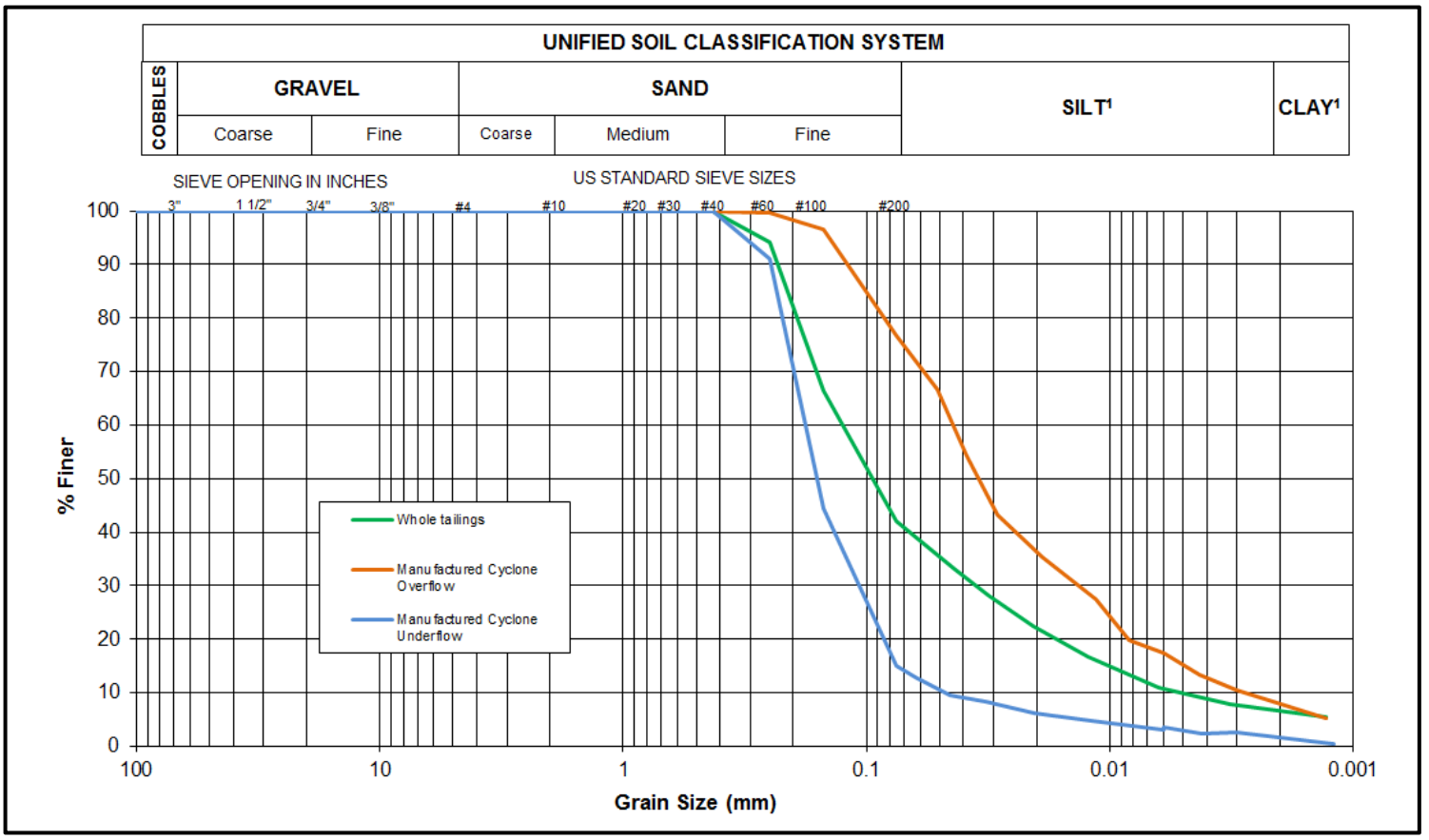


Figure 2.1 Particle Size Distribution for Tailings Samples

NOTES:

1. Silt and clay limits from the US Department of Agriculture definition. The Unified Soil Classification System defines all particles with diameters <0.075 mm as fines with silt and clay defined only by plasticity.

The methodology and complete results of the laboratory testwork are included in KPL report "Report on Laboratory Geotechnical Testing of Tailings Materials" (Ref. No. VA101-325/8-1, December, 2012). A summary of the laboratory testing and results is provided below.

2.2.1 Whole Tailings and Cyclone Overflow

The following is a list of the geotechnical tests conducted on the Whole Tailings and Cyclone Overflow samples:

- Undrained Settling
- Drained Settling (with Falling Head permeability measurement)
- Air drying
- Slurry Consolidometer Test (with permeability measurement), and
- Low Stress Slurry Consolidation (Burette) Test.

The slurry settling (sedimentation) tests provide an estimate of the density to which the tailings slurry will settle in a sub-aqueous environment, under undrained and drained conditions. These tests provide an estimate of expected tailings density in a storage facility after settling and before any significant consolidation or air drying occurs. The air drying test provides the geotechnical characteristics of the tailings for expected conditions on exposed beaches following deposition. The effect of air drying on moisture loss and tailings density is determined by this test.

The slurry consolidometer test is used to determine the consolidation, compressibility and permeability characteristics of the tailings over a wide range of confining pressures (typically corresponding to expected conditions in the field). These parameters are used to determine the amount and rate of consolidation, seepage rates, settlement and density increase for the tailings. The slurry consolidation cylinder test provides a measure of the consolidation characteristics of the tailings at very low effective stresses (representing freshly deposited tailings immediately following settling).

The following points summarize the pertinent findings of the tailings tests:

- For an initial slurry solids content of 55% the settled dry density of the Whole Tailings is approximately 1.0 tonnes/m^3 for undrained settling conditions and 1.09 tonnes/m^3 for drained settling conditions.
- For an initial slurry solids content of about 25% the settled dry density of the Cyclone Overflow is approximately 0.8 tonnes/m^3 for undrained settling conditions, and 0.95 tonnes/m^3 for drained settling conditions.
- Air drying of the tailings materials produces a significant increase in dry density over those from the undrained and drained settling tests. For the Whole Tailings with an initial slurry solids content of 55% a dry density of approximately 1.35 tonnes/m^3 is achieved under air drying conditions. For the Cyclone Overflow with an initial slurry solids content of 25% a dry density of 1.29 tonnes/m^3 is achieved.
- Relationships between coefficient of consolidation, void ratio and vertical coefficient of permeability to effective stress have been developed for the Whole Tailings and Cyclone Overflow material. The coefficients of consolidation generally increase with increasing effective stress, with calculated coefficients of consolidation for the Whole Tailings ranging from 100 m^2/year at very low stresses to over 1000 m^2/year at high stresses. Calculated coefficients of consolidation for the Cyclone Overflow range from 25 m^2/year at very low stresses to over 1000 m^2/year at high stresses.
- The dry density of the Whole Tailings and Cyclone Overflow increases with increasing effective stress (due to consolidation), with a value of approximately 1.6 tonne/m^3 achieved under effective stress conditions greater than about 500 kPa.
- Measured vertical permeability values for the Whole Tailings and Cyclone Overflow decrease with increasing effective stress. The permeability of the Whole Tailings ranges from approximately 1 x 10^{-4} cm/sec at low stresses (representing unconsolidated or fresher tailings near surface) to about 1 x 10^{-6} cm/sec at high stresses, corresponding to a reduction in void ratio (representing more consolidated or deeper tailings within the deposit). Similarly, the permeability of the Cyclone Overflow ranges from approximately 5 x 10^{-5} cm/sec at low stresses to about 1 x 10^{-6} cm/sec at high stresses.

2.2.2 Cyclone Underflow (Cyclone Sand)

The following is a list of the geotechnical tests conducted on the Cyclone Underflow sample:

- Compaction (Proctor) Test
- Tri-axial Shear Strength, and
- Flexible Wall Permeability.

The compaction test provides information on the expected density of the cyclone sand following placement as compacted sand fill for embankment construction. The optimum moisture content of the Cyclone Underflow sample was determined to be 16.7% and the maximum dry density was 1,559 kg/m^3.

The shear strength test provides information on the strength of the compacted sand over a range of confining stresses, and is used for embankment stability assessment. Similarly, the permeability test provides information on the expected permeability of the cyclone sand fill over a range of confining stresses. The permeability characteristics of the cyclone sand are an important consideration in the design of free-draining cyclone sand embankment dams. The shear strength and permeability tests were carried out over a large range of confining stresses to examine the influence of high confining stresses (corresponding to a large dam height) on the strength and permeability values.

The shear strength of the cyclone sand is defined by an average effective friction angle of 36 degrees and zero cohesion. The potential strength characteristics of the cyclone sand over a large stress range was examined by comparison of the laboratory test data to published information on the non-linear strength characteristics of similar granular materials (angular sands). This information suggests that the effective friction angle of the cyclone sand may be greater than 36 degrees at low confining stresses but potentially lower at very high stresses. However, the laboratory test results for the Cyclone Underflow sample suggest that there is no apparent loss of strength at the higher stresses, over the stress range tested (up to about 3000 kPa).

Permeability values determined for the Cyclone Underflow show a general trend of reducing permeability with increasing confining stress. This decrease is the result of the decrease in material density and potentially from the generation of finer particles due to particle crushing. However, the results do not appear to indicate a dramatic decrease in permeability at high stresses, which would be indicative of significant particle crushing and changes to the fines content of the material. The permeability of the Cyclone Underflow ranges from approximately 2×10^{-3} cm/sec at lower stresses to about 5×10^{-4} cm/sec at high stresses (approximately 3000 kPa). Extrapolation of these results suggests that the permeability of the Cyclone Underflow will remain greater than 1×10^{-4} cm/sec at very high stresses of about 4000 to 5000 kPa.

2.3 GEOCHEMICAL CHARACTERISTICS

Detailed laboratory testing and chemical analysis of the tailings (solids and process solutions) has been conducted by Others to determine their geochemical characteristics under saturated and unsaturated conditions. CMC has indicated that approximately 20% of the total tailings will comprise potentially acid generating material.

The PAG tailings are assumed to require complete subaqueous disposal in the TMF, to maintain the tailings deposit in a saturated state and inhibit their oxidation and potential reactivity.

The NAG tailings stream (80% of the tailings total) is assumed to be suitable for production of cyclone sand fill material for embankment construction.

3 – SITE CHARACTERISTICS

3.1 PHYSIOGRAPHIC SETTING

The project is located in the Dawson Range Mountains of the Klondike Plateau. The area is somewhat unique in that the region was not glaciated during the Wisconsin Advance. The characteristic terrain features are smooth, rolling topography, with moderate to deeply incised valleys. Major drainage channels extend below 1,000 m elevation. Most of the terrain lies between 1,000 m and 1,500 m elevation.

The tailings basin area is sited within the Casino Creek valley. The valley bottoms throughout the project area, with impeded drainage, have prominent permafrost features such as peat plateaus, palsas, hummocky tussock fields and polygons.

3.2 HYDROMETEOROLOGY

3.2.1 General

The climate at the Casino Project area is characterized by long, cold, dry winters and short, warm, wet summers, with conditions varying according to altitude and aspect. Streamflow in the region is typically highest in May due to melting of the winter snowpack. Annual peak instantaneous flows commonly occur in this freshet period on larger rivers, but on smaller streams they may also occur in summer or early autumn due to intense rain or rain on snow events. Flows decrease throughout the winter and minimum flows typically occur in March or April.

The climate and hydrology at the Casino Project site have been assessed based on both short-term site data and longer-term regional data. Climatic data were collected on-site at the Project climate station located in the upper Casino Creek sub-watershed at an elevation of 1200 m. The period of site record extends from 1993 to 1994 and from 2008 to 2011. Preliminary streamflow data were collected by Hallam Knight Piésold in 1993 and 1994. A new data streamflow collection program was initiated by AECOM in 2008, with the installation of ten streamflow gauging stations. As of 2012, nine streamflow gauging stations are considered to be in active operation and continue to be operated at present by Knight Piésold Ltd. (KPL). A summary of the hydrometeorological parameters is described below and the detailed analyses are presented in KPL report “Updated Hydrometeorology Report” (Ref. No. VA101-325/8-11, July 9, 2012).

3.2.2 Temperature

The mean annual temperature for the Casino Project area is estimated to be -3 °C, with minimum and maximum mean monthly temperatures of -17 °C and 12 °C occurring in January and July, respectively.

The mean monthly temperature values are presented in Table 3.1.

Table 3.1 Mean Monthly Temperature and Precipitation Values

Location	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Casino Project Station (El. 1200 m)	Precipitation (mm)	32	24	19	17	37	62	91	67	47	38	43	33	**510**
	Temperature (°C)	-16.8	-14.0	-10.2	-1.9	5.0	10.0	11.6	9.2	3.8	-4.5	-12.1	-15.3	**-2.9**

3.2.3 Precipitation and Evaporation

The Mean Annual Precipitation (MAP) for the Casino Project area is estimated to be 510 mm, with 65% falling as rain and 35% falling as snow. The mean monthly values are presented in Table 3.1.

The annual potential evapotranspiration (PET) value for the Casino Project area is estimated to be 300 mm, based on measured temperatures at the Project site climate station, and long-term regional temperature records. Potential evapotranspiration values generally provide reasonable estimates of lake evaporation rates, and are assumed to be appropriate for estimating evaporation from lakes and ponds in the Project area.

3.2.4 Annual Snowfall and Snowmelt

Based on the estimated MAP of 510 mm and a rain/snow ratio of 0.65/0.35, the annual snowfall value for Casino was estimated to be 179 mm. This is generally consistent with the 141 mm mean annual maximum snowpack value (snow water equivalent, SWE), taking into account approximately 40 mm lost to sublimation, recorded in the Project area at the Casino Creek snow course station (09CD-SC01) operated by the Yukon Department of Environment (1977-2011), Water Resources Branch.

Based on the complete years of snowpack data, the average monthly snowmelt distribution for the Casino Project area was estimated to be approximately 20% in April and the remaining 80% in May, although there is considerable variation from year to year.

3.3 REGIONAL GEOLOGY

Regional geological information in the vicinity of the TMF is derived from the interpretation of KPL drillhole and test pit data within both the TMF and surrounding areas. Several geotechnical site investigation programs were conducted in the area of the TMF in 1993 and 1994 and in 2010, 2011 and 2012. Details and results of the site investigations and the foundation conditions defined for the TMF basin are presented in the following KPL reports:

- "Report on Preliminary Surficial Geotechnical Investigations" (Ref. No. 1831/1, March, 1994),
- "Data Compilation Report on 1994 Geotechnical/Hydrogeological Investigations" (Ref. No. 1832/2, February 22, 1995),
- "2010 Geotechnical Site Investigation Data Report" (Ref. No. VA101-325/3-4, November 2, 2010),
- "2011 Geotechnical Site Investigation Data Report – Waste Management Facilities" (Ref. No., VA101-325/8-5, December, 2012), and
- "2012 Geotechnical Site Investigation Data Report" (Ref. No., VA101-325/8-14, December, 2012).

The TMF is underlain by the following geotechnical units:

- Overburden
  - Topsoil
  - Silty SAND to GRAVEL with some cobbles, trace clay (residual soil and colluvial veneer) along valley ridges and upper slopes
  - SILT and SAND with some gravel and cobbles, trace clay (colluvial apron) and interbedded SAND and gravelly SAND with some cobbles (alluvium) along the lower slopes and valley bottom
- Weathered Bedrock, and
- Fresh Bedrock.

The bedrock primarily comprises Dawson Range Batholith Granodiorite throughout the TMF Main Embankment and impoundment area, and Yukon Metamorphic Group Gneiss and Quartzite in the West Saddle Embankment area. Dawson Range Batholith (Mid-Cretaceous) is the main country rock in the TMF area and is dominantly granodiorite in composition. Quartz monzonite and diorite are less abundant. Yukon Metamorphic Group (Paleozoic) is found at depth within drillholes 94-345, 94-346, DH10-01, DH10-02 and DH10-04. The Yukon Metamorphic group was also encountered in test pits near the west embankment. It consists primarily of mafic gneiss, with less abundant meta-diorite/amphibolite, quartz-rich and intermediate gneiss, and quartzite. The Yukon Group represents an older suite of metamorphic rocks which were intruded by the Dawson Range intrusives. Along slopes and ridges in Casino Creek valley the depth to bedrock varies from about 0.5 to 7.5 meters, with an average overburden thickness of between 2 and 3 metres. Depths to bedrock in the Casino Creek valley bottom vary from approximately 2 to 23 metres.

3.4 HYDROGEOLOGY

The interpreted baseline groundwater conditions are based on piezometric levels in standpipes throughout the study area, in addition to shut-in pressure tests performed during drilling in 1994. Permeability results are based on packer tests and falling head tests performed in the drillholes and piezometer standpipes in the different geotechnical units.

Estimates of in situ permeability values, along with supporting hydrogeologic observations are summarized as follows:

- In situ packer and falling head permeability tests were carried out in various drillholes within the TMF basin and Main and West Embankment areas during the 1994, 2010 and 2011 geotechnical/hydrogeological investigations. One packer test and two falling head tests were conducted in the overburden soils near the bottom of the Casino Creek valley in drillholes 94-345 and DH10-04. Permeabilities within the overburden soils ranged from 3×10^{-6} cm/s to 3×10^{-5} cm/s, with a geometric mean value of approximately 7×10^{-6} cm/s. These permeabilities are lower than expected possibly due to a high percentage of fines and/or frozen ground conditions in the vicinity of the tests.
- Permeabilities within Highly Fractured bedrock ranged from 2×10^{-3} cm/s to 2×10^{-7} cm/s, with a geometric mean value of approximately 5×10^{-5} cm/s.
- Permeabilities within Slightly to Moderately Fractured bedrock ranged from 6×10^{-4} cm/s to 2×10^{-7} cm/s, with a geometric mean value of approximately 1×10^{-5} cm/s.

- Permafrost has an important effect on hydrogeology. Saturated frozen soil and rock have a much lower permeability when frozen compared to a thawed or unfrozen state. In situ hydraulic conductivity test results showing very low hydraulic conductivities potentially indicate frozen soil or rock. Thermistors were installed during the 2011 and 2012 site investigations to provide a better understanding of the thermal regime in the subsurface. The permafrost conditions at the TMF site are discussed in detail in Section 4.0.

Well water level elevations in the TMF impoundment area within Casino Creek valley range from approximately 720 to 970 metres. The highest water levels are located at the West Saddle Embankment and the lowest at the Main Embankment, which indicates southeast moving groundwater flow from the West Saddle Embankment to the Main Embankment.

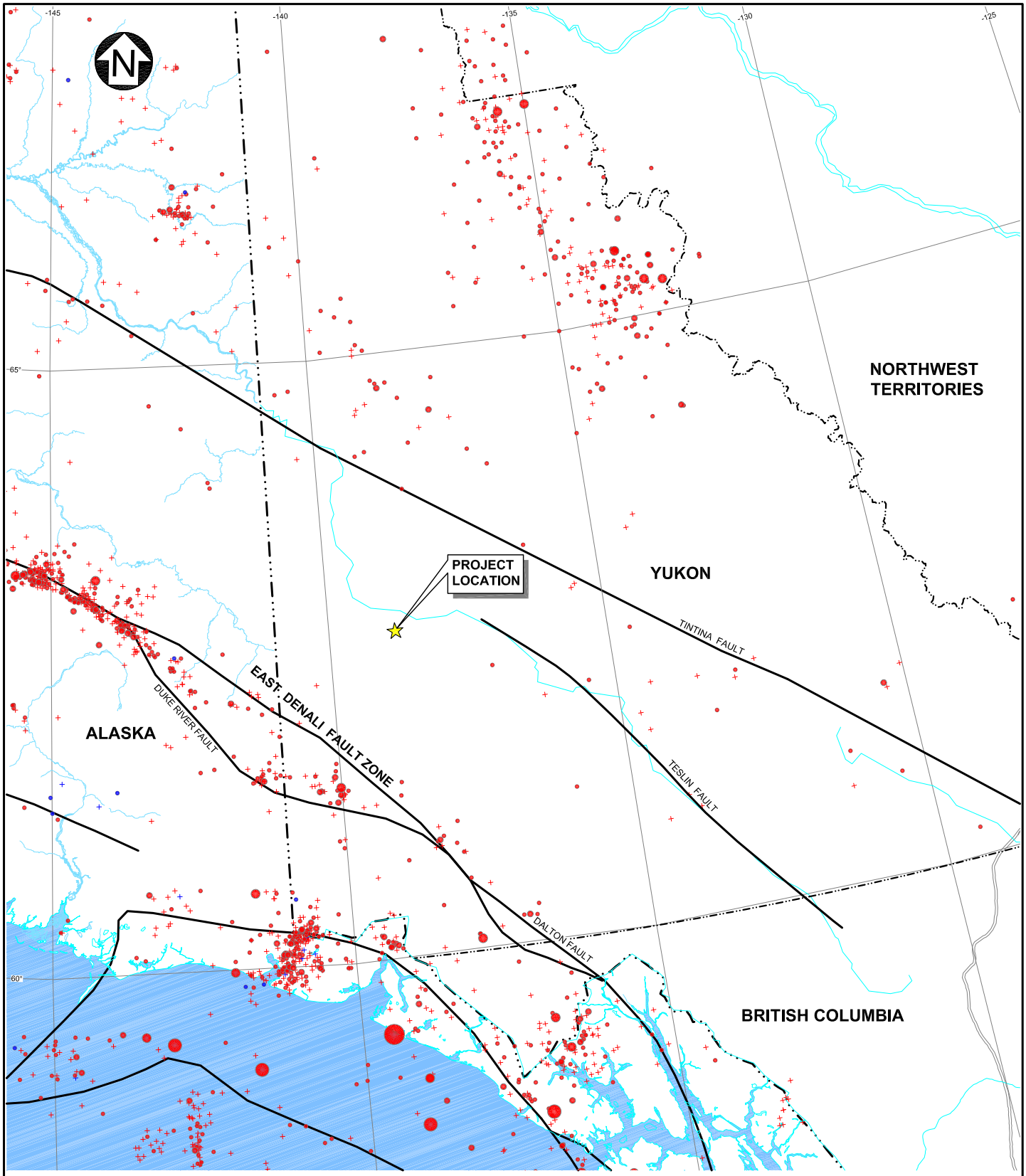
3.5 SEISMICITY

3.5.1 Regional Tectonics and Seismicity

A review of the regional tectonics and historical seismicity has been carried out to enable selection of appropriate design earthquake events for the TMF for use in seismic stability assessment.

The region of the southwest Yukon Territory and northwest British Columbia is one of the most seismically active areas in Canada. The seismic hazard in the region is also influenced by the seismically active region of southeast Alaska. The coastal region has experienced many large earthquakes, including events with magnitudes in the range of magnitude 7.0 to 8.0. In 1958 a magnitude 7.9 earthquake occurred along the Fairweather fault (the northern extension of the Queen Charlotte transform fault). The most significant inland zone of seismicity follows the Dalton and Duke River segments of the East Denali fault zone through the southwest Yukon. Farther inland there is only minor seismicity between the Denali and Tintina fault systems, including the region of the Casino Project site.

Figure 3.1 shows the regional tectonics and historical seismicity of the Yukon and surrounding regions and the location of the Casino project. Review of historical earthquake records and regional tectonics indicates that the Casino Project site is situated in a region of low seismicity.



SYMBOL SIZE PROPORTIONAL TO MAGNITUDE

- 3.5 - 3.9
- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- 8.0 - 8.9
- 9.0 +

NOTES:

1. GLOBAL COORDINATE SYSTEM IS UTM WITH NAD83 DATUM, ZONE 10 m, CENTRAL MERIDIAN.
2. HISTORICAL EARTHQUAKE DATA FROM NRCAN, USGS, AND NGDC DATABASES.
3. INCLUDES RECORDED EARTHQUAKES FROM 1600 TO 1973 (MAGNITUDE > 6.0) AND FROM 1973 TO SEPTEMBER 2012 (MAGNITUDE > 3.5).

SCALE A: 50 25 0 50 100 150 200 250 km

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REGIONAL TECTONICS AND HISTORICAL SEISMICITY

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FIGURE 3.1 | REV 0

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3.5.2 Seismic Hazard Analysis

The seismic hazard for the Casino project has been defined using probabilistic methods of analysis. Design ground motion parameters have been determined for the project site using information provided by the probabilistic seismic hazard database of Natural Resources Canada (NRC) (http://earthquakescanada.nrcan.gc.ca/hazard-alea/zoning/haz-eng.php). The results are summarized in Table 3.2 in terms of earthquake return period, probability of exceedance (for a 22 year design operating life) and the corresponding peak ground acceleration (median and mean hazard values). For a return period of 500 years the corresponding median peak ground acceleration is 0.07g, indicating a low to moderate seismic hazard for the site.

Table 3.2 Summary of Probabilistic Seismic Hazard Analysis

Return Period (Years)	Probability of Exceedance[1] (%)	Peak Ground Acceleration (PGA)[2]	
		Median PGA[3,4] (g)	Estimate Mean PGA[5] (g)
100	20	0.04	0.05
500	4	0.07	0.08
1,000	2	0.08	0.10
2,500	1	0.11	0.13
5,000	0.4	0.14	0.17
10,000	0.2	0.18	0.22

NOTES:

1. Probability of exceedance calculated for a design life of 22 years:
   $q = 1-\exp(-L/T)$
   Where: q = probability of exceedance
   L = design life in years
   T = return period in years
2. Peak ground accelerations are for soft rock/very dense soil (Vs_{30} = 360 to 760 m/sec) .
3. Median peak accelerations for return period up to 2,500 years obtained from the seismic hazard database of Natural Resources Canada.
4. Median peak ground accelerations for return periods of 5,000 and 10,000 years obtained from site-specific analysis using EZ-FRISK.
5. Mean PGA values estimated as 1.2 x median values.

However, the NRC database only provides ground motion parameters up to a return period of approximately 2,500 years (corresponding to a 2% probability of exceedance in 50 years). Therefore, a probabilistic seismic hazard analysis was conducted to provide ground motion parameters beyond 2,500 years, specifically for return periods of 5,000 and 10,000 years.

The computer program EZ-FRISK (Risk Engineering, Inc., 2008) was used to develop a seismic hazard model for the Yukon and the surrounding regions. The seismic hazard analysis module available with EZ-FRISK includes a database provided by Risk Engineering Inc. of faults and areal seismic sources for the pertinent regions of western Canada. Seismic sources defined in the hazard model include the regions of the southern Yukon Territory, southeastern Alaska, and the Denali and Fairweather fault systems. The seismic hazard model was used to determine the relationship between peak ground acceleration and annual frequency of occurrence for the project site. Predicted values for the project site are included in Table 3.2 for return periods of 5,000 and 10,000 years. Predicted values for lower return periods were very similar to those provided by the NRC seismic hazard database.

The seismic hazard for the project site is predominantly from shallow crustal earthquakes (magnitudes up to M7) in the region of the southern Yukon, but it is also influenced by the potential for larger magnitude earthquakes (approximately M7.5 to 8.0) occurring farther from the site on the East Denali fault zone.

Details of the probabilistic seismic hazard assessment are provided in Appendix B.

4 – SITE GEOTECHNICAL CONDITIONS

4.1 SITE INVESTIGATIONS

Geotechnical site investigation programs were conducted by KPL in the area of the TMF in 1993 and 1994 and more recently in 2010, 2011 and 2012. The programs included drillholes and test pits to investigate the geotechnical characteristics and foundation conditions. Geophysical surveys were carried out by Frontier Geosciences Inc. as part of the 2011 site investigations, and included seismic refraction surveys, Ground Penetrating Radar (GPR) surveys and an EM31 conductivity survey. The geotechnical data has been used to evaluate the tailings basin and embankment foundation conditions, and to evaluate the geological factors affecting design of the TMF.

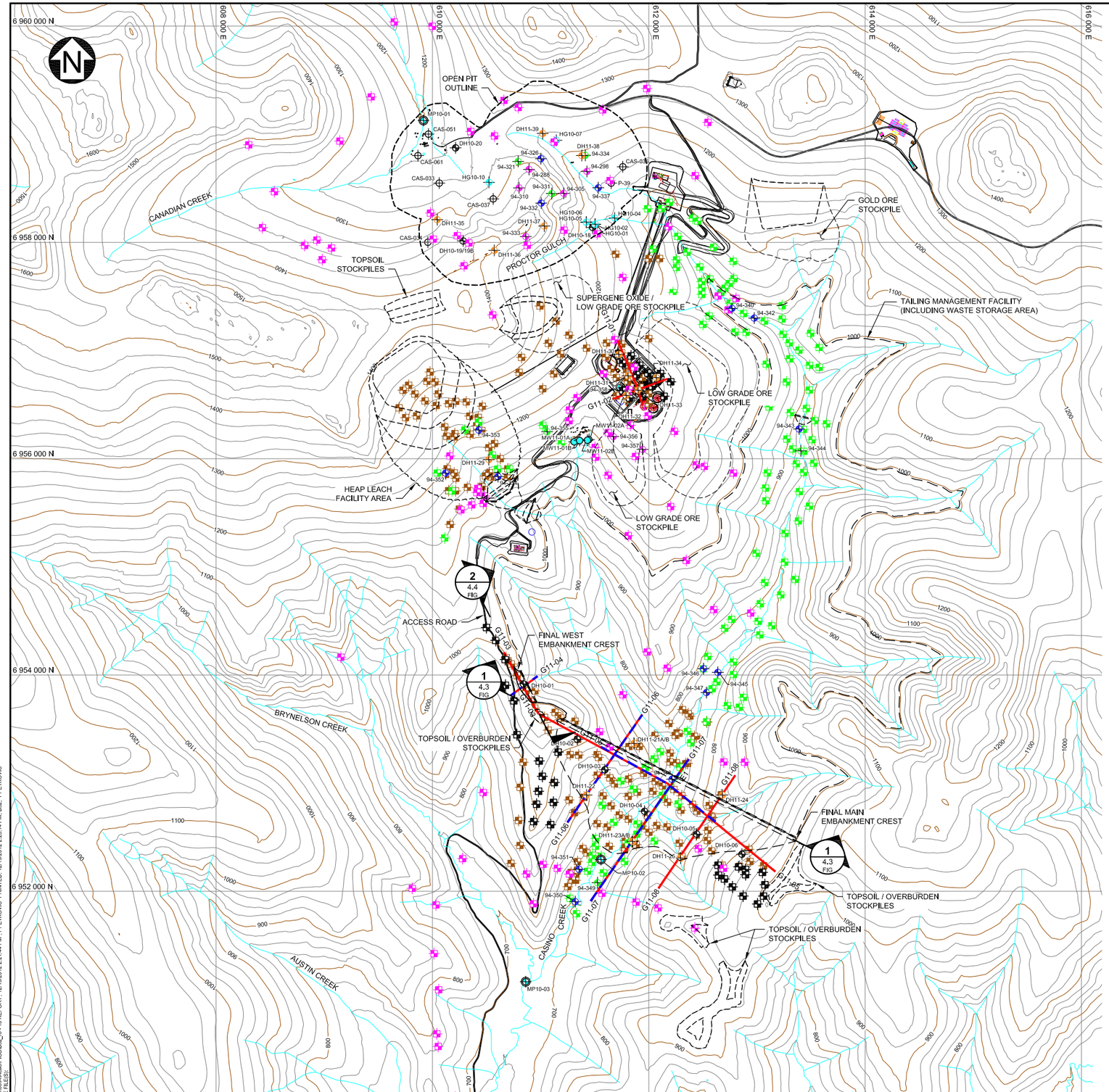
The site investigations conducted in the area of the proposed TMF site included the following:

- Preliminary surficial geotechnical investigations were carried out in 1993 at the Casino project area. The investigations were carried out as part of the Placer Lease Agreement Program to provide a preliminary overview of the surficial materials and foundation conditions for the various potential mine-site components, including the Open Pit, Plant site, Heap Leach Pad, Waste Rock Storage and Tailings Impoundment sites. The exposed surficial materials were described and characterized, and representative samples were selected for laboratory testing. The laboratory testwork was carried out on site by KPL and included particle size analyses, natural moisture contents, Atterberg limits (plasticity), compaction tests and permeability tests. The results of the investigations are included in KPL report “Report on Preliminary Surficial Geotechnical Investigations” (Ref. No. 1831/1, March, 1994).
- Eleven drillholes were completed in 1994 near the proposed TMF embankment and impoundment areas. Groundwater monitoring wells were installed in nine of these drillholes, and thermistors were installed in two other holes. In situ packer, falling head permeability tests, and shut-in pressure tests were conducted within the drillholes. The investigation program also included the excavation of test pits for visual inspection and characterization of surficial materials. Representative test pit samples were collected for laboratory testing. The laboratory testwork included particle size analyses, natural moisture contents, Atterberg limits and compaction tests. The results of the investigations are included in KPL report “Data Compilation Report on 1994 Geotechnical and Hydrogeotechnical Investigations” (Ref. No. 1832/2, February 22, 1995).
- The 2010 Site Investigation program included six geotechnical drillholes, all near the crest of the proposed TMF Main Embankment. In situ packer and falling head permeability tests were conducted within the drillholes and piezometers. A test pit investigation was performed around the TMF embankment area to determine the suitability and availability of potential embankment construction materials. Representative test pit samples were collected for laboratory test work. The soil samples were subjected to particle size analysis, natural moisture content, Atterberg limit, specific gravity, flexible wall permeability, triaxial shear and compaction tests. Additionally, AECOM installed mini piezometer MP-02 downstream of the proposed TMF and a water level logger in drillhole 94-352 at the HLF area. The results of the investigations performed by KPL are included in KPL report “2010 Geotechnical Site Investigation Data Report” (Ref. No. VA101-325/3-4, November 2, 2010). The hydrogeological investigations by AECOM are summarized in

the report “Casino Project – Hydrogeological Technical Report – DRAFT” (Ref. No. 60146995-9, March 2011).

- A total of seven KPL geotechnical drillholes were completed in 2011 in the TMF area. Standpipe piezometers were installed in five of these drillholes, and thermistors were installed in two other holes. In situ packer and falling head permeability tests were conducted within the drillholes, as well as Standard Penetration Tests (SPT). More than 100 test pits were excavated for visual inspection and characterization of surficial materials. Laboratory testing on representative samples included particle size analyses, natural moisture content, organic content, Atterberg limit, specific gravity, flexible wall permeability, and compaction tests. Geophysical investigations comprised seismic refraction surveys along six sections, Ground Penetrating Radar (GPR) surveys along five sections, and an EM31 conductivity survey along one section across the TMF area. The results of the investigations are included in KPL report “2011 Geotechnical Site Investigation Data Report - Waste Management Facilities” (Ref. No. VA101-325/8-5, December 2012).
- Three drillholes were drilled in the TMF area during the 2012 site investigations. Thermistors were installed in all three drillholes. The investigation program also included the excavation of test pits for visual inspection and characterization of surficial materials, and to obtain representative test pit samples for laboratory testing. The laboratory testwork included particle size analyses, natural moisture content, organic content, soluble salts, Atterberg limit, flexible wall permeability, and compaction tests. The results of the investigations are included in KPL report “2012 Geotechnical Site Investigation Data Report” (Ref. No. VA101-325/8-14, December 2012).

Geological sections have been prepared with the site investigation results along the embankment crest. Figure 4.1 shows the locations of drillholes, test pits and geophysical survey lines from previous site investigations, and includes the locations of the geological sections. The site investigation plan for the 2012 site investigation is shown on Figure 4.2, and includes the outline of the colluvial apron under the embankment footprint. The geological section along the Main Embankment is shown on Figure 4.3 and the section along the West Saddle Embankment on Figure 4.4.



LEGEND:

- DH11-30 — 2011 GEOTECHNICAL DRILLHOLE
- MW11-01A — 2011 MONITORING WELL
- MP10-01 — MINI PIEZOMETER
- HG10-01 — 2010 HYDROGEOLOGICAL DRILLHOLE
- DH10-01 — 2010 GEOTECHNICAL DRILLHOLE
- CAS-033 — EXPLORATION DRILLHOLE WITH PIEZOMETER OR THERMISTOR
- 94-305 — 1994 GEOTECHNICAL DRILLHOLE
- 94-344 — 1994 GEOTECHNICAL DRILLHOLE WITH THERMISTOR
- 94-350 — 1994 GEOTECHNICAL DRILLHOLE WITH 50 mm DIA. WELL
- 2011 TEST PIT LOCATION
- 2010 TEST PIT LOCATION
- 1994 TEST PIT LOCATION
- 1993 TEST TRENCH LOCATION
- 2011 SEISMIC REFRACTION LINE
- 2011 GROUND PENETRATING RADAR (GPR) LINE
- 2011 EM31 LINE

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT IS SHOWN AT ITS FINAL OUTLINE AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. HEAP LEACH PAD IS SHOWN AT ITS MAXIMUM SIZE.
7. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.
8. TEST PITS ID'S ARE NOT SHOWN ON FIGURE TO IMPROVE CLARITY

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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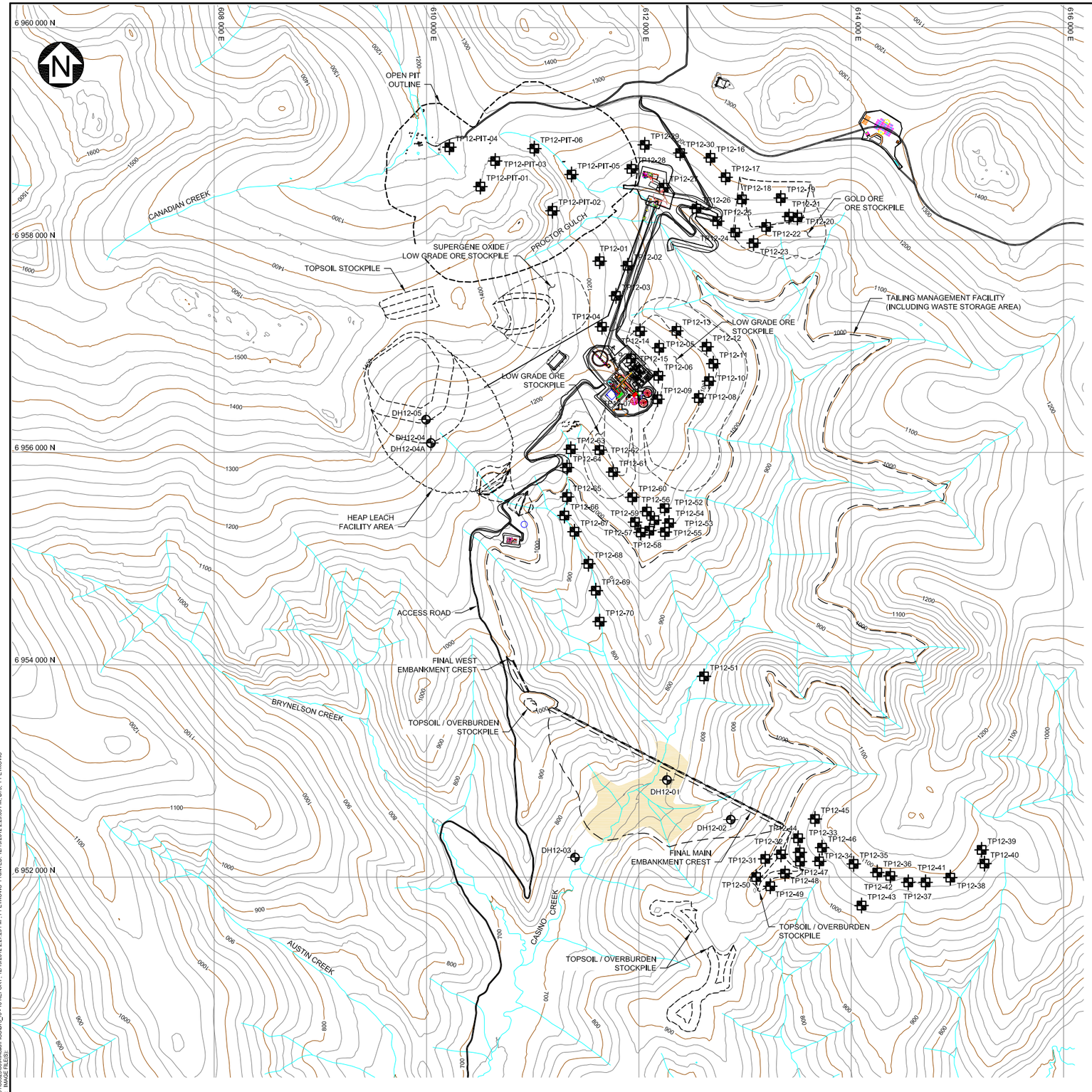
PREVIOUS SITE INVESTIGATIONS

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FIGURE 4.1 | REV 0

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LEGEND:

- DH12-01 — 2012 GEOTECHNICAL DRILLHOLE
- TP12-39 — 2012 TEST PIT
- APPROXIMATE EXTENT OF COLLUVIAL APRON

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT IS SHOWN AT ITS FINAL OUTLINE AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. HEAP LEACH PAD IS SHOWN AT ITS MAXIMUM SIZE.
7. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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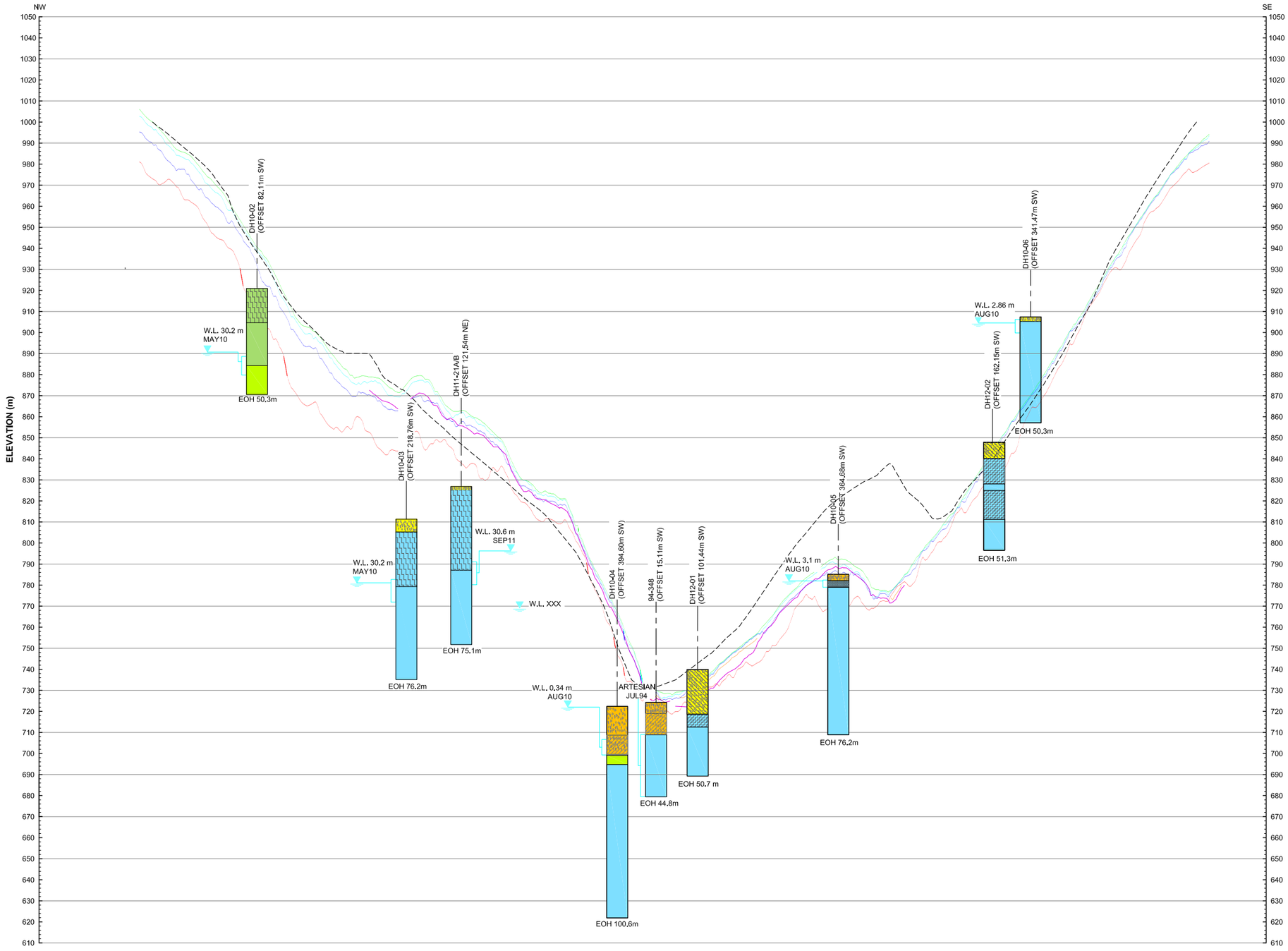
2012 SITE INVESTIGATION

Knight Piésold CONSULTING

P/A NO. VA101-325/8 | REF NO. 10

FIGURE 4.2 | REV 0

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LEGEND:

- WEATHERED YMQT
- YUKON METAMORPHIC COMPLEX - QUARTZITE (YMQT)
- YUKON METAMORPHIC COMPLEX - GNEISS (YMGN)
- WEATHERED WRGD
- DAWSON RANGE BATHOLITH - GRANODIORITE (WRGD)
- COLLUVIAL VENEER
- COLLUVIAL VENEER FROZEN
- COLLUVIAL APRON
- COLLUVIAL APRON FROZEN
- GROUND SURFACE ALONG GEOPHYSICS LINE
- SEISMIC SURFICIAL LAYER
- SEISMIC INTERMEDIATE LAYER
- SEISMIC BASAL LAYER
- GPR REFLECTOR
- GPR ICE BOTTOM REFLECTOR
- GROUND SURFACE

NOTES:

LOCATION OF DRILLHOLES DH12-01 AND DH12-02 PRESENTED ON FIGURE 4.2.

SCALE B: 20 10 0 20 40 60 80 100 m

SCALE A: 100 50 0 100 200 300 400 500 m

1 / 4.1 FIG **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B

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CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

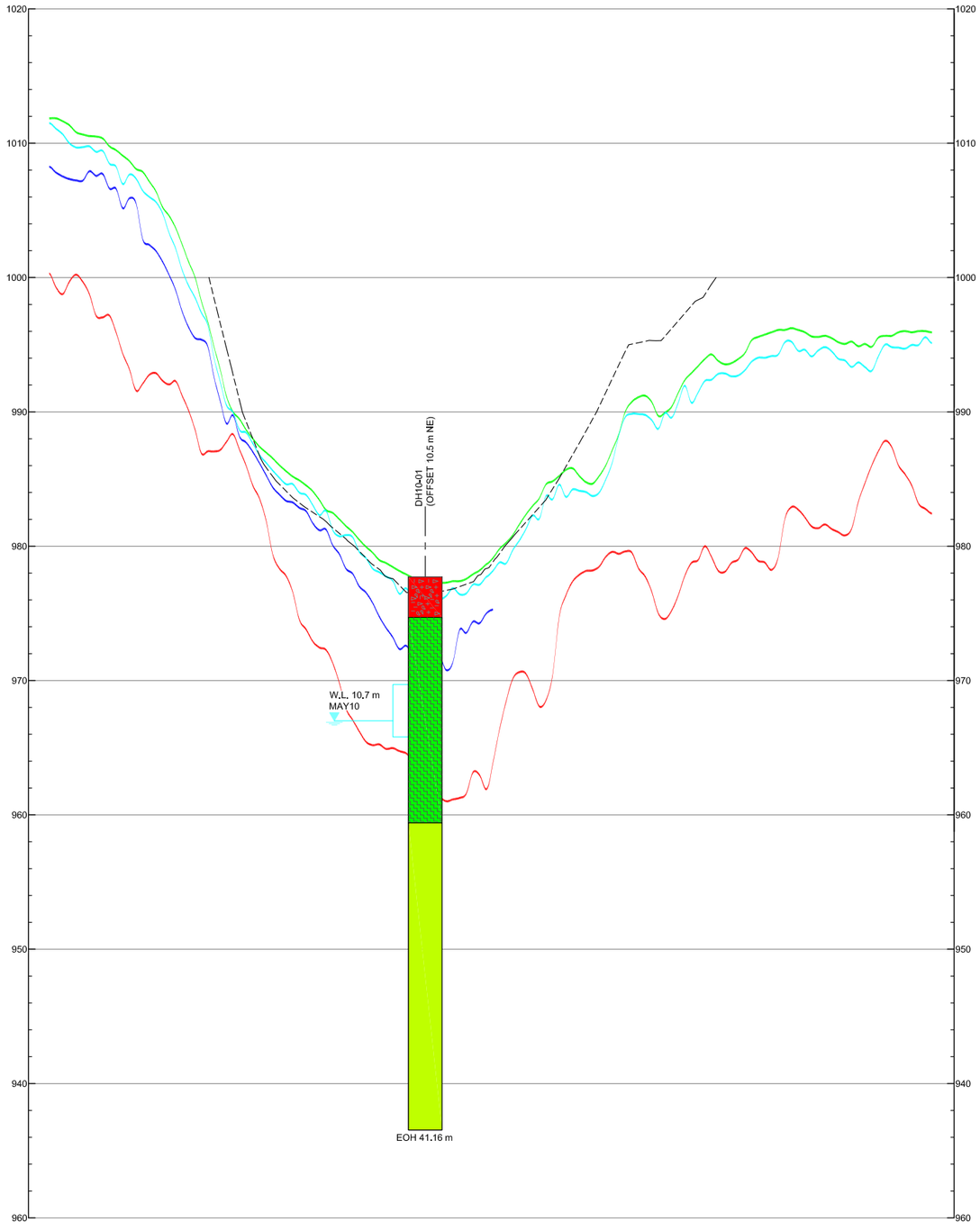
TAILING MANAGEMENT FACILITY
GEOLOGICAL SECTION
MAIN EMBANKMENT

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P/A NO. VA101-325/8 | REF NO. 10

FIGURE 4.3 | REV 0

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2 **SECTION**
4.1 FIG
HORIZONTAL: SCALE A
VERTICAL: SCALE B

LEGEND:

- RESIDUAL SOIL
- WEATHERED YMGN
- YUKON METAMORPHIC COMPLEX - GNEISS (YMGN)
- GROUND SURFACE ALONG GEOPHYSICS LINE
- SEISMIC SURFICIAL LAYER
- SEISMIC INTERMEDIATE LAYER
- SEISMIC BASAL LAYER
- GROUND SURFACE

PROGRESS PRINT
DEC. 19, 2012 (2:36 PM)

SCALE B: 4 2 0 4 8 12 16 20 m

SCALE A: 40 20 0 40 80 120 160 200 m

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CASINO COPPER-GOLD PROJECT

TAILING MANAGEMENT FACILITY
GEOLOGICAL SECTION
WEST SADDLE EMBANKMENT

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FIGURE 4.4

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4.2 EMBANKMENT FOUNDATION

4.2.1 General

This section discusses in detail the geotechnical conditions encountered throughout the embankment area of the TMF in previous site investigation programs. Permafrost considerations and foundation preparation requirements are also discussed.

4.2.2 Geotechnical Conditions

Overburden

The results from site investigations show that overburden is generally shallow along the ridges and upper slopes of Casino Creek valley. The overburden depth in this area varies from 0.5 to 7.5 m, with an average thickness between 2 and 3 m. The overburden consists of residual soil and colluvial veneer, overlain by approximately 0.3 m of silty, mossy topsoil.

Residual soils are mainly present along ridges at higher elevations and along the upper parts of slopes. The residual soil is generally comprised of loose to compact silty sand and gravel with some cobbles and trace clay. The material is derived from in situ weathering of host bedrock. Weathering is dominated by frost action rather than chemical weathering, and as a result little clay is present. The material is locally silt-rich due to windblown loess enrichment. The residual soils coarsen with depth to fractured rock as the influence of frost action decreases.

The ridges and upper slopes are characterized by well drained colluvial and residual sandy soils, supporting stands of tall spruce and poplar. The colluvial veneer is locally overlying residual soils near the top of the slopes. The colluvial soils have been transported down-slope by gravity, causing variations in composition and intermixing of organic material. The colluvium is relatively thin along the upper part of particularly south facing slopes, and generally absent on ridges where residual soils predominate.

The colluvial veneer along the slopes of Casino Creek valley is comprised of a fine to medium grained sand with some silt, supporting coarse gravel and cobble sized broken rock fragments. The thickness and organic content generally increase down-slope. On north-facing slopes, the colluvial veneer is mostly frozen.

The depth to bedrock is considerably larger near the valley bottom, where slopes are gentler. The overburden thickness in the Casino Creek valley bottom varies from approximately 2 to 23 m. This material is classified as colluvial apron, which has a higher fines and organic content than the colluvial veneer. The colluvial apron is mostly frozen, with excess ice and massive ice layers, as recovered in DH11-23A. The colluvial apron is underlain by alluvium close to Casino Creek. The alluvium is coarse grained and comprised of interbedded sands and gravelly sands with cobbles. It is typically overlain by frozen, organic-rich colluvial apron, except near the creek where the alluvium is non-frozen and at surface. The alluvium is generally at surface in tributary valleys, and consists of highly saturated, ice rich, fine grained sands and clayey silts.

It is not always possible to differentiate residual soils from colluvial soils, as colluvial soils are essentially residual soils that have migrated down-slope. The gradations of residual and colluvial soils are often similar and range from sandy silt to gravel with many cobbles, depending on the

degree of weathering with depth, localized windblown silt enrichment and down-slope transportation processes.

Bedrock

Bedrock is considered "weathered" if weathering processes have considerably weakened the rock and penetrative discoloration has occurred. Geotechnical logging of drillholes revealed weathered bedrock (Granodiorite) up to 38 m thick. The average thickness of the weathered bedrock zone is approximately 17.5 m. The average RMR for weathered bedrock is approximately 40, indicating a rock mass quality of POOR to FAIR (Bieniawski, 1989).

Dawson Range Batholith Granodiorite was encountered in all 2011 and 2012 drillholes in the TMF Main Embankment area. The fresh bedrock is strong with an average unconfined compressive strength (UCS) field estimate of 70 MPa. The average RMR for fresh bedrock is approximately 60, and is considered FAIR to GOOD rock mass quality.

Drillholes from the 1994 and 2010 site investigations also indicate that Dawson Range Batholith Granodiorite is the primary lithology in the embankment area. The bedrock underlying the proposed West Embankment and the topographical knob between the West Embankment and the Main Embankment consist of Yukon Metamorphic Complex Gneiss and Quartzite. These lithologies were also encountered in the 2011 test pits near the proposed West Embankment. The 1994 drillholes that were drilled in the TMF impoundment area indicate the presence of Dawson Range Batholith Granodiorite, Yukon Metamorphic Complex Gneiss and Patton Porphyry.

Two narrow zones of low velocity within the competent bedrock were encountered in the seismic refraction data at chainage 40 NE on line G11-08 (on the east abutment of the Main Embankment) and at chainage 600 NE on line G11-06 (near drillhole DH10-03 on the west abutment). These low velocities are consistent with zones of highly fractured and weathered granodiorite, and likely indicate shear or fault zones in the bedrock. Confirmation and detailed mapping of these fault zones will require additional investigations.

4.2.3 Permafrost

Permafrost is discontinuous over the TMF embankment area, and is primarily present at the valley bottom, north-facing slopes and shaded areas. The ridges at higher elevations and upper slopes on the west abutment are southeast-facing, and are generally free of permafrost except for some local shaded areas.

Permafrost is common in the northwest-facing east abutment area, where test pits were terminated at shallow depths in frozen colluvium and residual soils. Permafrost occurs here as thin ice lenses in fine grained soils and as small ice wedges in broken rock.

Permafrost is abundant in the organic, silty colluvial apron of the Casino Creek and tributary valley bottoms. The overburden is generally saturated and frozen in these areas, with high ice contents. Massive ice layers were encountered in the colluvial apron in DH11-23A. The massive ice was also identified in the GPR data in more than half of the survey line length along the valley bottom. The GPR data also indicated ground ice close to tributaries leading to Casino Creek.

Alluvium lies at surface in very close proximity to Casino Creek, where it is not frozen due to the presence of a talik (permanently unfrozen ground). Permafrost is also absent in localized areas

along Casino valley as indicated by the presence of tall grasses and willows, and the absence of thick mosses. These areas are discontinuous and likely result from the historic shifting of the creek channel which acts to maintain a thawed region under the creek.

Thawing of ice-rich soils may lead to excessive settlements, and loss of strength. The ice-rich soils typically exhibit very low strengths when thawed, and flow even under very flat slopes. Two gelifluction lobes that were observed within the colluvial apron in the TMF embankment area are evidence of this potential for instability. Ice-rich soils also have the potential for long term creep displacements.

Disturbance or removal of the vegetative cover may result in the melting of permafrost and the development of unstable conditions. Frozen overburden and bedrock that are underlying part of the tailings impoundment and embankments are expected to thaw over time, as the tailings and water stored in the TMF will act as a heat source. It is therefore recommended that all ice-rich overburden encountered during construction be removed along the entire foundation of the TMF embankments. Ground ice is not expected to be significant in bedrock which will likely provide a stable foundation for the embankments. Preferential seepage paths may develop when ice filled discontinuities thaw. Bedrock may have to be steamed and grouted if this is the case.

Thermistors were installed during the 2011 and 2012 site investigations to provide a better understanding of the thermal regime in the bedrock. Additional site investigations will be required to confirm the characteristics of the overburden and bedrock, and the extent of permafrost within the TMF embankment area. Thermal modelling may also be required to predict the effect of the proposed TMF on foundation conditions.

4.2.4 Foundation Preparation

Foundation preparation for the TMF embankments will involve the stripping of topsoil and vegetation and the removal of all talus boulders. The topsoil will be stockpiled for reclamation purposes. The underlying frozen soils will be excavated down to a competent, stable bedrock or non-frost susceptible overburden foundation. Ice-rich and frost-susceptible materials will be removed to spoil and are expected to be unsuitable for use as borrow in embankment construction. The quantity of spoil will be significant and may require special measures such as dams or berms to provide containment of the thaw-saturated materials. The ice-rich spoil material will be placed in the TMF impoundment to satisfy this requirement.

The embankment footprint area that covers colluvial apron or other ice-rich overburden will be excavated to competent foundation, absent of frost susceptible soil. The removed material will be replaced with core, filter or shell zone material, depending on the location relative to the embankment. The average thickness of the colluvial apron is expected to be approximately 10 metres based on the findings of the site investigations.

A low permeability cut-off is required beneath the core zone of the Main Embankment and West Saddle Embankment at locations where no colluvial apron or other ice rich soil is present, to provide an effective seepage control barrier. The seepage cut-off trench will extend through the foundation soils and key into competent bedrock, at an average depth of about three meters for both the Main and West Embankment.

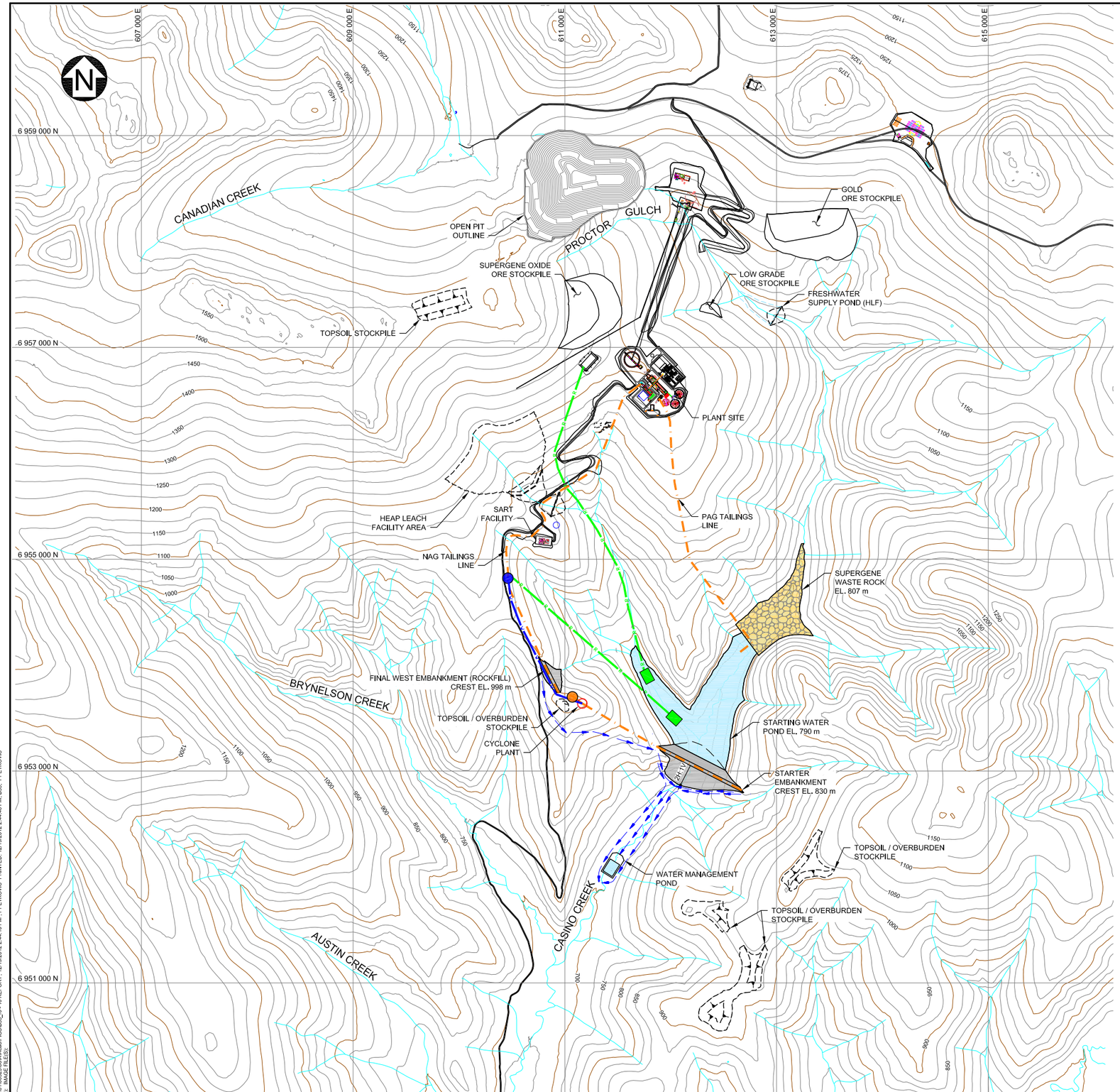
5 – TAILINGS MANAGEMENT FACILITY DESIGN

5.1 GENERAL

The principal objectives of the Feasibility design for the Tailings Management Facility (TMF) are to ensure protection of the regional groundwater and surface waters both during operations and in the long-term (post-closure), and to achieve effective reclamation at mine closure. The Feasibility design of the TMF has taken into account the following requirements:

- Permanent, secure and total confinement of all solid waste materials within an engineered disposal facility.
- Control, collection and removal of free draining liquids from the tailings during operations for recycling as process water to the maximum practical extent.
- The use of cyclones to generate clean sand, from the bulk Non-Acid Generating (NAG) tailings, for embankment construction.
- The inclusion of monitoring features for all aspects of the facility to ensure performance goals are achieved and design criteria and assumptions are met.
- Staged development of the facility over the life of the project.

The overall project general arrangement of the TMF is shown on Figure 1.2. General arrangements illustrating the development at the end of pre-production (Year -1), at interim stages (Years 1, 4 and 10), and the final arrangement (Year 22) are shown on Figures 5.1 to 5.5, respectively. Typical sections showing the development of the TMF and WSA during mine operations (Years 1, 4, 10 and 22) are provided on Figure 5.6.



NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. TOPSOIL / OVERBURDEN STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE.

LEGEND:

- WASTE ROCK
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY GENERAL ARRANGEMENT STARTER (PRE-PRODUCTION)

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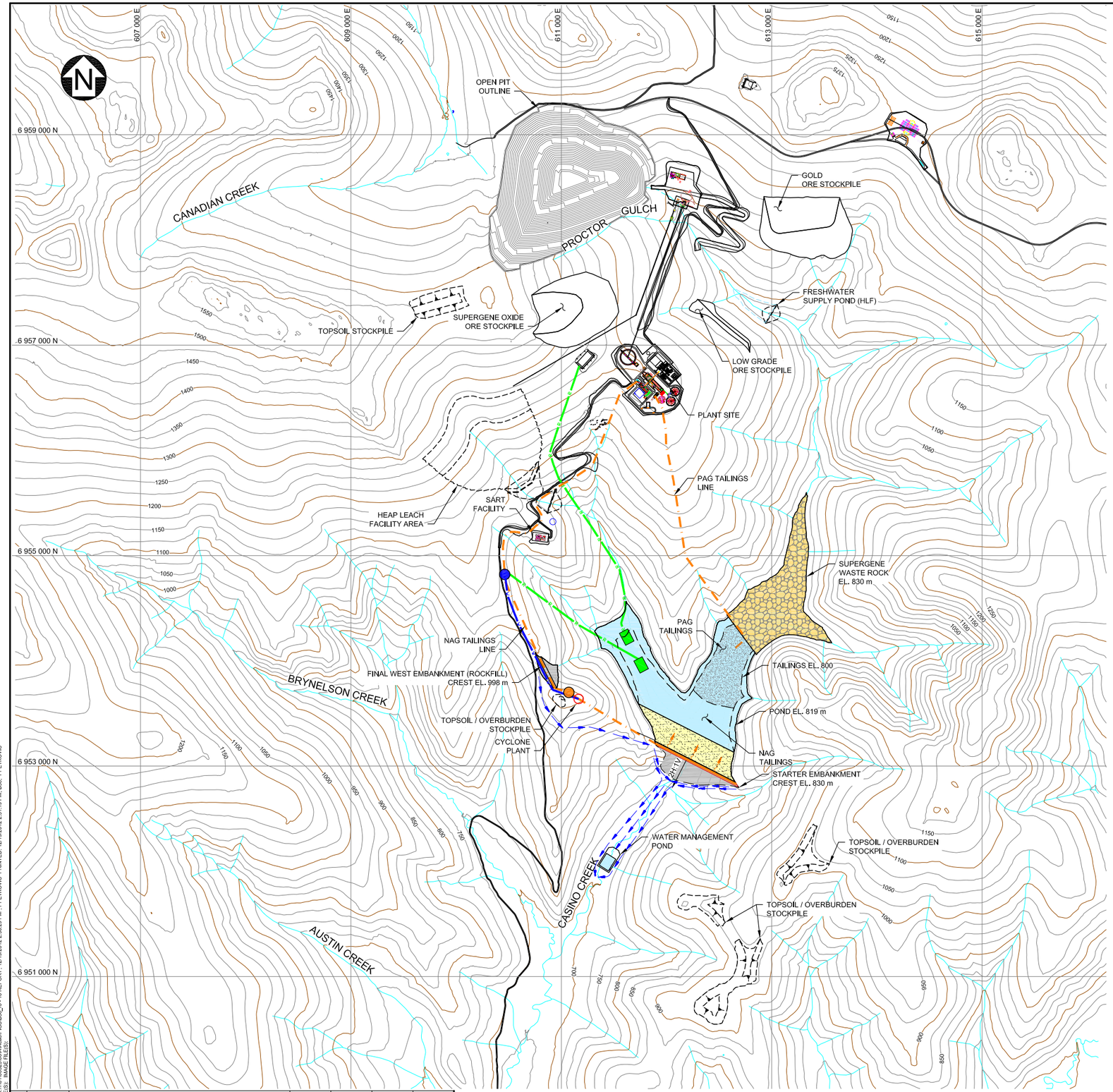
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REF NO. 10

FIGURE 5.1

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NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. EXCESS CYCLONE SAND THAT WILL BE DEPOSITED AT EMBANKMENT TOE IS NOT SHOWN ON DRAWING.
5. OPEN PIT AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
6. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
7. TOPSOIL / OVERBURDEN STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE.

LEGEND:

- WASTE ROCK
- TAILINGS
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

SCALE A 400 200 0 400 800 1200 1600 2000 m

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CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

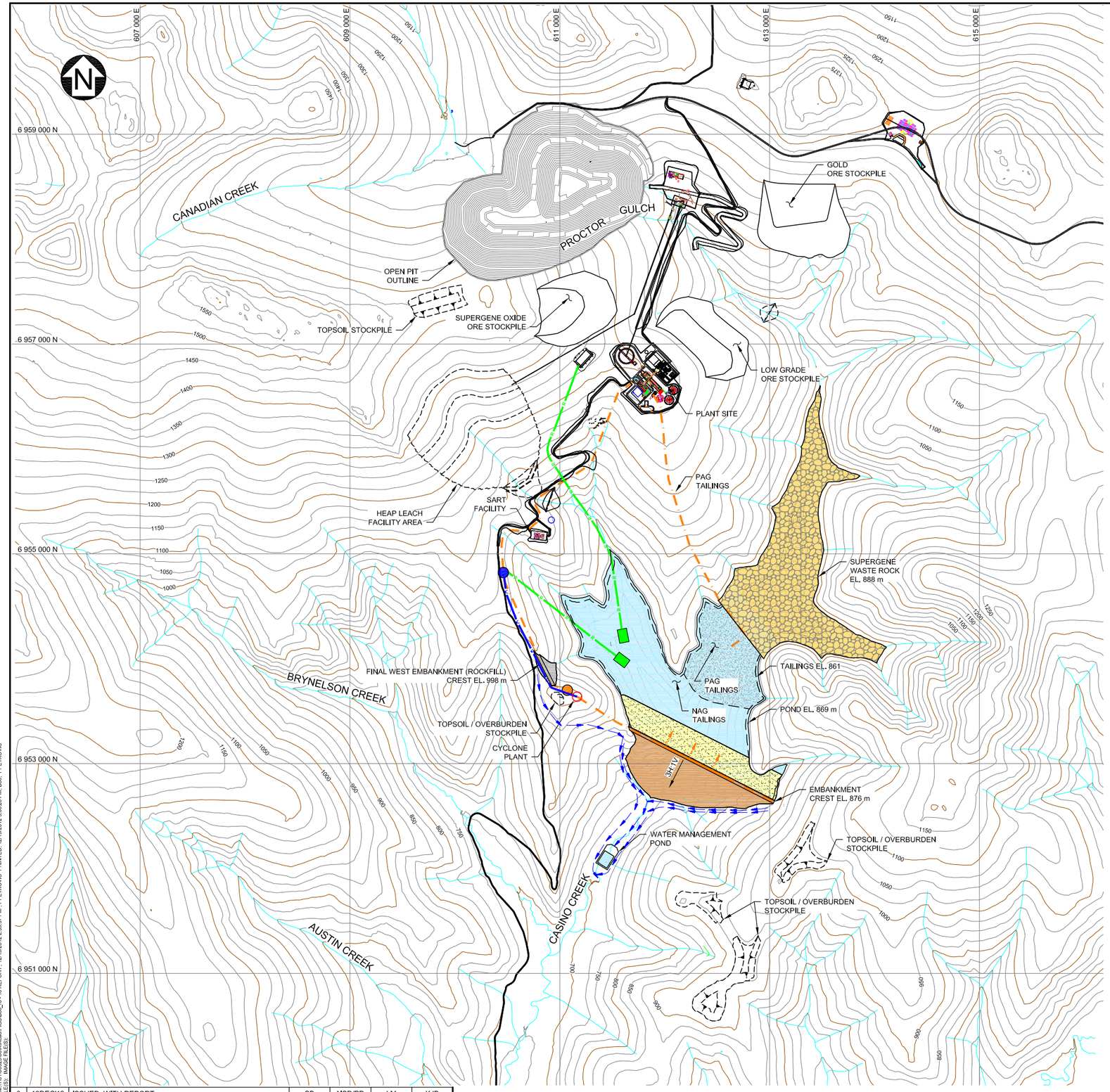
TAILINGS MANAGEMENT FACILITY GENERAL ARRANGEMENT YEAR 1

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FIGURE 5.2 | REV 0

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NOTES:

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2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. EXCESS CYCLONE SAND THAT WILL BE DEPOSITED AT EMBANKMENT TOE IS NOT SHOWN ON DRAWING.
5. OPEN PIT AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
6. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
7. TOPSOIL / OVERBURDEN STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE.

LEGEND:

- WASTE ROCK
- TAILINGS
- EMBANKMENT (CYCLONE SAND)
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY GENERAL ARRANGEMENT INTERIM (YEAR 4)

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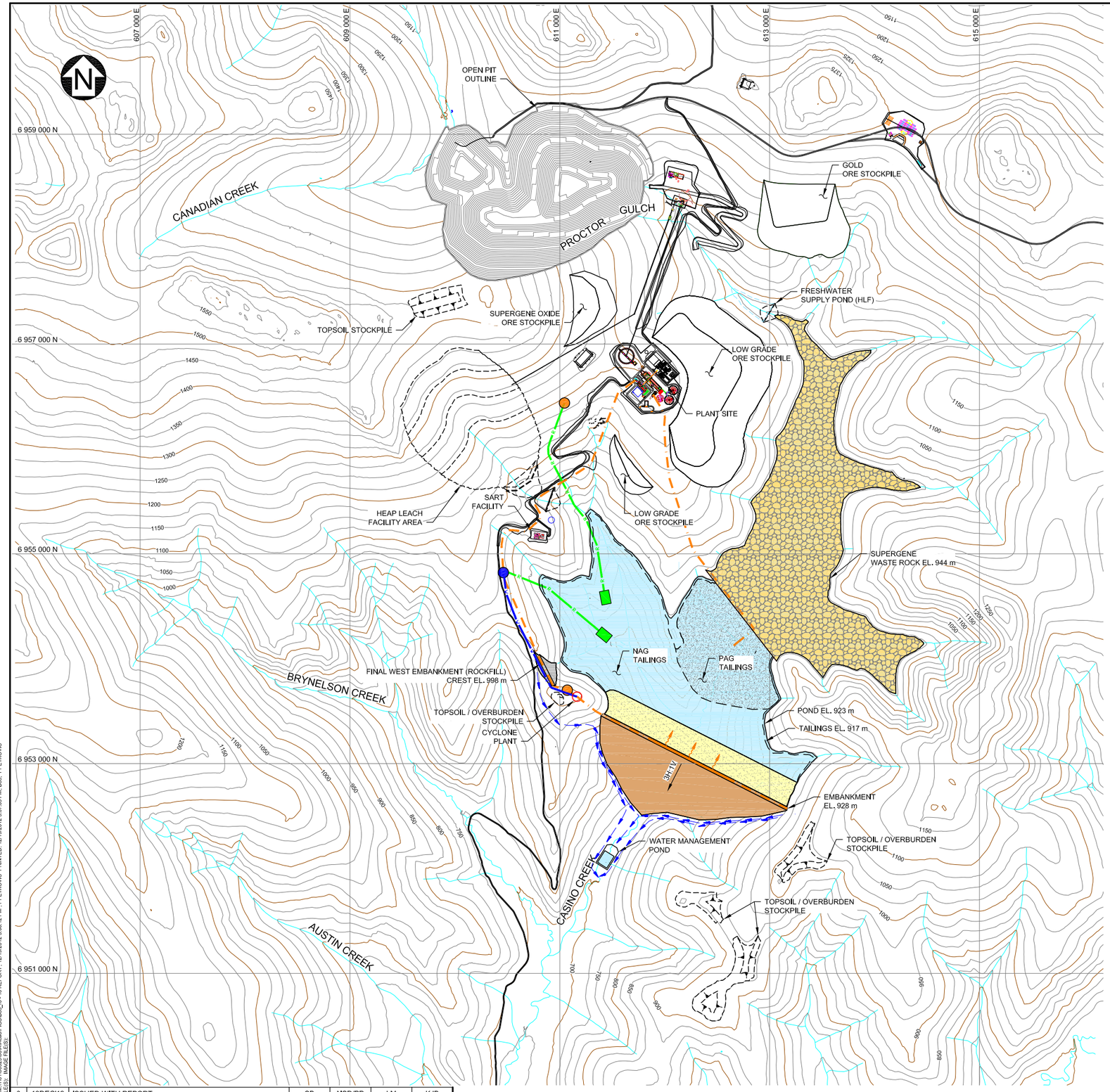
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FIGURE 5.3

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2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. EXCESS CYCLONE SAND THAT WILL BE DEPOSITED AT EMBANKMENT TOE IS NOT SHOWN ON DRAWING.
5. OPEN PIT AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
6. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
7. TOPSOIL / OVERBURDEN STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE.

LEGEND:

- WASTE ROCK
- TAILINGS
- EMBANKMENT (CYCLONE SAND)
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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CASINO COPPER-GOLD PROJECT

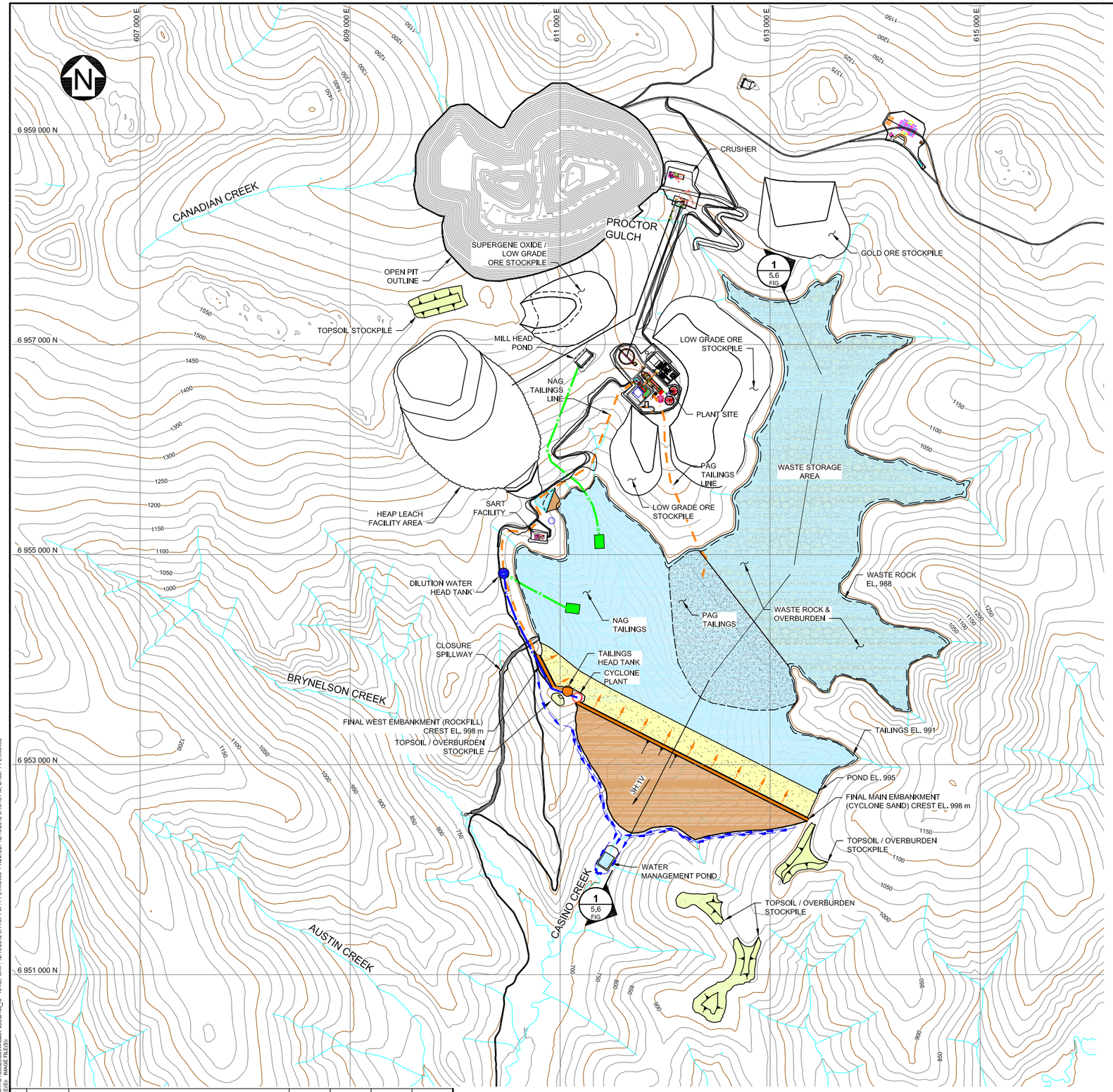
TAILINGS MANAGEMENT FACILITY GENERAL ARRANGEMENT INTERIM (YEAR 10)

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P/A NO. VA101-325/8 | REF NO. 10 | REV 0

FIGURE 5.4

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NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

LEGEND:

- TOPSOIL / OVERBURDEN
- TAILINGS
- EMBANKMENT (CYCLONE SAND)
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

SCALE A: 400 200 0 400 800 1200 1600 2000 m

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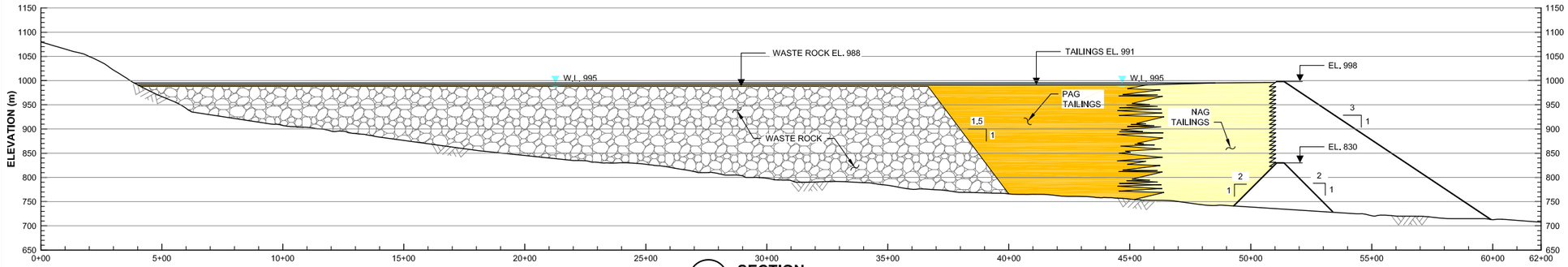
TAILINGS MANAGEMENT FACILITY GENERAL ARRANGEMENT FINAL (YEAR 22)

Knight Piésold CONSULTING

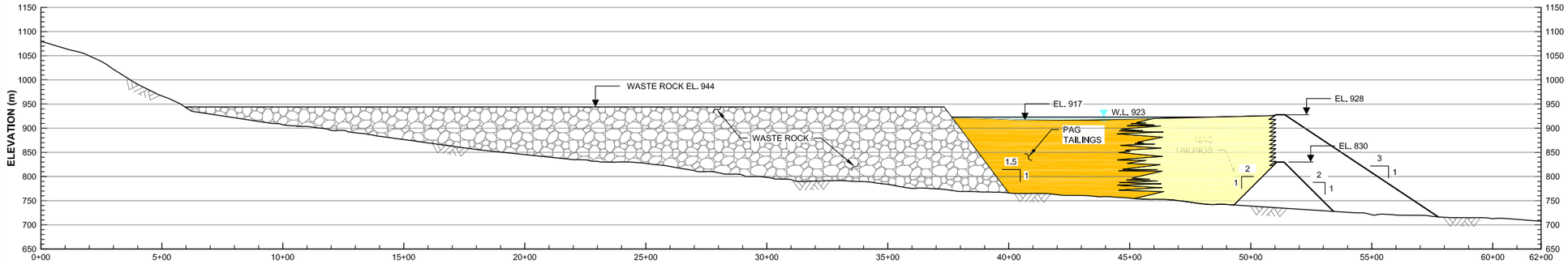
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FIGURE 5.5 | REV 0

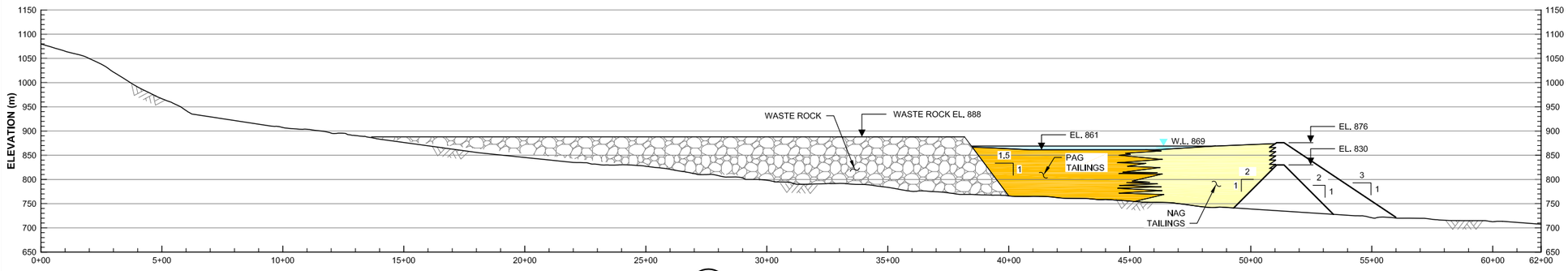
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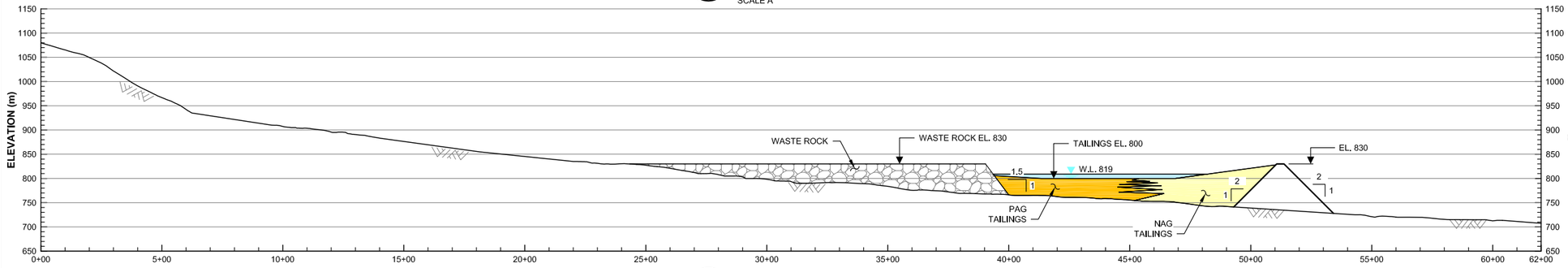
1 / 5,5 FIG **SECTION**
YEAR 22
SCALE A



1 / 5,5 FIG **SECTION**
YEAR 10
SCALE A



1 / 5,5 FIG **SECTION**
YEAR 4
SCALE A



1 / 5,5 FIG **SECTION**
YEAR 1
SCALE A

NOTES:

1. DIMENSIONS ARE IN METRES UNLESS NOTED.

VERT. SCALE 100 50 0 100 200 300 400 500 m
HORIZ. SCALE 200 100 0 200 400 600 800 1000 m

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CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY
WASTE DEPOSITION STRATEGY
TYPICAL SECTIONS (YEARS 1, 4, 10 and 22)

Knight Piésold CONSULTING

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FIGURE 5.6 | REV 0

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5.2 DESIGN BASIS AND ASSUMPTIONS

Mining of the open pit will yield approximately 965 million tonnes of ore (789 million tonnes of direct feed mill ore, 32 million tonnes of Supergene Oxide ore and 144 million tonnes of Low Grade ore). The mill will operate at a nominal mill throughput of approximately 125,000 tonnes per day of ore. The total estimated tonnage of tailings solids over the 22 year operating life of the mine is approximately 956 million tonnes, assuming an average one percent concentrate recovery during ore processing. Approximately 20% of the mill tailings will consist of PAG material and will be managed separately.

It is assumed that the NAG tailings (80% of the tailings total) will be passed through a cyclone station for approximately nine months of each year (on average) to produce suitable cycloned sand for embankment construction. Cyclone operations will likely not be possible for a portion of the year due to freezing temperatures in the winter. The cyclone sand plant is assumed to have 90% availability over the 9 month period. A required design criterion for the cyclone plant sand product is that the fines content (% passing a #200 sieve) must be 12% or less. The quantity of cyclone sand used in embankment construction is approximately 221 million tonnes. It is estimated that 50% of the NAG tailings can be recovered as cyclone sand when the cyclone station is operating. This amounts to approximately 7.2 to 7.5 million m^3 (12 to 12.5 million tonnes) of cyclone sand fill material produced annually, except for Years 1 and 22. For estimating cyclone sand fill requirements for embankment construction a conservative average in situ dry density of 1.65 tonne/m^3 was assumed for compacted fill. Typical values for compacted cyclone sand fill are in the range of 1.6 to 1.65 tonne/m^3.

A total of 658 million tonnes of mine waste materials will be mined from the open pit. The results of waste characterization studies completed by Others indicate that almost all of the waste rock is potentially reactive material (based on the mining schedule issued by CMC on November 1, 2012). This potentially reactive material made up of PAG and Metal Leaching (ML) waste rock and overburden will be stored subaqueously within the proposed TMF in a Waste Storage Area located in the upper (northern) region of the TMF basin.

The TMF has been sized to provide sufficient capacity to store approximately 956 Mt of tailings (including cyclone sand tailings used as embankment fill) and co-disposal of up to 658 million tonnes of potentially reactive waste rock and overburden materials. Approximately 221 million tonnes of NAG tailings will be used as cyclone sand fill for embankment construction. The remaining 735 million tonnes of tailings (544 million tonnes of bulk NAG tailings and NAG cyclone overflow, plus 191 million tonnes of PAG tailings) will report to the TMF as slurry for permanent storage.

For development of the TMF filling schedule, a tailings dry density of 1.2 t/m³ was assumed during the first three years of production, 1.3 t/m³ in Year 4 and 1.4 t/m³ for Years 5 to 22 (end of operations). These values were based on predicted average dry density values provided by tailings consolidation modelling incorporating the consolidation characteristics of the tailings (see Section 5.9). The average dry density is predicted to increase gradually to approximately 1.5 tonne/m^3 by the end of operations. However, a conservative lower value of 1.4 tonne/m^3 was adopted for determining the capacity requirements of the TMF. The depth-area-capacity relationship and filling schedule for the TMF are shown on Figures 5.7 and 5.8, respectively.

Each stage of TMF development has been sized to store tailings (based on the mine production schedule), together with potentially reactive waste rock from the open pit and a supernatant water

pond. Additional capacity is also provided for storm water storage for the inflow design flood event (see Section 5.3.1) and an allowance of two additional metres of embankment freeboard for wave run-up protection.

A summary of the design basis and operating criteria for the TMF is given in Table 5.1.

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TABLE 5.1

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SUMMARY OF DESIGN BASIS AND OPERATING CRITERIA

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ITEM	DESIGN CRITERIA
1.0 GENERAL	
Site Coordinates	613,000 E 6,955,000 N (WGS84/NAD83) Zone 7
Climate	• Estimated Mean Annual Precipitation = 510 mm • Estimated Effective Runoff Coefficient = 0.4 • Estimated Mean Annual Temperature = -2.9 °C at 1200 m elevation. • Average Annual Lake Evaporation = 300 mm
Hazard Classification Consequence Category	• **HIGH**, as defined by the Canadian Dam Association (CDA) "Dam Safety Guidelines" (2007)
Design Flood	• Inflow Design Flood (IDF) up to and including Year 1 = 1,000 years event for 72 hour storm duration. • Inflow Design Flood (IDF) during operations = "one third between 1,000 years and the Probable Maximum Flood (PMF) event for 72 hour storm duration" • Inflow Design Flood (IDF) for closure = Probable Maximum Flood (PMF) event for 24 hour storm duration
Seismic Design[(2)]	• Operating Basis Earthquake (OBE) = 1/500 ◦ Mean maximum firm ground acceleration = 0.08 g, Magnitude = 8.0 • Maximum Design Earthquake (MDE) = 1/2,500 ◦ Mean maximum firm ground acceleration = 0.13 g, Magnitude = 8.0
2.0 PRODUCTION	
Mine Production	• Total Ore Milled = 965.2 Million tonnes (Mt) • Nominal Throughput = Approximately 125,000 tpd • Mine Life = 22 years • Average Stripping Ratio = 0.7 (Waste:Ore) • Concentrate = 1.0 %
Tailings	• Total tailings = 955.6 Mt • Bulk tailings specific gravity = 2.70 t/m^3 • Two tailings streams (55% solids by weight) ◦ 80% Non Acid Generating (NAG) tailings (764.5 Mt) ◦ 20% Potentially Acid Generating (PAG) tailings (191.1 Mt) • Tailings stored in impoundment = 734.3 Mt • NAG tailings specific gravity = 2.7 t/m^3 • PAG tailings specific gravity = 3.0 t/m^3 • 1.2 t/m^3 - in situ average dry density for Years 1, 2 and 3 • 1.3 t/m^3 - in situ average dry density for Year 4 • 1.4 t/m^3 - in situ average dry density for Years 5 to 22
Cyclone Sand	• Cycloning of NAG tailings only. • Approximately 50% of NAG tailings solids assumed to be produced by cyclone plant as sand fill suitable for embankment construction (based on expected tailings particle size distribution). • Cyclone sand production for average 9 months per year. • Cyclone sand production begins at start of Year 1. • Cyclone plant availability is 90%, during 9 months per year. • Cyclone sand material produced = 221.3 Mt • Cyclone sand product has no more than 12% fines (silt/clay fraction) • Compacted cyclone sand average dry density = 1.65 t/m^3 • Cyclone Overflow solids content = 24% • Cyclone Underflow solids content (undiluted) = 74% • Cyclone Underflow solids content (diluted for discharge) = 65%
Mine Waste Rock and Overburden	• Total waste material = 657.9 Mt (stored in TMF impoundment) • Total Hypogene waste material produced = 241.9 Mt • Total Supergene waste material produced (overburden, leach cap, supergene sulfide and supergene oxide) = 414.7 Mt • Total Unclassified waste material produced = 1.3 Mt • Waste material produced from Pre-Production to Year 19 • Subaqueous disposal within TMF • 2.0 t/m^3 - in situ average density (estimated) • Approximately 2 Mt of non reactive waste material available during pre-production.

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TABLE 5.1

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SUMMARY OF DESIGN BASIS AND OPERATING CRITERIA

3.0 WATER MANAGEMENT	
Site Water Management Priorities During Operations	• Maximum recycle to mill circuit. • Collect and recycle runoff from mine affected areas including open pit, plant site, heap leach facility, ore stockpiles, and tailings management facility. • Minimum TMF pond volume of 15 Mm^3 required (3 months of process water supply). • Project water supply (design by Others)
4.1 TAILINGS FACILITY EMBANKMENTS	
Embankment Crest Width	• 30 m
Design Freeboard	• Sufficient freeboard to accommodate Inflow Design Flood above maximum supernatant pond level at each stage plus 2 m allowance for wave run-up.
Construction Schedule	• Staged centreline construction ◦ Starter Embankment for 1 year of tailings storage and waste rock storage ◦ Final Embankment for 22 years of tailings and reactive waste rock storage
Construction Materials	• Overburden and/or non-reactive waste rock from open pit and borrow sources, and cyclone sand.
Water Management System & Monitoring Measures	• Embankment keyed into native overburden foundation • Seepage collection systems include: ◦ Embankment under-drains; ◦ Surface ditching system; ◦ Water management pond; and ◦ Groundwater monitoring wells (if required).
Stability Analyses	• The minimum acceptable factors of safety based on the CDA "Dam Safety Guidelines" (2007) are as follows: ◦ During construction 1.3 ◦ Long term (post closure) 1.5 ◦ Post-earthquake (full liquefaction of tailings assumed) 1.2
4.2 TAILINGS BASIN	
Geological and Geotechnical Conditions	• Previous data reports
Surface Soil Salvage and Stockpiles	• Topsoil from embankment foundation preparation will be stockpiled for reclamation. • Low grade ore stockpiled during operations ◦ Maximum size = 143.8 Mt • Supergene Oxide ore stockpiled during operations ◦ Maximum size = 32.4 Mt • Gold Ore stockpiled during operations (to Heap Leach Facility) ◦ Maximum size = 39.4 Mt
5.0 CLOSURE REQUIREMENTS	
General	• Saturated storage of potentially reactive mine waste rock and overburden. • Concurrent reclamation of disturbed areas conducted where possible. • TMF reclamation to include for revegetation of exposed embankments. • Remove all pipeworks, pump stations and surface structures. • Decommission and reclaim all non-essential access roads and diversion ditches. • Stockpiles topsoil and overburden required for reclamation of the tailings beach and downstream slope of the TMF embankment. • Closure spillway to pass 24 hr PMF event.

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\Tables\[Table 5.1 Rev 0 - TMF Design Basis.xlsx]Table 5.1

NOTES:

1. MINE SCHEDULE PROVIDED BY CASINO MINING CORPORATION (VERSION SCHED01NOV2012).
2. FOR A MEASURE OF ROBUSTNESS, ADDITIONAL STABILITY CALCULATIONS HAVE BEEN PERFORMED USING THE 1/10,000 EARTHQUAKE WITH MEAN MAXIMUM FIRM GROUND ACCELERATION OF 0.22g.

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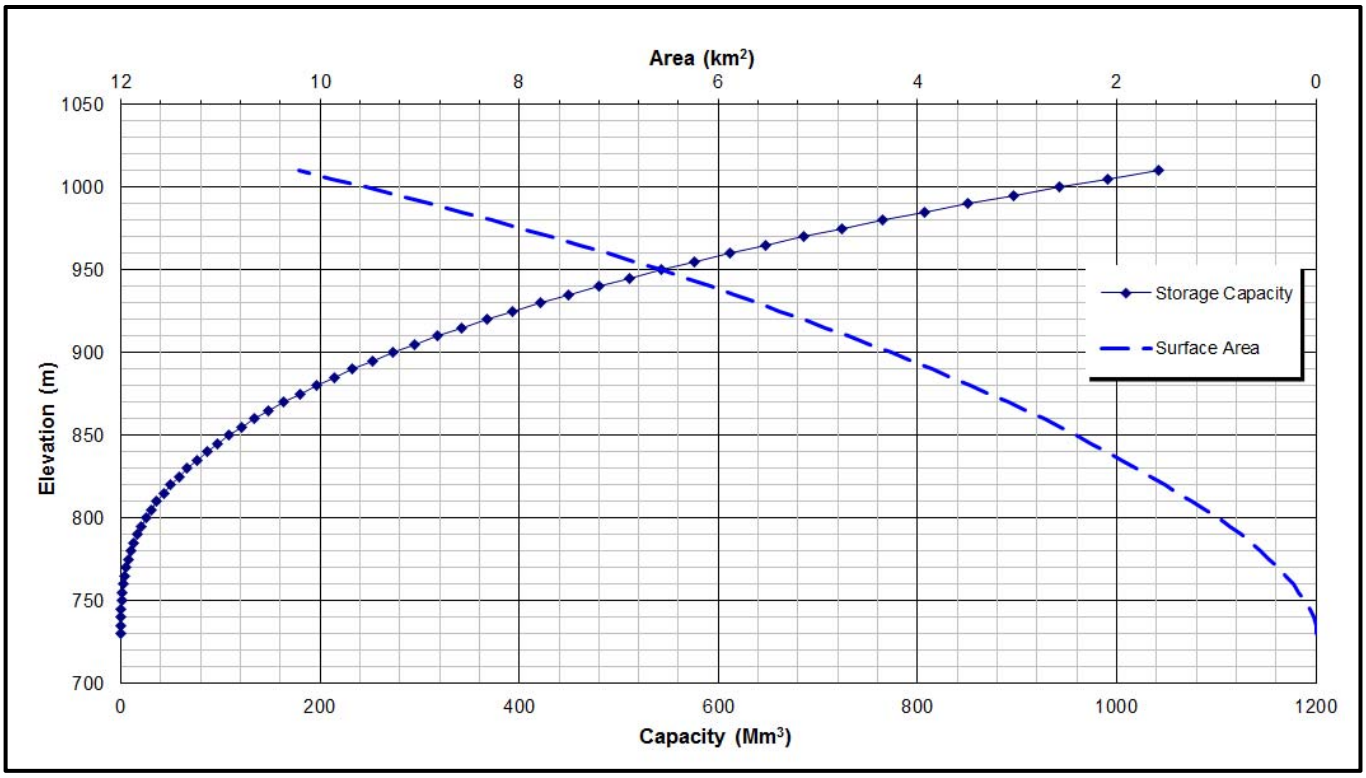


Figure 5.7 Tailings Management Facility – Depth-Area-Capacity Curves

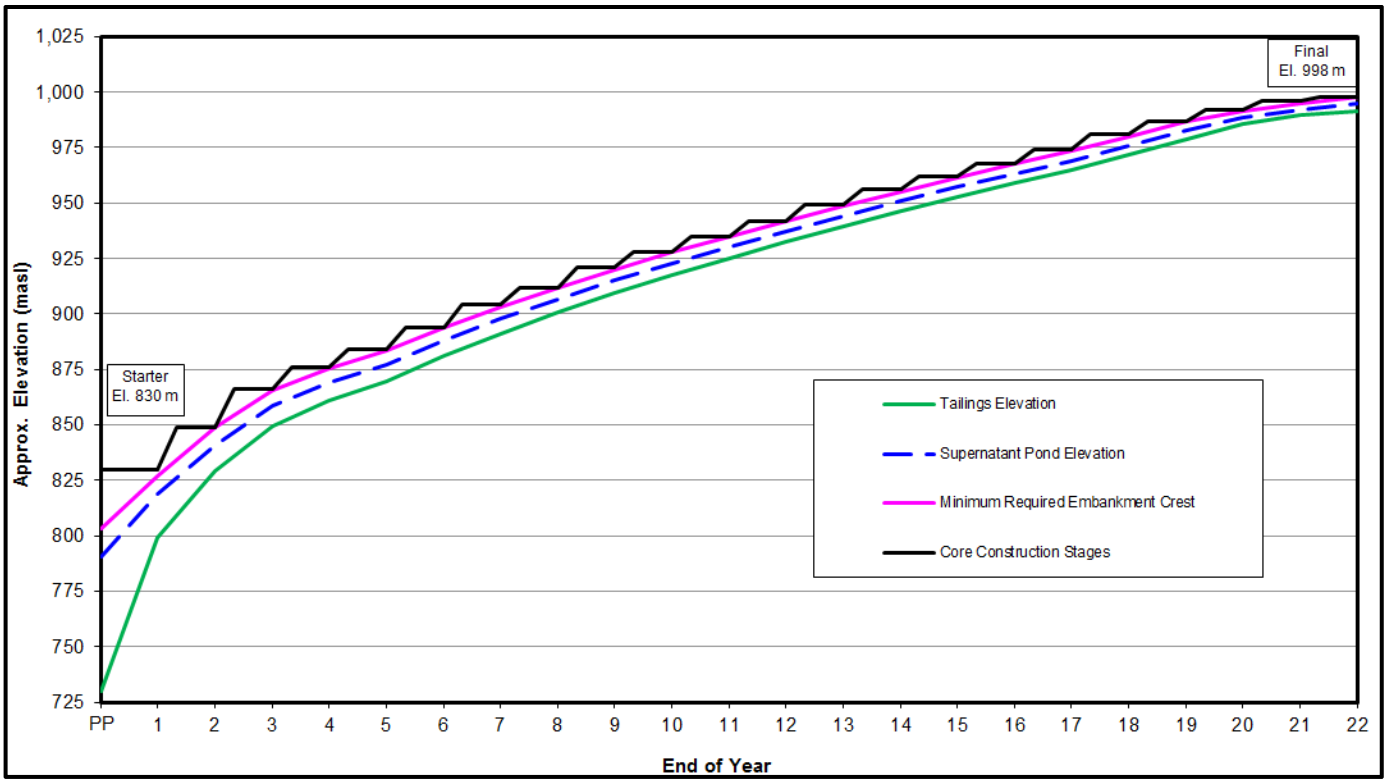


Figure 5.8 Tailings Management Facility – Production and Filling Schedule Curves

NOTES:

1. The filling schedule accounts for 734.3 Mt of tailings and 657.9 Mt of waste rock.
2. The average dry density of the tailings is assumed to be 1.2 t/m^3 in the first three years of production, 1.3 t/m^3 in Year 4 and 1.4 t/m^3 from Year 5 to end of mine life.
3. Compacted cycloned sand dry density assumed to be 1.65 t/m^3.
3. Nominal ore production is approximately 125,000 tpd.
4. Minimum required embankment crest includes freeboard to accommodate Inflow Design Flood (IDF) and two metres for wave run-up protection.
5. Tailings and waste rock modelled as a horizontal surface.
6. Waste rock average dry density assumed to be 2.0 t/m^3.
7. Core zone construction period assumed to be 4 months per year.

5.3 DAM CLASSIFICATION

A preliminary dam classification has been carried out to enable appropriate design earthquake and flood events to be determined for the TMF. The selection of appropriate design earthquake and flood events has been based on classification of the tailings dam using criteria provided by the Canadian Dam Association's (CDA) "Dam Safety Guidelines" (2007), shown in Table 5.2.

Table 5.2 Dam Classification

Dam Class	Population at Risk[1]	Incremental Losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	Zero	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities; seasonal workplaces, and infrequently used for transportation services
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

NOTES:

1. Definitions for population risk:
   None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
   Temporary – People are only temporarily in the dam-breach inundation zone (e.g. seasonal cottage use, passing through on transportation routes, participating in recreational activities).
   Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g. as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).
2. Implications for loss of life:
   Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Classification of a tailings dam is carried out by considering the potential incremental consequences of a failure. The incremental consequences of failure are defined by the CDA as *"the total damage from an event with dam failure minus the damage that would have resulted from the same event had*

the dam not failed." The consequences of failure considered include loss of life, environmental and cultural impacts and losses, and economic loss.

There is no permanent population at risk downstream of the TMF. The potential for loss of life from a dam failure is likely minor but cannot be discounted, particularly during operations when there will be work activities in the waste storage area and intermittently in areas downstream of the TMF. The economic consequences (including clean-up, repair and remedial works) would also be high.

The environmental impact on downstream watercourses has the potential to be significant if a failure resulted in the release of tailings and/or process water into Casino Creek. An uncontrolled release into Casino Creek may flow into Dip Creek and potentially to the Yukon River by way of the Klotassin, Donjek and White Rivers. Fish species present in Casino Creek include Arctic Grayling, Burbot, and Slimy Sculpin. In addition to these species, Round Whitefish have been observed, and Chinook Salmon are likely present in Dip Creek. The fish species present are all currently listed as 'Unthreatened' under the Species at Risk Act and are widespread in the region, as is rearing habitat. Based on the methodology presented by Eagen and Greenaway (2010, 2011) and the results of environmental baseline studies, the environmental consequences of a dam failure would be defined as HIGH, based on the classification criteria provided by the CDA Guidelines.

Consequently, a HIGH dam classification has been assigned to the TMF. This dam classification should be reviewed for future design studies and revised if appropriate.

5.3.1 Design Flood Event

Selection of an appropriate Inflow Design Flood (IDF) is required to carry out a safety assessment of the TMF and to determine storm storage requirements. The size of the IDF is dependent on the dam classification, as shown in Table 5.3. Based on the HIGH dam classification assigned to the TMF, an appropriate IDF is an event equal to "one third between 1,000 years and the Probable Maximum Flood (PMF)" event. For closure of the TMF the IDF has been defined as the PMF.

During operations there is no spillway to pass flood waters from the TMF. Therefore, the IDF has been defined using 72-hour 1:1,000 and PMF events. However, for the short-term Stage I TMF (pre-production and Year 1 of operations) the 72-hour 1:1,000 year event was adopted. This reduced IDF has been implemented in the TMF design so that it remains sufficiently large, but not so conservative that it would result in a Stage I embankment that is excessively oversized. A spillway will be constructed at the end of operations for closure water management. Accordingly, the IDF for closure has been defined as the PMF associated with the 24-hour maximum precipitation event.

The Hershfield (1977) method was used to estimate the probable maximum precipitation (PMP) and 1:1,000 year return period rainfall event values based on the 24-hour maximum precipitation data available in the Rainfall Frequency Atlas for Canada (RFAC) (Hogg and Carr, 1985). The 72-hour PMP and 1:1,000 year rainfall depths were estimated by scaling the 24-hour values by ratios of 1.6 and 1.3, respectively, based on measured depth-duration values developed by the National Oceanic and Atmospheric Administration (NOAA, 1999). The resulting 24-hour and 72-hour rainfall depths for the project area are summarized below:

- 24-hour 1:1,000 year rainfall depth = 66 mm
- 72-hour 1:1,000 year rainfall depth = 85 mm
- 24-hour PMP depth = 159 mm, and

- 72- hour PMP depth = 255 mm.

Potential snowmelt during an extreme rainfall event has to be taken into consideration when estimating the resulting flood event. The snowpack present during the IDF was assumed to be equivalent to a 1:100 year snowpack of 256 mm, based on fitting the annual average maximum snowpack (140 mm) and standard deviation (36.9 mm) to a Gumbel distribution. The derivation of the annual average snowpack and 24-hour rainfall depths are presented in KPL report "Updated Hydrometeorology Report" (Ref. No. VA101-325/8-11, July 9, 2012).

The potential snowmelt that could occur in conjunction with the 24-hour 1:1,000 year rainfall or PMP event was then estimated by applying a formula that considered how much snow would melt given a maximum daily temperature of 15 degrees Celsius and a wind speed of 8 m/s (Coulson, 1991). The highest potential snowmelt for the 24-hour rainfall events, assuming a clear catchment with no trees, is:

- 24-hour PMP snowmelt = 156 mm, and
- 24-hour 1:1,000 year snowmelt = 138 mm.

The additional snowmelt that would occur over the subsequent 24 hour periods for a 72-hour event was estimated based on the proportion of rain that is assumed to fall in the second and third 24-hour periods of a 72-hour event. For the 72-hour 1:1,000 year rainfall and PMP events, the total potential snowmelt was predicted to be 393 mm and 425 mm, respectively. However, the snowmelt is limited by the assumed available snowpack of 256 mm (equivalent to the 1:100 year snowpack); accordingly it was assumed that all of the available snowpack would melt during the IDF event. Furthermore, the IDF volume is typically applied to the maximum TMF pond volume in a given year, which generally occurs during the freshet months when the snowpack is melting. Since the maximum TMF pond volume already accounts for snowmelt of the average annual maximum snowpack (140 mm), this depth was then subtracted from estimated potential snowmelt of 256 mm, resulting in an estimated 116 mm of snowmelt contributing to the IDF storage volume requirements.

The resulting total potential runoff depth from a combined return period rainfall event and snowmelt for the 24-hour and 72-hour events are:

- 72-hour 1:1,000 year total runoff depth = 201 mm
- 24-hour PMP total runoff depth = 175 mm, and
- 72-hour PMP total runoff depth = 371 mm.

The total runoff depths were applied to the inflow catchment area of the TMF of 35 km^2. This results in an IDF flood volume of 7.0 million m^3 for the 72-hour 1,000 year event used for Stage I (Pre-production and Year 1), 9.0 million m^3 for the 72-hour one third value between the 1,000 year and PMF event used for the remainder of TMF operations, and 6.1 million m^3 for the 24-hour PMF event used for the TMF at closure, once the spillway is operational.

The design of the TMF embankments includes storm storage volume requirements for the IDF above the operating supernatant pond elevation, plus an additional two metres for wave run-up protection.

5.3.2 Design Earthquakes

Consistent with the current design philosophy for geotechnical structures such as dams, two levels of design earthquake have been considered: the Operating Basis Earthquake (OBE) for normal operations, and the Maximum Design Earthquake (MDE) for extreme conditions (ICOLD, 1995).

Values of Peak Ground Acceleration (PGA) and design earthquake magnitude have been determined for both the OBE and MDE.

The OBE is usually selected from the results of a probabilistic hazard evaluation. The hazard level selected for the OBE is often chosen as the earthquake with a 10% probability of exceedance in 50 years (with a corresponding return period of about 500 years). For design of the TMF, the OBE has been taken as the 1 in 500 year return period event. The probability of exceedance for this event is only 4% for a 22 year operating period. The corresponding median PGA for this event is 0.07g. However, for geotechnical structures it is recommended that the mean average PGA value be used for design (CDA Dam Safety Guidelines, 2007). The mean PGA is likely to be approximately 15 to 20 percent greater than the median value, giving an estimated value of 0.08g. A design earthquake magnitude of 8.0 has been selected for the OBE, based on a review of regional tectonics and historical seismicity. The TMF would be expected to function in a normal manner after the OBE.

An appropriate MDE for embankment design has been selected, based on the HIGH dam classification defined for the TMF and the criteria for design earthquakes provided by the Canadian Dam Association's (CDA) "Dam Safety Guidelines" (2007), and presented in Table 5.3. The CDA Guidelines require that a HIGH dam classification be designed for a probabilistically derived event (defined as the Earthquake Design Ground Motion) having an annual exceedance probability (AEP) of 1/2,500. Consequently, the MDE selected for the TMF is the 1 in 2,500 year earthquake. The median PGA is 0.11g for the 1 in 2,500 year earthquake. The corresponding mean average PGA used for design is estimated to be 0.13g. A design earthquake magnitude of 8.0 has been selected for the MDE, based on a review of regional tectonics and historical seismicity. Limited deformation of the tailings embankment is acceptable under seismic loading from the MDE, provided that the overall stability and integrity of the TMF is maintained and that there is no release of stored tailings or water (ICOLD, 1995).

To demonstrate the robustness of the embankment design to seismic loading the 1 in 10,000 year earthquake has also been considered. The mean PGA for the 1 in 10,000 year event is 0.22g.

Table 5.3 Suggested Design Flood and Earthquake Levels

Dam Class	Annual Exceedance Probability (AEP)	
	Inflow Design Flood (IDF)[1]	Earthquake Design Ground Motion (EDGM)[3]
Low	1/100	1/500
Significant	Between 1/100 and 1/1,000[4]	1/1,000
High	1/3 between 1/1,000 and Probable Maximum Flood[5]	1/2,500[6]
Very High	2/3 between 1/1,000 and Probable Maximum Flood[5]	1/5,000[6]
Extreme	Probable Maximum Flood (PMF)[6]	1/10,000

NOTES:

1. As defined in Table 5.2 – Dam Classification.
2. Extrapolation of flood statistics beyond 1/1,000 year flood (10^{-3} AEP) is discouraged.
3. AEP levels for EDGM are to be used for mean rather than median estimates for the hazard.
4. Selected on the basis of incremental flood analysis, exposure, and consequence of failure.
5. PMF has no associated AEP. The flood defined as "1/3 between 1/1,000 year and PMF" or "2/3 between 1/1,000 year and PMF" has no defined AEP.
6. The EDGM value must be adjusted to demonstrate conformance to societal norms of acceptable risk. Justification can be provided with the help of failure modes analysis focused on the particular modes that can contribute to failure initiated by a seismic event. If justification cannot be provided, the EDGM should be 1/10,000.

5.4 LAYOUT AND OPERATING STRATEGY

5.4.1 General

Tailings and potentially reactive waste rock and overburden will be deposited in an impoundment located in the Casino Creek valley southeast from the open pit. Specific overall features of the TMF are illustrated on Figures 5.1 to 5.6 and are listed below:

- Two earth-rockfill-cyclone sand, zoned embankments, referred to as the Main Embankment and West Saddle Embankment
- Cyclone sand plant
- Tailings distribution pipelines – bulk NAG tailings, PAG tailings, cyclone sand, cyclone overflow (fines)
- Two separate reclaim water systems – mill and cyclone plant
- Waste Storage Area – for potentially reactive waste rock and overburden
- Supernatant (surface water) pond, and
- Water Management system – seepage collection ditches and pond, and seepage recycle system.

5.4.2 Confining Embankments

The Main Embankment will be developed in stages throughout the life of the TMF using a combination of suitable non-reactive earth and rock fill borrow materials and cyclone sand.

The Main Embankment will be expanded in stages across the Casino Creek valley. The Stage IA (Starter) embankment is designed to store runoff as a source for mill start-up water and accommodate tailings and potentially reactive waste rock and overburden production for approximately one year of initial operations. Cyclone sand production in Year 1 of operations will be used to extend the downstream shell of the Main Embankment (Stage IB), allowing the dam crest

and core zone to be raised after about 1 year. Ongoing raises will comprise centreline raises with a vertical low permeability core zone and adjacent downstream filter zones. Cyclone sand will be produced from bulk NAG tailings at the Cyclone Plant and discharged into the cyclone sand shell zones (upstream and downstream of the core zone) where it will be spread in cells and compacted using bulldozers. Bulk tailings that bypass the Cyclone Plant and cyclone overflow (fines) produced during cycloning operations will be discharged into the impoundment.

The alignment of the Main Embankment has been revised since previous studies to take advantage of topographic features (based on the latest site topographic data). The alignment has been revised to minimize the size of the Stage I embankment, reduce seepage flows from the TMF and minimize the volume of colluvial apron material requiring excavation in the embankment footprint.

The West Saddle Embankment will be constructed at the south-western corner of the TMF (as shown on Figures 5.1 to 5.5), and is required at the start of operations to provide a pipeline corridor at a suitable grade for tailings delivery to the cyclone sand plant and the TMF. The embankment will be developed in pre-production years using suitable non-reactive earth and rockfill from local borrow sources.

5.4.3 Water Management

The Stage IA (Starter) Main Embankment will be constructed in pre-production years, with construction scheduled to provide enough time to impound sufficient surface water runoff for mill start-up. It is assumed that a start-up water pond of approximately 15 million m^3 is required, corresponding to about 3 months of mill water requirements. Mill process water for ongoing operations and water for cyclone plant operations will be reclaimed from the TMF supernatant pond.

A monthly operational mine site water balance, incorporating stochastic analysis for climate conditions, indicates that the TMF will be in a water deficit condition for the majority of the mine operating life. To satisfy mill requirements a make-up water supply system will be required, and has been design by Others.

Design provisions to minimize seepage losses from the TMF include the installation of a seepage cut-off beneath the Main Embankment and West Saddle Embankment, a low permeability blanket beneath the Stage I embankment, a seepage interception and recovery system and contingency measures for groundwater recovery and recycle.

Seepage water from the TMF will be collected by a Water Management System, which consists of an under-drain system and a surface ditch system which both discharge into a water management pond located downstream of the Main Embankment. Seepage collected in the pond will be pumped back into the TMF. The Water Management System has been designed to accommodate seepage through the TMF embankments, water recovered from cyclone sand embankment construction and surface runoff.

The water balance model developed for the TMF indicates that there will be a water surplus at closure. A spillway will be provided at closure to facilitate control and discharge of excess water accumulation within the TMF and to provide safe passage of storm water volumes from the TMF.

5.4.4 Tailings Distribution

Three distinct tailings streams will discharge into the TMF:

- PAG tailings – 12 months of the year,
- Bulk NAG tailings – approximately three months of the year plus any periods when the cyclone plant is not operating, and
- Cyclone overflow (fine fraction of bulk NAG tailings) – approximately nine months of the year.

It is assumed that approximately 80% of the tailings will be geochemically innocuous NAG material, following the removal of the pyrite component. The discharge of bulk NAG tailings and cyclone overflow will be from valved offtakes located along the Main Embankment and from the West Saddle Embankment. The coarser fraction of the discharged tailings will settle rapidly, tending to accumulate closer to the discharge points and forming a beach slope. Finer tailings particles will travel farther and settle at a flatter slope beneath the supernatant pond. Deposition will be developed and managed, with the intent to maximize storage efficiency in the TMF and to maintain the deeper, cleaner locations of the supernatant pond in the vicinity of the reclaim barges. Schematic development plans for tailings discharge are included on Figures 5.2 to 5.5, for Years 1, 4, 10 and 22 of operations respectively.

Approximately 20% of the total tailings will be PAG tailings. The PAG tailings deposit will be developed in a separate central region of the TMF by discharging the tailings from the north-western side of the TMF, close to the WSA. The discharge point will be relocated frequently throughout operations to manage the deposition of the PAG tailings and to accommodate raises of the WSA. Deposition in this area will keep the PAG tailings between the WSA and NAG tailings deposit, remote from the confining embankments. This will minimise seepage from the PAG tailings and ensure that they remain in a subaqueous state.

Unsuitable colluvial apron material excavated from the footprint of the Main Embankment will be placed upstream within the TMF basin. This material can be placed in a location to provide a simple barrier between the initial zones of PAG and NAG tailings deposition. This will ensure PAG tailings deposited in the initial months of TMF operations will not flow towards the Main Embankment prior to establishment of a NAG tailings beach area.

A flat surface profile for deposited tailings solids has been assumed for capacity considerations. Detailed design studies should evaluate the potential impact of sloping sub-aerial and sub-aqueous beach areas. Consideration of tailings beach configurations may result in modifications to staged embankment heights and the tailings deposition strategy.

5.4.5 Waste Storage Area

Potentially reactive waste rock and overburden will be hauled to the TMF for co-disposal with tailings and submergence by tailings and the supernatant pond. The Waste Storage Area (WSA) will be developed in the northern section of the TMF impoundment area, upstream of the PAG tailings deposit. Development of the waste storage area has been designed in step with the mine production schedule presented in Table 5.4. It will be developed at the same or similar rate of rise as the tailings but will be several meters higher to provide a dry, stable placement surface. The ongoing maximum elevation of the WSA will be maintained at an elevation above the flood level of the supernatant pond (defined by the IDF event).

Waste rock delivery to the WSA is complete in Year 19. By the end of operations the WSA will be submerged below tailings (from the processing of Low Grade ore) and supernatant pond water,

ensuring long-term subaqueous containment for closure. The operational water balance developed for the TMF (see Section 6.0 and Appendix D) indicates that the WSA will be completely covered by the supernatant pond in Year 20, approximately one year following the end of waste rock deposition. Based on the present mine production schedule and development strategy, approximately three years of tailings deposition will occur after final placement of potentially reactive waste rock. This will result in a thin layer of tailings over the top of the WSA (approximately 3 metres thick). The depth of the final supernatant pond overlying the WSA and tailings is estimated to be approximately 4 metres deep.

Schematic development of the WSA during TMF operations is included on Figures 5.1 to 5.5, for Years -1 (pre-production), 1, 4, 10 and 22 of operations respectively.

In the case of a premature mine closure, a portion of the WSA may need to be excavated to an elevation below the natural pond elevation in the TMF. This would be required to ensure potentially reactive waste materials will be maintained in a saturated state with a sufficient minimum pond cover (2 metres).

Additional information on the development and operation of the WSA and a stability assessment are provided in the KPL report ““Waste Storage Area and Stockpiles Feasibility Design” (Ref. No. VA101-325/8-12, December, 2012).

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TABLE 5.4

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
TAILINGS AND WASTE PRODUCTION SCHEDULE

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YEAR	ORE TO MILL				CONCENTRATE	TAILINGS		WASTE MATERIAL			
	Direct Feed	Ore Stockpiles		Total	Concentrate	NAG	PAG	Hypogene	Supergene	Unclassified Waste	Total Waste
		Low Grade	Supergene Oxide								
	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes
PP	0	0	0	0	0	0	0	0	9,470,000	210,000	9,680,000
1	34,500,000	0	0	34,500,000	345,000	27,324,000	6,831,000	5,000	22,429,000	78,000	22,512,000
2	45,928,000	0	0	45,928,000	459,280	36,374,976	9,093,744	159,000	29,031,000	116,000	29,306,000
3	45,814,000	0	0	45,814,000	458,140	36,284,688	9,071,172	943,000	36,757,000	211,000	37,911,000
4	42,056,000	0	3,600,000	45,656,000	456,560	36,159,552	9,039,888	573,000	38,759,000	31,000	39,363,000
5	41,653,000	0	3,600,000	45,253,000	452,530	35,840,376	8,960,094	10,690,000	30,585,000	64,000	41,339,000
6	41,605,000	0	3,600,000	45,205,000	452,050	35,802,360	8,950,590	14,096,000	20,972,000	21,000	35,089,000
7	41,576,000	0	3,600,000	45,176,000	451,760	35,779,392	8,944,848	10,579,000	27,036,000	64,000	37,679,000
8	42,145,000	0	3,600,000	45,745,000	457,450	36,230,040	9,057,510	12,401,000	25,529,000	39,000	37,969,000
9	42,491,000	0	3,600,000	46,091,000	460,910	36,504,072	9,126,018	8,952,000	26,680,000	226,000	35,858,000
10	41,175,000	0	3,600,000	44,775,000	447,750	35,461,800	8,865,450	6,369,000	28,591,000	55,000	35,015,000
11	41,095,000	0	3,600,000	44,695,000	446,950	35,398,440	8,849,610	7,931,000	44,635,000	132,000	52,698,000
12	42,251,000	0	3,610,000	45,861,000	458,610	36,321,912	9,080,478	15,273,000	32,380,000	10,000	47,663,000
13	46,249,000	0	0	46,249,000	462,490	36,629,208	9,157,302	20,341,000	23,455,000	1,000	43,797,000
14	45,798,000	0	0	45,798,000	457,980	36,272,016	9,068,004	31,372,000	11,413,000	0	42,785,000
15	45,187,000	0	0	45,187,000	451,870	35,788,104	8,947,026	31,379,000	6,445,000	5,000	37,829,000
16	45,064,000	0	0	45,064,000	450,640	35,690,688	8,922,672	37,370,000	563,000	1,000	37,934,000
17	44,772,000	0	0	44,772,000	447,720	35,459,424	8,864,856	20,242,000	0	0	20,242,000
18	44,934,000	0	0	44,934,000	449,340	35,587,728	8,896,932	8,266,000	0	0	8,266,000
19	14,676,000	30,915,000	0	45,591,000	455,910	36,108,072	9,027,018	4,932,000	0	0	4,932,000
20	0	45,053,000	0	45,053,000	450,530	35,681,976	8,920,494	0	0	0	0
21	0	44,985,000	0	44,985,000	449,850	35,628,120	8,907,030	0	0	0	0
22	0	22,875,000	0	22,875,000	228,750	18,117,000	4,529,250	0	0	0	0
TOTALS	788,969,000	143,828,000	32,410,000	965,207,000	9,652,070	764,443,944	191,110,986	241,873,000	414,730,000	1,264,000	657,867,000

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\Tables\[Table 5.4 Rev 0 - Tailings and Waste Production Schedule.xlsx]Table 5.4

NOTES:

1. MINE SCHEDULE PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 01, 2012).
2. PP = PRE-PRODUCTION YEARS -3, -2 AND -1.
3. CONCENTRATE ASSUMED TO BE 1% OF MILL FEED.
4. POTENTIALLY ACID GENERATING (PAG) TAILINGS ASSUMED TO BE 20% OF TOTAL TAILING; NON-ACID GENERATING (NAG) TAILINGS ASSUMED TO BE 80% OF TOTAL TAILINGS.
5. APPROXIMATELY 2 Million Tonnes OF WASTE MATERIAL IS NON-ACID GENERATING AND BECOMES AVAILABLE DURING PRE-PRODUCTION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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5.5 CYCLONE SAND DESIGN CONSIDERATIONS

Numerous large cyclone sand embankments are utilized at mining operations in many regions of the world, including Anglo's Los Bronces mine, Southern Peru Copper's Quebrada Honda mine, and the Los Quillayes tailings impoundment operated by Minera Los Pelambres in Chile. Several large cyclone sand dams have been constructed to dam heights in the range of approximately 150 m to 200+ m and are often located in seismically active areas. The Los Quillayes tailings dam was constructed with cyclone sand to a maximum height of 198 m. The Mauro cyclone sand dam at the Los Pelambres mine was constructed to a height of 248 m in a region of high seismicity.

The particle size distribution of the Casino mill tailings is a key consideration for determining the suitability of the bulk NAG tailings to provide cyclone sand of suitable quality and in sufficient quantity. Coarser tailings are preferred, as a higher sand fraction or 'split' can be realized. Clean sand with sufficiently low fines content (% passing a #200 sieve) will be required for placement, in order to facilitate rapid drainage and subsequent compaction. The anticipated particle size distribution of the Casino tailings (see Section 2.2 and Figure 2.1) is well within the range of tailings particle size distributions that have been successfully cycloned at other tailings operations.

Experience from existing cyclone sand dams indicates that the sand fill should have an in situ permeability equal to or greater than 2×10^{-4} cm/s (Barrera, Valenzuela and Campana, 2011). This will ensure the rapid drainage of construction water (following cyclone sand placement), seepage water and direct precipitation. It is typical to present specifications limiting the fines content of the cyclone sand. For copper tailings a fines content in the range of 15 and 20 percent typically provides sufficient permeability for sand drainage. This criterion continues to be valid provided the sand grain size is not significantly changed by particle crushing, due to very large confining pressures imposed by dams of large height. Chilean experience for large copper cyclone sand tailings dams indicates that large confining pressures do not significantly affect the sand grain size. However, this may not be valid for tailings with a different mineralogy. Therefore, for large cyclone sand dams it is prudent to conduct permeability tests at large confining pressures to simulate the behavior of the material.

Permeability testing has been conducted on a laboratory generated sample of cyclone underflow (cyclone sand), as discussed in Section 2.2. The results of the permeability tests did not indicate any evidence of particle crushing and measured permeability values were greater than 2×10^{-4} cm/s, even at very high confining pressures.

From consideration of the large height and size of the Main Embankment it is recommended that the fines content of the cyclone sand be less than 15%, in order to maximize fill placement rates and to ensure adequate compaction, strength and drainage. A maximum fines content of 12% has been adopted for the Feasibility design. There may be an opportunity to increase the fines content a few percent to allow increased sand quantities, based on actual performance during operations and material characteristics (permeability and strength) of the cyclone sand. The potential to provide more sand fill material will allow increased operating flexibility related to construction activities.

The large embankment height associated with the Main Embankment limits the sand placement options and likely necessitates construction using sand cells, where additional vibratory compaction will be required to ensure a sufficiently dense, high strength material. It is important to provide a cyclone sand fill material that is sufficiently dense to provide adequate strength for embankment stability (with consideration of the high confining stresses) and to ensure the material is not

susceptible to cyclic softening or flow liquefaction under seismic loading. A requirement of the cyclone sand placement will be to achieve a dry density of 95% Standard Proctor compaction.

It is recommended that future studies include examination of the influence of cyclone underflow solids content on the compaction characteristics of in situ cyclone sand fill. This will enable determination of the optimum solids content of the cyclone underflow to achieve good compaction of the sand fill.

There is ample precedent in North America for tailings dam construction using cyclone sand, but this technique has not been used for large tailings dams in the Yukon. There is potential for cold winter conditions to reduce the construction period for cyclone sand placement, partly due to the potential for freezing and ice entrainment in the sand fill and partly because of snow drifting into sand cells. Examples of mine operations in British Columbia, where cyclone sand is used to construct the tailings dams, include the Kemess, Gibraltar and Highland Valley mines. To accommodate cold operating conditions in the winter months, the construction season at Gibraltar is typically from March to October. Longer cycloning operations for sand fill construction have apparently been possible at the Kemess mine, with operations possible at temperatures as low as -25°C. Dam construction typically runs 6 to 10 months of the year at Highland Valley. During the remainder of the year, tailings are used to construct an upstream beach between the dam and the tailings supernatant pond. For this Feasibility design the cyclone plant and cyclone sand placement activities are assumed to be operational for an average 9 months of the year (with a 90% sand plant availability to account for maintenance and other downtime).

5.6 EMBANKMENT CONSTRUCTION

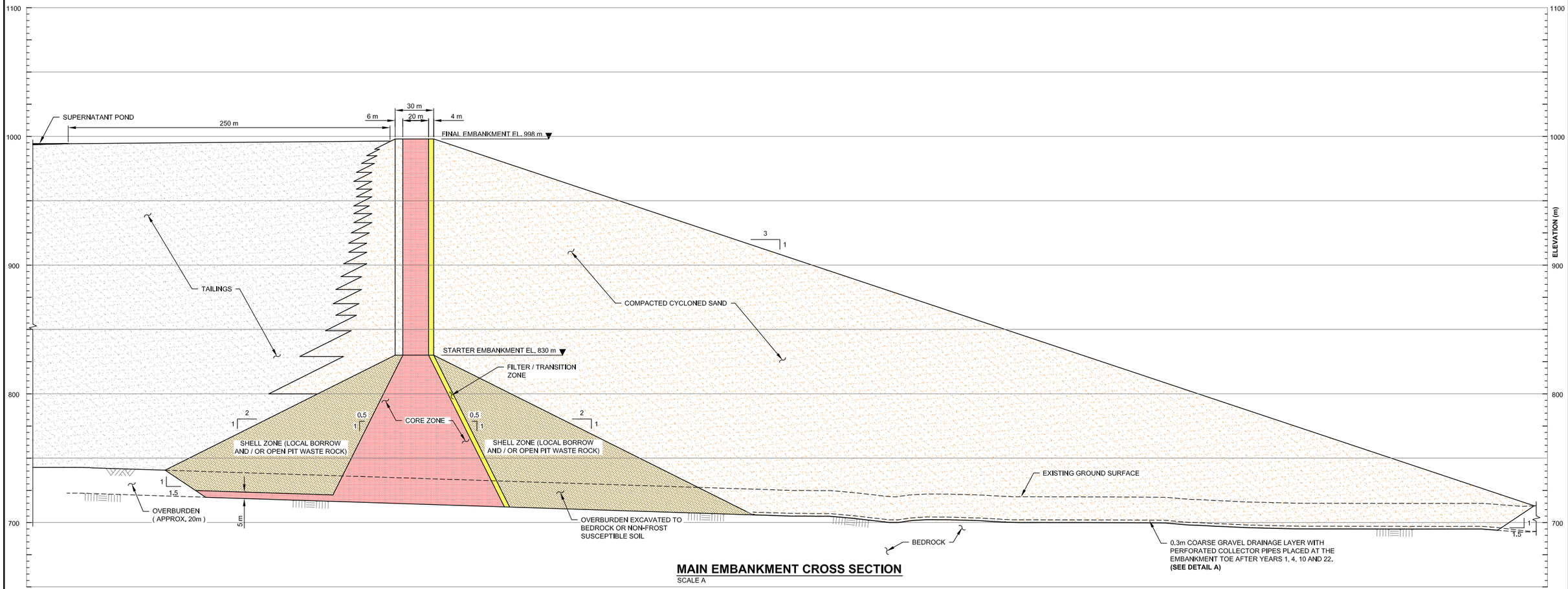
The embankments will be constructed as water-retaining zoned structures with a low permeability core zone and appropriate filter and transition zones to prevent downstream migration of fines. The core zone will include a seepage cut-off keyed into competent rock in the foundation.

5.6.1 Main Embankment

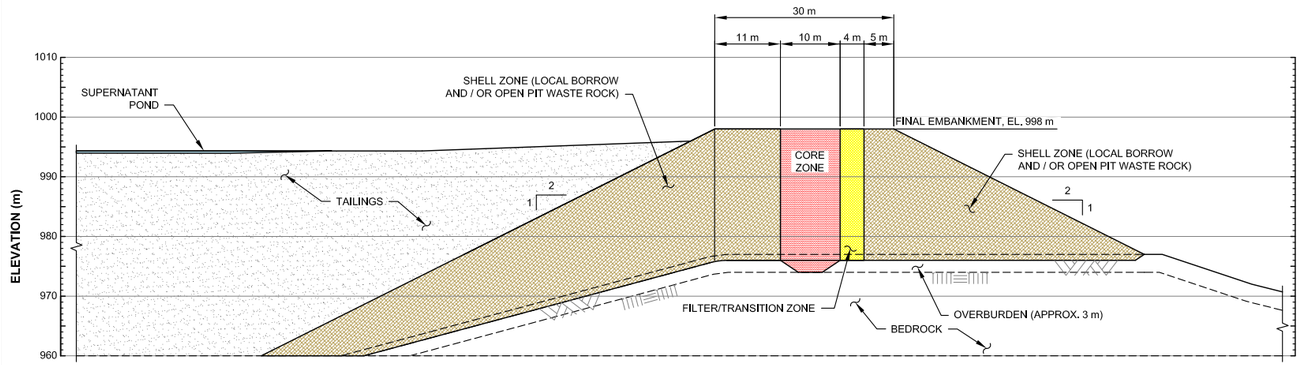
The Main Embankment required for the TMF has been designed to be constructed in several stages over the operating life of the mine. It will consist of an initial starter (Stage IA) embankment, an extension of the downstream shell during the first year of operations (Stage IB), and staged raises thereafter over the life of the project using the centreline method of construction. The filling schedule for the TMF is included on Figure 5.8. On-going raises of the embankment crest and core zone to support the staged expansion will be carried out annually, during the summer months of operations.

The Stage I embankment will comprise an approximately 105 metres high dam (crest to downstream toe) constructed to El. 830 m. A cofferdam will be required in order to drain and prepare the foundation prior to Stage I embankment construction in the pre-production years. The cofferdam will be constructed upstream of the Main Embankment footprint to capture upstream surface water flows and route it around the construction work area and back into Casino Creek in a surface pipeline. The embankment shell zones for the Stage IA (Starter) dam will be constructed with random fill comprising suitable rockfill from local borrow sources, supplemented by available non-reactive waste rock. Approximately 2 to 3 million tonnes of non-reactive waste rock (leach cap) material is available from initial open pit stripping operations.

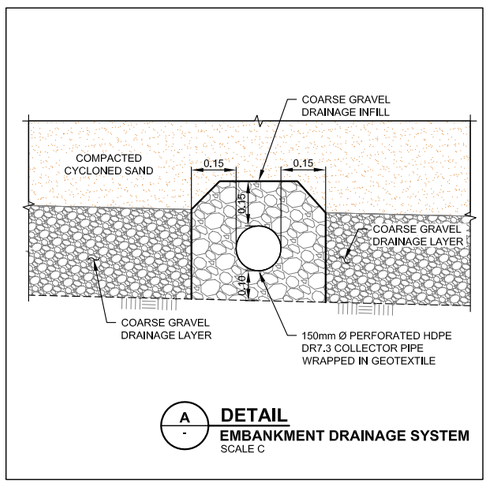
The crest of the final embankment will reach an elevation of 998 m, providing storage capacity for 22 years of tailings and potentially reactive waste rock and overburden production. A typical section through the final Main Embankment is shown on Figure 5.9. The maximum height of the final embankment (crest to downstream toe) will be approximately 286 metres. Construction of each of the embankment stages will be scheduled to correspond with material availability for cyclone sand (produced from NAG tailings), local borrow sources and the tailings impoundment filling rate.



MAIN EMBANKMENT CROSS SECTION
SCALE A



WEST EMBANKMENT CROSS SECTION
SCALE B



A
-
DETAIL
EMBANKMENT DRAINAGE SYSTEM
SCALE C

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED.
3. GENERALIZED TOPOGRAPHY SHOWN.

SCALE C: 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 30 15 0 50 100 150 m

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CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY
TYPICAL EMBANKMENT SECTIONS

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P/A NO. VA101-325/8 | REF NO. 10

FIGURE 5.9 | REV 0

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For each stage of embankment construction the foundations will require clearing and stripping preparation for fill placement. An average stripping depth of one meter has been assumed within the embankment footprint. For the embankment footprint area that covers colluvial apron or other ice-rich overburden, all unsuitable material will be excavated to competent foundation, absent of frost susceptible soil. The average thickness of the colluvial apron is expected to be approximately 10 metres based on the findings of site investigations. The removed material will be replaced with core, filter or shell zone material, depending on the location relative to the embankment. A 5 metre thick low permeability upstream blanket is also included to reduce seepage from the TMF, as shown on Figure 5.9.

A low permeability cut-off is required beneath the core zone of the Main Embankment and West Saddle Embankment at locations where no colluvial apron or other ice rich soil is present, to provide an effective seepage control barrier. The seepage cut-off trench will extend through the foundation soils and key into competent bedrock, at an average depth of about three meters for both the Main and West Embankment.

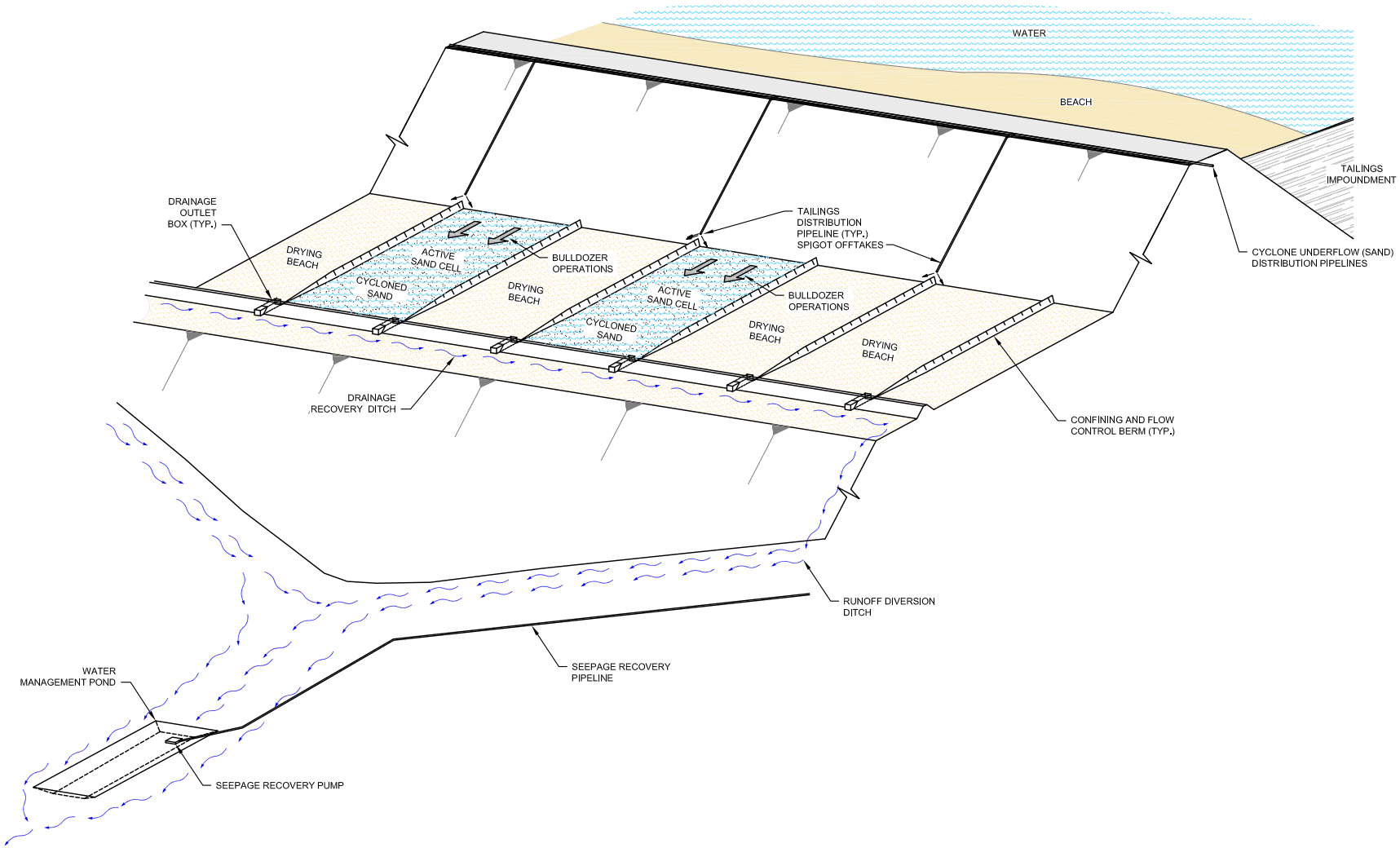
Ongoing embankment stages will comprise centreline raises with a vertical low permeability core zone (20 metres wide) and adjacent downstream filter and transition zones. The development of sufficient tailings beach area will be required between the supernatant pond and the embankment to provide a stable upstream construction surface for the centreline embankment raises. The upstream and downstream shell zones will be constructed from compacted cyclone sand.

The embankment filter zone will prevent piping of the core zone material and will reduce pore pressures within the embankment. The transition zone will prevent the migration of fines from the dam core zone and filter zone into the pervious downstream shell zone (rockfill and cyclone sand). The filter and transitions zones will consist of suitable crushed and screened rock or local borrow materials.

Cyclone sand will be produced from bulk NAG tailings at the Cyclone Plant and discharged into the cyclone sand shell zones where it will be spread in cells and compacted using bulldozers. Cyclone sand slurry will be discharged into each construction cell to depths of 0.5 m to 2.0 m, and will be heavily track packed by dozers. Water expelled from the sand by the track packing will drain from the cells for collection in the downgradient water management pond at the toe of the embankment. The draining and track packing will provide compacted zones of cyclone sand that meet 95% Standard Proctor compaction density specification. The in situ density, moisture content, and fines content will be obtained from within 48 hours of sand placement. The embankment design relies on maintaining a free-draining downstream sand embankment for static and seismic stability.

Cell construction using narrow sand deposition panels will be required for raising the downstream shell of the Main Embankment. The panel method involves the construction and maintenance of long, narrow cells (typically approximately 100 m by 20 m) along the face of the embankment. A schematic of the panel construction sequence is shown on Figure 5.10.

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NOTES:

1. SAND CELL PLACEMENT OPERATIONS OCCUR SIMULTANEOUSLY IN TWO OR THREE CELLS.

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CYCLONE SAND DEPOSITION SCHEMATIC

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P/A NO. VA101-325/8

REF NO. 10

FIGURE 5.10

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Cyclone sand production commencing in Year 1 of operations will be used to extend the downstream shell of the Main Embankment (Stage IB), allowing the dam crest and core zone to be raised after about one year. The availability of cyclone sand needs to be matched with the filling schedule for the TMF, to ensure adequate embankment heights are provided well in advance of the rising tailings surface. The Stage IA (Starter) embankment must be high enough to allow sufficient quantities of sand to be produced and placed to facilitate subsequent embankment raises.

It is estimated that approximately 7.2 to 7.5 million m^3 (12 to 12.5 million tonnes at an in situ dry density of 1.65 tonne/m^3) of cyclone sand fill material can be produced annually, except for Year 1, using the production values presented in Table 5.5. Approximately 5.6 million m^3 of cyclone sand can be produced in Year 1 as the mill ramps up to full production. This volume is less than the fill volume required for embankment construction in Year 1. The annual shortfall of embankment fill material will need to be made up with suitable fill material from a local borrow source or quarry. It is estimated that approximately 1.2 million m^3 of rockfill will be required to supplement the shortfall in cyclone sand production in Year 1. This rockfill can be preferentially placed in the bottom area of the downstream shell to further promote drainage of the cyclone sand. Additional filter and transition layers will be required between the cyclone sand and rockfill to prevent the migration of sands into the rockfill and to provide drainage for the transport of water released from the sand.

The current material balance indicates that sufficient cyclone sand material is available to meet embankment fill requirements for Years 2 to 22. Table 5.5 provides a detailed summary of embankment fill quantities for each of the zones by year.

The materials balance for construction requirements is sensitive to the factors assumed for cyclone sand production (including cold weather operations). Therefore, additional local borrow may be required for embankment construction in the event that cyclone sand production does not meet targets in any given year during operations.

The Stage IA Main Embankment requires approximately 9.3 million m³ of total fill material. The total fill requirement for the final Main Embankment (including the seepage cut-off) is 152 million m³.

The sequencing of sand cell construction in relation to the requirements for embankment crest raising will need to be carefully evaluated for detailed design studies.

Placement of additional rockfill against the downstream shell of the Main Embankment can be used to provide additional structural support, if required. However, stability assessment (see Section 5.10) indicates that the embankment satisfies operating and long-term (post-closure) stability requirements without downstream buttressing.

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TABLE 5.5

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
EMBANKMENT FILL VOLUME REQUIREMENTS

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Stage	End of Year	Min. Crest Elevation	Main Embankment						West Saddle Embankment				Total Core Volume [1]	Total Filter and Transition Volume	Total Shell Volume	Total Volume
			Core Zone[1]	Filter and Transition Zone	Shell Zone			Stage Volume	Core Zone	Filter and Transition Zone	Shell Zone Local Borrow	Stage Volume				
					Local Borrow	Open Pit Waste Rock	Cycloned Sand									
		(m)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)
IA	PP	830	2,975,000	201,000	5,118,000	1,000,000	0	9,294,000	53,000	18,000	284,000	355,000	3,028,000	219,000	6,402,000	9,649,000
IB	1	830	0	0	1,200,000	0	5,589,000	6,789,000	0	0	0	0	0	0	6,789,000	6,789,000
II	2	849	433,000	86,000	0	0	7,440,000	7,959,000	0	0	0	0	433,000	86,000	7,440,000	7,959,000
III	3	866	441,000	87,000	0	0	7,422,000	7,950,000	0	0	0	0	441,000	87,000	7,422,000	7,950,000
IV	4	876	331,000	65,000	0	0	7,396,000	7,792,000	0	0	0	0	331,000	65,000	7,396,000	7,792,000
V	5	884	256,000	50,000	0	0	7,331,000	7,637,000	0	0	0	0	256,000	50,000	7,331,000	7,637,000
VI	6	894	371,000	73,000	0	0	7,323,000	7,767,000	0	0	0	0	371,000	73,000	7,323,000	7,767,000
VII	7	904	363,000	72,000	0	0	7,319,000	7,754,000	0	0	0	0	363,000	72,000	7,319,000	7,754,000
VIII	8	912	303,000	60,000	0	0	7,411,000	7,774,000	0	0	0	0	303,000	60,000	7,411,000	7,774,000
IX	9	921	350,000	69,000	0	0	7,467,000	7,886,000	0	0	0	0	350,000	69,000	7,467,000	7,886,000
X	10	928	318,000	63,000	0	0	7,254,000	7,635,000	0	0	0	0	318,000	63,000	7,254,000	7,635,000
XI	11	935	285,000	56,000	0	0	7,241,000	7,582,000	0	0	0	0	285,000	56,000	7,241,000	7,582,000
XII	12	942	290,000	57,000	0	0	7,429,000	7,776,000	0	0	0	0	290,000	57,000	7,429,000	7,776,000
XIII	13	949	339,000	67,000	0	0	7,492,000	7,898,000	0	0	0	0	339,000	67,000	7,492,000	7,898,000
XIV	14	956	260,000	51,000	0	0	7,419,000	7,730,000	0	0	0	0	260,000	51,000	7,419,000	7,730,000
XV	15	962	263,000	52,000	0	0	7,320,000	7,635,000	0	0	0	0	263,000	52,000	7,320,000	7,635,000
XVI	16	968	311,000	61,000	0	0	7,300,000	7,672,000	0	0	0	0	311,000	61,000	7,300,000	7,672,000
XVII	17	974	272,000	54,000	0	0	7,253,000	7,579,000	0	0	0	0	272,000	54,000	7,253,000	7,579,000
XVIII	18	981	278,000	55,000	0	0	2,569,000	2,902,000	0	0	0	0	278,000	55,000	2,569,000	2,902,000
XIX	19	987	284,000	56,000	0	0	2,569,000	2,909,000	0	0	0	0	284,000	56,000	2,569,000	2,909,000
XX	20	992	194,000	38,000	0	0	2,569,000	2,801,000	0	0	0	0	194,000	38,000	2,569,000	2,801,000
XXI	21	996	149,000	29,000	0	0	2,000,000	2,178,000	0	0	0	0	149,000	29,000	2,000,000	2,178,000
XXII	22	998	151,000	29,000	0	0	1,000,000	1,180,000	0	0	0	0	151,000	29,000	1,000,000	1,180,000
TOTALS			9,217,000	1,431,000	6,318,000	1,000,000	134,113,000	152,079,000	53,000	18,000	284,000	355,000	**9,270,000**	**1,449,000**	**141,715,000**	**152,434,000**

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\Tables\[Table 5.5 Rev 0 - TMF Staged Embankment Volumes.xlsx]Volumes Rounded

NOTE:

1. CORE VOLUME INCLUDES LOW PERMEABILITY UPSTREAM BLANKET (206,000 m³)
2. NEAT LINE VOLUMES (NO OVERBUILD ALLOWANCE INCLUDED).

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5.6.2 West Saddle Embankment

The West Saddle Embankment will comprise an earth-rockfill dam, constructed from local borrow materials. This embankment is not required for tailings and supernatant pond confinement until about Year 18 of operations. However, the embankment will be constructed for the start of operations to provide a pipeline corridor at a suitable grade for tailings delivery to the cyclone sand plant and the TMF. The embankment is required to a maximum height of approximately 21 m at El. 998 m.

Information collected during the site investigation programs in the West Embankment area indicated that the depth to bedrock throughout the area is likely to be less than three meters and the shallow overburden will likely comprise residual and colluvial soils.

The embankment includes a vertical low permeability core zone (10 metres wide) and adjacent downstream filter and transition zones. A cut-off trench will likely be required beneath the core of the dam to provide an effective seepage control barrier within the underlying permeable foundation soils. The seepage cut-off trench will extend through the permeable soils and key into competent rock, at an average depth of about three meters.

A typical section through the West Saddle Embankment is included on Figure 5.9.

The total fill required for construction of the West Saddle Embankment is approximately 0.36 million m^3.

5.6.3 Borrow Materials

Local borrow sources are required to provide the following materials for embankment construction:

- Core zone – locally sourced low permeability overburden.
- Filter and transition zones – required gradation depends on the gradation of the core zone material. Local borrow is likely the main source for this material.
- Rockfill Shell Zones – partly sourced from non-reactive open pit waste, the remainder will be sourced from local borrow (quarries).

All embankment construction materials will need to be non-reactive. Rockfill is expected to be sourced relatively easily on site, including use of excavated material from preparation of the plant site foundations. The borrow sources for the filter and transition zones have not been identified at this stage as this depends on the gradation of the core zone material. An effort has been made to identify potential borrow sources for low permeability core zone material and the upstream blanket.

- Laboratory permeability test results on compacted residual and colluvial soil from 1993, 2010, 2011 and 2012 test pit samples indicate that permeabilities range from approximately 1×10^{-5} cm/s to 1×10^{-9} cm/s, depending on material gradation, moisture content, compactive effort and confining pressure. The more recent testing carried out in 2011 and 2012 indicates that permeability values in the range of approximately 1×10^{-6} cm/s to 1×10^{-5} cm/s are typically achievable for the finer grained soils (with more than 20% fines) present at the project site. The laboratory testing also suggests that the permeability will reduce at higher confining stresses, with a permeability decrease from 1×10^{-5} cm/s to 1×10^{-6} cm/s reported for an increase in confining stress from 200 kPa to 600 kPa. Confining stresses will exceed 600 kPa in the majority of the embankment core zone for the TMF Main Embankment (from about 30 metres below the dam crest). Therefore, it is expected that a permeability of about 1×10^{-6} cm/s, and

perhaps less, will be achieved in the majority of the core material. Additional testing is required to confirm the suitability of core materials.

The criteria that have been used to determine suitability of the material for use as low permeability core zone borrow material are:

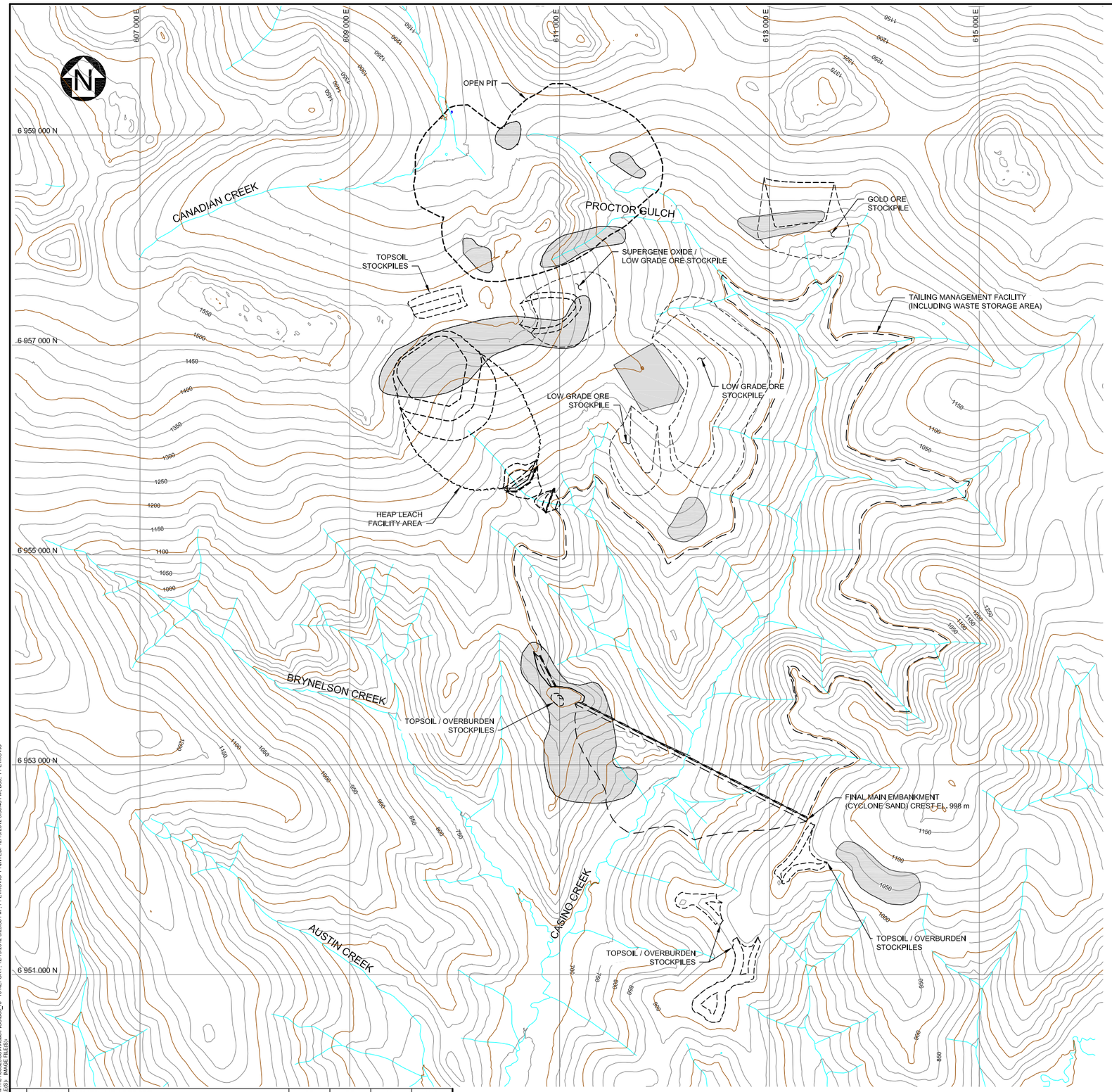
- ≥ 20% fines. Material with ≥ 20% fines is expected to have a sufficiently low permeability for use as core zone material, based on available laboratory testing and experience with other projects.
- No organic content. Where the presence of organic material is indicated by laboratory testing or geotechnical logging, the material is considered unsuitable for use as core material. Organic material can oxidize over time, potentially causing settlements and leading to preferential seepage paths.
- Non frost susceptible. Ice rich soils are considered unsuitable as these are difficult to excavate when frozen. Thawing of ice rich soils will cause excess water to be released, which causes the soil to flow and makes it very difficult to handle and compact.

The residual soil and colluvial veneer materials identified at the site are potentially suitable core zone borrow materials. The colluvial apron in Casino Valley is typically organic-rich, saturated and frozen, and is not suitable for use as core zone construction material.

Residual soils are locally silt rich due to windblown loess enrichment. Residual soils at the site are mainly present along ridges at higher elevations and along the upper parts of some slopes. In the open pit and Gold Ore stockpile areas, residual soils are locally thick and clay-rich due to the presence of alteration zones and preferential weathering along shear and fault structures.

Colluvial veneer is found along valley slopes. The nature of colluvium, i.e. material that has been transported down slopes, causes local variations in the composition. The downslope migration also causes organic material to be included in the deposit at some locations. The organic content generally increases down-slope. On north facing slopes, the colluvial veneer is mostly frozen and not considered to be a suitable borrow source.

Several potential core zone borrow source areas have been identified at the project site and are shown on Figure 5.11.



NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT IS SHOWN AT ITS FINAL OUTLINE AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. HEAP LEACH PAD IS SHOWN AT ITS MAXIMUM SIZE.
7. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

LEGEND:

POTENTIAL CORE ZONE BORROW AREA

SCALE A 400 200 0 400 800 1200 1600 2000 m

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POTENTIAL CORE ZONE BORROW MATERIAL

Knight Piésold CONSULTING

P/A NO. VA101-325/8 | REF NO. 10 | REV 0

FIGURE 5.11

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The main challenges to be considered in the sourcing of suitable core zone borrow materials are as follows:

- Colluvial veneer has a variable composition and has the potential of intermixed organics.
- The layer of suitable material is typically only between 1 and 2 meter thick, underlying an unsuitable (topsoil) layer of 0.3 m or more. This may lead to large spoil piles and disturbance areas.
- Topsoil overlying potential borrow sources should be carefully stripped in order to avoid contamination of the borrow materials with organic material.
- Permafrost and frost susceptible materials should be avoided.

Specific materials will be required at specific times from the borrow areas. For example, large quantities of free draining, possibly processed material will be required to construct the downstream filter and transition zones. This material will be prepared in advance and stockpiled near the work area. Alluvial soil deposits in the area may provide suitable free draining material for construction of the embankment filter and transition zones. Additional site investigations and laboratory testing will be required for future design studies to confirm the suitability of local borrow sources and provide sufficient material characterization to enable fill placement specifications to be defined (including lift thickness, particle size distribution and compaction requirements).

These investigations will also be required to confirm the extent and availability of sufficient suitable borrow materials for embankment core zone construction throughout the life of the facility. Future studies may also need to consider alternative core zone materials and options, if additional characterisation and delineation of borrow sources indicates a potential shortfall of suitable low permeability material.

Future studies should also confirm specific borrow sources for filter zone and quarried rockfill materials required for embankment construction.

5.7 TMF OPERATIONS UNDER FREEZING CONDITIONS

Numerous mines have operated or currently operate tailings facilities under severe winter (freezing) conditions. In many instances a frozen layer forms over the TMF supernatant pond, which is maintained and operated under the ice.

Design and operating considerations, developed from mine operating experiences under freezing conditions, which may be considered for winter operations at Casino, include the following:

- Shape the tailings impoundment surface (during summer tailings deposition) to provide a winter pond that can be maintained "localized" in one or specific areas of the facility.
- Concentrate winter tailings discharge from a single, relocateable, point. This will tend to channelize the flow and move it through and under the ice cover where the solid/liquid separation occurs. This prevents sheet tailings flow over the ice.
- Commence winter tailings discharge from a more remote location and retreat the deposition point closer to the source/pond/recovery point, in steps, as winter progresses.
- Store sufficient water in the tailings facility prior to freezing, to provide for all anticipated ice and pore water losses during winter (i.e. develop and maintain a good water/ice balance).
- The potential for dusting can be exacerbated during cold winter conditions as a 'freeze drying' process tends to destroy capillary tensions in partially saturated sand materials, making it more

susceptible to dusting. Appropriate provisions will be required to prevent dusting of cyclone sand fill. This may mean that the cyclone sand will need capping with erosion resistant fill material, particularly during the cold winter months, when it may be impractical to continue with active sand placement.

5.8 WATER MANAGEMENT SYSTEM

The Water Management System for the TMF has been designed to accommodate seepage through the TMF embankment, water recovered from the cyclone sand embankment construction and surface runoff from the 1 in 10 year 24-hour design storm event.

Seepage from the TMF will result from infiltration of ponded water directly through the embankment fill and the natural ground and from expulsion of pore water as the tailings mass consolidates. The seepage will largely be controlled by the low permeability core zone of the embankments, the seepage cut-off provided beneath the core of the dams, the upstream low permeability blanket provided for the Main Embankment and the tailings deposit.

Cyclone sand embankment construction will be undertaken for approximately nine months of the year and it is expected that there will be significant water recovery as a by-product of the construction process. The majority of water recovered will be collected as surface runoff, with a portion also collected as infiltration and drainage through the cyclone sands placed as embankment fill.

The 1 in 10 year 24-hour design storm event is anticipated to generate periodic high flow surface runoff events.

The Water Management System consists of an under-drain system and a surface ditch system which both discharge into a water management pond located downstream of the Main Embankment. The under drain system, which is installed beneath the Main Embankment, incorporates a 0.3 metre thick gravel drainage blanket with perforated collection pipes to convey collected water away from under the embankment (see Figure 5.9). The layout of the collection pipes has been designed with pipes installed at four phases during development, Year 1, Year 4, Year 10 and Year 22. The collection pipes will be spaced approximately every 230 metres as the footprint of the embankment increases with staged expansions. As the embankment height increases, it is expected that the perforated pipes will deform and likely collapse due to the embankment loading, however the majority of infiltration drainage from the cyclone sand operation is anticipated to be complete at this stage and any remaining drainage will still infiltrate through the gravel drainage blanket.

The surface ditch system has been configured as a dual-ditch design (two parallel ditches, one ‘clean’ and one ‘dirty’), with the upslope ditch (constructed along the toe of the embankment) collecting surface runoff from the embankment (generated by either precipitation or cyclone sand placement), and the downslope ditch diverting ‘clean’ surface runoff. The dual-ditch system was adopted to reduce the quantity of water that requires storage in the water management pond and pumping back to the TMF. Lining and scour protection of the ditching will be required to prevent erosion of the ditch channels. Similar to the underdrain system, the ditch system has been designed to be constructed with four development phases to accommodate staged embankment expansions. The ditch alignments through the four development phases are included on Figures 5.2 to 5.5.

The water management pond (see Figures 5.1 to 5.5) has been designed as a dry-pond and is sized to manage the 1 in 10 year 24-hour storm event. Any storm events greater than the 1 in 10 year will discharge through the pond discharge channel. A pump station to return the water stored in the pond back to the TMF will be controlled through level controls. Supplemental booster pump stations will be required as the TMF embankment height increases.

Groundwater will be monitored in wells situated downstream of the Main Embankment and West Saddle Embankment. If deemed necessary, groundwater recovery wells may be installed in the same locations, with water being pumped back to the TMF.

On-going water quality monitoring will be required to assess the effectiveness of the Water Management System. In the unlikely event that the Water Management System is found to not effectively collect and recover seepage, it will be necessary to install additional seepage control provisions.

5.9 TAILINGS CONSOLIDATION ANALYSES

On-going consolidation of the tailings deposit is an important consideration for the design and construction of the TMF during operations and after closure. Consolidation occurs continuously within the tailings deposit during deposition and will continue after completion of operations until all excess pore pressures have dissipated. Expulsion of pore fluids during consolidation produces settlement of the tailings surface and a corresponding increase in the average density of the deposit.

KPL have developed a one-dimensional finite difference computer model which predicts the magnitude and rate of tailings consolidation and the corresponding average density of the deposit. This model incorporates the consolidation characteristics of the tailings, the tailings deposition rate and large strain consolidation theory.

Analyses were performed to predict average tailings dry densities and consolidation seepage rates during operations and after closure of the TMF. The effect of co-disposal of waste rock within the TMF on the tailings rate of rise was accounted for in the analysis.

An average tailings dry density of approximately 1.2 tonne/m^3 was predicted during the initial three years of operations, increasing to 1.3 tonne/m^3 in Year 4. Thereafter, the average dry density is predicted to increase gradually to approximately 1.5 tonne/m^3 by the end of operations when tailings deposition ceases. The density of the deposit will increase once tailings deposition ceases at closure and self-weight consolidation continues, assisted by surface desiccation due to evaporation from exposed tailings beach areas. Following the end of operations the average dry density of the tailings deposit is predicted to increase to approximately 1.55 to 1.6 tonne/m^3 once fully consolidated conditions are achieved.

The large majority of consolidation seepage from the tailings deposit (typically about 80% to 90%) flows upwards and towards the supernatant pond. Most of the remaining consolidation seepage will likely flow toward the more free-draining tailings beach areas, confining embankments and Waste Storage Area. The low quantity of downward consolidation seepage is due to the increasing drainage path length during operations (between freshly deposited tailings and the base of the TMF) and the low permeability of deeper, more consolidated, tailings at the base of the facility.

The tailings will remain partially consolidated during operations and for a period of time after closure until all excess pore water pressures have dissipated. The actual time taken for complete consolidation will be dependent on the in situ consolidation characteristics of the tailings material.

The methodology, assumptions and results of the tailings consolidation analysis are included in the KPL document "Report on Revised Tailings Management Facility Seepage Assessment" (Ref. No. VA101-325/8-13, December, 2012).

5.10 SEEPAGE ANALYSES

Steady-state seepage analyses for the TMF were carried out to estimate the amount of seepage through the embankments and foundation materials. The analyses were completed using the finite element computer program SEEP/W. Seepage rates through the Main Embankment, West Saddle Embankment and tailings basin were examined.

The seepage rate through foundation materials and embankment fill zones is influenced by the following factors:

- Permeability of the embankment zones
- Permeability of the foundation materials
- The thickness and permeability of the tailings stored within the TMF
- Distribution of waste rock within the TMF
- Seepage gradients in the embankment and foundation zones, and
- The seepage area available (increases with time during operations).

The seepage flow rate will vary over the life of the TMF as it gradually fills with tailings, potentially reactive mine waste rock and supernatant water. During operation of the TMF the tailings deposit will increase in thickness and decrease in permeability due to on-going consolidation. The seepage analyses have been performed to predict seepage flows from the TMF for the embankments at various stages throughout operations (Year 1, Year 10 and Final).

The seepage analyses have been based on typical cross-sections through the TMF, as shown on Figures 5.6 and 5.9. Foundation conditions incorporated into the seepage analyses were based on information provided by the geotechnical site investigation programs (described in Section 4.0).

Material permeabilities were determined for each of the embankment fill zones, tailings deposit and foundation materials. All foundation permeability values are based on the results of in situ testing performed during the 1994, 2010 and 2011 geotechnical site investigation programs. The permeability of core zone and cyclone sand fill zones in the Main Embankment were based on the results of laboratory testing. Permeability values adopted for the tailings deposit were estimated using the results of laboratory testing and consolidation modelling.

Flow rates for seepage components passing through the TMF embankments and passing directly into the TMF foundation (from the tailings and Waste Storage Area) were estimated. The predicted total seepage rate from the TMF is approximately 5 l/sec for Year 1 (Stage I Embankment), increasing to about 20 l/sec by Year 10 and approximately 40 l/sec for the final embankment arrangement (El. 998 m). Approximately 70% of the total seepage is estimated to flow directly into original ground and about 30% through the Main Embankment and West Saddle Embankment. For the final TMF arrangement approximately 97 % of the total seepage through the embankments is estimated to flow through the Main Embankment and 3 % through the West Saddle Embankment.

Long-term (post-closure) seepage rates from the TMF are expected to be similar or less than the predicted values for the final embankment arrangement at the end of operations, but will be dependent on the reclamation and closure plan developed for the facility.

Details of the material permeabilities, modelling assumptions and results of the steady-state seepage analyses provided by the SEEP/W models are presented in the KPL report "Revised Tailings Management Facility Seepage Assessment" (Ref. No. VA101-325/8-13, December, 2012).

Water quality studies and environmental effects assessment are on-going and take into account the quantity and quality of seepage from the TMF, including any seepage that will not be recovered by the Water Management System. The findings of this assessment will dictate if additional seepage collection and recovery systems will be required, such as groundwater recovery wells.

5.11 EMBANKMENT STABILITY ANALYSES

Stability analyses were carried out to investigate the stability of the Main Embankment under both static and seismic loading conditions. These comprised checking the stability of the embankment arrangement for each of the following cases:

- Static conditions during operations and post-closure
- Earthquake loading from the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE), and
- Post-earthquake conditions using residual (post-liquefaction) tailings strengths.

The stability analyses were based on a typical cross-section through the Main Embankment for the final TMF with a supernatant pond elevation of 995 m and an embankment crest elevation of 998 m.

The stability analyses were carried out using the limit equilibrium computer program SLOPE/W. In this program a systematic search is performed to obtain the minimum factor of safety from a number of potential slip surfaces. Factors of safety have been computed using the Morgenstern-Price method.

In accordance with international recommendations (ICOLD, 1995) and standard industry practice, the minimum acceptable factor of safety for the tailings embankment under static conditions is 1.3 for short-term operating conditions and 1.5 for long-term (post-closure) of the TMF. A factor of safety of less than 1.0 is acceptable under earthquake loading conditions provided that calculated embankment deformations resulting from seismic loading are not significant and that the post earthquake stability of the embankment maintains a factor of safety greater than 1.2, implying there is no flow slide potential. For the post earthquake case the tailings deposit was conservatively assumed to be fully liquefied, and an appropriate low residual strength was applied.

The results of the stability analyses satisfy the minimum requirements for factors of safety and indicate that the proposed design is adequate to maintain both short term (operational) and long term (post-closure) stability. The seismic analyses indicate that any embankment deformations during earthquake loading from the OBE or MDE would be minor, and would not have any significant impact on embankment freeboard or result in any loss of embankment integrity. The results also indicate that the embankment is not dependent on tailings strength to maintain overall stability and integrity.

Details of the embankment stability analyses, including the adopted material strength parameters are presented in Appendix C.

6 – SITE WATER MANAGEMENT

6.1 GENERAL

The main objective of the site water management plan is to effectively control all water that originates within the project area, or is brought into the project area, in an environmentally responsible manner. This includes optimizing the use of available water sources to supply the water requirements of the milling process and related mining activities, thereby reducing the demand for external make-up water. Water sources that will be controlled include surface water runoff, groundwater from the open pit, process water, tailings consolidation seepage, TMF seepage and bleed water from cyclone sand placement.

Freshwater is required to supplement process water requirements at start-up and to provide makeup water to the mill throughout operations. Freshwater for use during mill start-up will be supplied by constructing the starter (Stage IA) embankment in pre-production years concurrent with open pit stripping, with construction scheduled to provide enough time to capture sufficient surface water runoff for mill start-up. It is anticipated that approximately 3 months of mill water requirements will be available in the start-up water pond prior to commencement of mill operations. Provisions for makeup water to the mill have been included in the TMF water balance. The freshwater source is assumed to be the Yukon River and/or a groundwater well field.

A monthly water balance model was developed for the TMF to assess the various flows to and from the facility, to predict the variation in supernatant pond volume during operations and to estimate makeup water requirements. The determination of an accurate water balance for the operating facility is a key part of the TMF design process.

6.2 WATER BALANCE MODEL

A stochastic analysis was carried out on the base case monthly operational mine site water balance using the GoldSim© software package. The intent of the modelling is to estimate the magnitude and extent of any water surplus and/or deficit conditions in the TMF based on a range of possible climatic conditions. The modelling timeline includes two pre-production years (Year -2 and Year -1), and 22 years of operation (Years 1 to 22), based on the mine production schedule. The TMF pond is assumed to have a minimum pond volume of 15 million m^3 (approximately 3 months of slurry water requirements) in all months throughout operations. Therefore, a deficit condition is defined as when the TMF pond volume is at the minimum volume of 15 million m^3 and that the system (including the TMF, open pit, and contributing catchments) is not able to supply enough water to meet the mill process water requirements, thereby indicating the need for make-up water. Details of the water balance model including a schematic of the model and a summary table of input values are included in Appendix D.

The water balance indicates that the mine site will likely be in a deficit condition over the operating life of the TMF, except for the last 1 to 2 years. The maximum annual volume of makeup water required occurs in Year 3 for all climate scenarios. The 95th percentile wet and dry values are defined as having a 5% and 95% chance of being equalled or exceeded in any year, respectively. The range of monthly TMF pond volumes from Years -2 to 22, for the 95th percentile dry, median and 95th percentile wet scenarios is included in Appendix D.

It should be noted that the water balance results are very sensitive to the input values, which are best estimates based on currently available information, so changes to the inputs could result in substantial changes to the results.

7 – TAILINGS DISTRIBUTION AND RECLAIM WATER SYSTEMS

7.1 GENERAL

There will be two separate tailings slurry streams from the mill. The principal (rougher) stream (80%) will consist of bulk Non-Acid Generating (NAG) tailings. The minor stream (20%) will be Potentially Acid Generating (PAG) material that will be handled and stored separately and maintained under water. Both of these tailings streams will leave the mill at a solids content of approximately 55%. For approximately nine months of each year on average the NAG tailings will be passed through a cyclone plant to produce clean sand for embankment construction. The cyclone plant will also produce a high volume low solids content stream, containing the fines fraction of the tailings (cyclone overflow). This material will be discharged into the TMF at a solids content of approximately 24%. A flow diagram of the tailings handling process is shown on Figure 7.1.

Only clean (geochemically innocuous) bulk NAG tailings may be cycloned to produce sand fill material for embankment construction. No potentially reactive materials can be used for embankment construction. Management of the PAG tailings stream during system maintenance or breakdown needs to be coordinated, to ensure that any combined tailings that includes the PAG stream is not directed to the cyclone sand plant.

On this basis the design must consider four separate tailings streams:

- PAG tailings
- Bulk NAG tailings
- Cyclone sand (underflow), and
- Cyclone overflow.

The higher elevation of the mill relative to the TMF will enable gravity discharge for the tailings streams, including cyclone sand products for most, if not the entire project life.

Water will be reclaimed from the tailings supernatant pond by two floating, barge mounted, pump-stations. One reclaim barge reports to the process water settlement pond located above the mill terrace for mill water and the other to a dilution water head tank to provide gravity flow to the cyclone feed tank.

General locations for the tailings delivery lines, cyclone plant and reclaim system over the operating life of the TMF are included on Figure 5.1 for pre-production conditions (start of operations) and Figures 5.2 to 5.5 for operating years 1, 4, 10 and 22 (Final) respectively.

Summaries of the tailings distribution, cyclone sand production and reclaim water systems are provided in the following sections.

ORE

~ 125,000 TPD

CONCENTRATE (1%)

MILL

PAG TAILINGS (20%)
55% SOLIDS

BULK TAILINGS (80%)
55% SOLIDS (NOTE 1)

CYCLONE FEED TANK

36% SOLIDS

CYCLONE OVERFLOW

(24% SOLIDS)

CYCLONE UNDERFLOW PUMP

CYCLONE PLANT

~ 74% SOLIDS

65% SOLIDS

CYCLONE SAND FOR DAM CONSTRUCTION

WATER TO CYCLONES

CYCLONE BYPASS LINE

RECLAIM WATER TO PLANT

WATER TRANSFER
AS REQUIRED

BARGE #1

BARGE #2

TAILINGS MANAGEMENT FACILITY

SEEPAGE PUMPS

WATER COLLECTION POND

NOTES:

1. BULK NAG TAILINGS AT 55% SOLIDS ARE DIRECTED TO CYCLONE PLANT FOR APPROXIMATELY 9 MONTHS PER YEAR OTHERWISE DISCHARGE IS DIRECTLY INTO TMF.

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TAILINGS HANDLING PROCESS FLOW DIAGRAM

Knight Piésold CONSULTING

P/A NO. VA101-325/8

REF NO. 10

FIGURE 7.1

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7.2 PAG TAILINGS DISTRIBUTION

A single PAG tailings line will be laid heading approximately east from the mill, between low grade ore stockpiles, down to the TMF. Valved tees located at intervals in the line will enable subaqueous deposition of the PAG tailings into the TMF. This can be accomplished using a floating HDPE pipeline with submerged exit holes. The line will be moored to shore to allow its location to be managed. Floatation will be provided to ensure that the line remains at surface. Consideration will be given in future design studies to the possibility of the floating line freezing during winter conditions.

The design of the PAG tailings delivery system from the mill to the TMF has been designed by Others.

7.3 BULK NAG TAILINGS DISTRIBUTION

Bulk NAG tailings will be delivered to the southwest end of the TMF, either for the production of sand via the cyclone plant (for approximately nine months per year) or for direct deposition into the TMF.

The design of the NAG tailings delivery system from the mill to the tailings head tank (feeding the cyclone plant) has been designed by Others. The design of the tailings delivery systems from the tailings head tank onwards have been designed by Paterson and Cooke (details are provided in Appendix E).

The same pipe system used to deliver the cyclone overflow stream to the TMF can also be used for the undiluted Bulk NAG tailings stream when the cyclone station is by-passed (see Section 7.4.2). Tailings discharge into the TMF will be from a selected valved off-take along a pipeline on the embankment crest. Valves will be spaced at approximately 100 meter intervals. Normally only one off-take will be open to manage the tailings discharge. Discharge into the TMF will not be continuous from any one location in the pipeline. It will be rotated between off-takes as appropriate for tailings distribution within the TMF. This will ensure adequate beach development adjacent to the embankments and maximize the ability of the reclaim system to recover clean water.

Discharge from the line will be enabled at appropriately located tees, each provided with a downstream isolation valve and an off-take valve. The off-take will typically include a downstream section of pipeline to allow single point tailings out-flow to be delivered into the surface water pond or beach, with minimum erosion of the confining embankment face.

7.4 CYCLONE SAND PRODUCTION

The design of the Cyclone Sand Plant and delivery systems from the sand plant to the TMF have been designed by Paterson and Cooke of Vancouver, B.C. Details of the design of the cyclone sand plant, cyclone underflow (sand) distribution system, cyclone overflow (fines) distribution system (including the bulk NAG tailings by-pass system) and associated water systems are provided in the Paterson Cooke report “Casino Project Tailings Cyclone and Transport Study – Feasibility Study Report, December, 2012). This document is included as Appendix E.

A required design criterion for the cyclone plant sand product is that the fines content (% passing a #200 sieve) must be 12% or less. The current particle size distribution of the bulk NAG tailings (approximately 58% sand fraction) and information provided by cyclone suppliers indicates that single-stage cycloning will be sufficient to achieve a clean sand product with 12% fines or less and a

sand recovery of approximately 50% by weight from the bulk tailings stream. The cyclone feed will require water addition to reduce the cyclone feed solids content to 36%. The sand (cyclone underflow) product will be produced at approximately 74% solids by weight. This will require water addition and mixing to a solids content of approximately 65% for distribution to discharge points along the embankment crest.

7.4.1 Cyclone Sand Discharge to Main Embankment

Cyclone sand will be delivered through a piping system on the downstream side of the embankment.

The pipe system consists of four sections:

- 18" downhill pipe
- 18" horizontal pipe on the sand jacking header
- 14" downhill pipes – from jacking header, and
- 14" downhill pipe – jacking header bypass for high turn down throughput requirements.

The 18" cyclone sand pipeline initially follows the 15% site gradient down towards the dam. At the Main Embankment the pipeline continues on a jacking header. 14" take off valves are provided every 100 metres from the main pipeline for sand deposition. Each take-off valve is connected to a mobile 14" HDPE DR 11 pipe, running downhill on the embankment to sand deposition cells (approximately 100 m by 20 m in size). Each 14" individual branch pipe is capable of transporting the full sand plant production to fill a cell at a time.

7.4.2 Cyclone Overflow Discharge

In conjunction with the production of the cyclone sand, the cyclone plant produces a large volume of tailings fines (combined cyclone overflow), at a low solids content (approximately 24%). This material is discharged into the TMF from points upstream of the Main Embankment, generally over the same locations as the bulk NAG tailings.

This system handles the cyclone overflow stream as well as the undiluted Bulk NAG tailings stream when the cyclone station is by-passed.

The system consists of three sections:

- 36" HDPE DR 11 downhill pipe
- 32" CS Std Sch horizontal pipe on jacking header, and
- 16" HDPE DR 17 take-off pipes from the jacking header.

The cyclone overflow pipeline initially follows the 15% site gradient down to the Main Embankment. On the embankment the pipe is laid on a hydraulically raised jacking header, which is a separate structure from the sand jacking header. 16" take-offs with valves are placed every 100 metres. Each take-off valve is connected to a 16" HDPE DR 17 pipe running down from the jacking header onto the beach of the TMF.

7.5 RECLAIM WATER SYSTEM

Water will be reclaimed from the tailings supernatant pond by two floating, barge mounted, pump-stations. One reclaim barge reports to the process water settlement pond located above the mill terrace for mill water and the other to a dilution water head tank to provide gravity flow to the cyclone

feed tank. The floating pump-stations will be located in the general southwest corner of the TMF at the start of operations.

Additional pump-stations in series are currently envisaged for the mill reclaim system, due to the significant elevation difference between the initial supernatant pond in the TMF and the mill, coupled with the possibility of a shallow supernatant pond increasing the risk of barge grounding.

The design of the reclaim water system from the TMF to the mill and from the TMF to the dilution water head tank has been completed by Others.

Water reclaimed from the TMF consists of supernatant from the settled tailings, as well as run-off from precipitation, snowmelt and ice melt, from within the TMF catchment area. Dedicated pipelines will convey reclaimed water to the settlement pond located up-gradient of the mill and a water head tank up-gradient of the cyclone plant. The initial mill reclaim discharge pipeline will run approximately northwest and relatively directly to the mill head tank. The cyclone plant water line will run approximately west from the TMF.

Water reclaim from the surface water pond begins with two shallow draft, barge mounted, reclaim pump-stations, that float within the TMF. These will be installed at locations remote from the point of normal tailings discharge to ensure clean water recovery. A shallow draft maximizes the potential for year round recovery of water of acceptable clarity. Relocation of the barges is required to accommodate ongoing development of the TMF, changes in the elevation of the surface water pond and encroachment of the tailings discharge plume into the vicinity of the barge.

The barges will be fitted with vertical turbine pumps, including standby pumping capacity and all necessary control, check, drainage and isolation valves. One pump will normally be operated on the mill reclaim barge at all times during winter, to reduce the potential for water freezing in the reclaim pipeline. The cyclone reclaim system will be drained and the barge winterized appropriately.

8 – INSTRUMENTATION AND MONITORING

8.1 GENERAL

Geotechnical instrumentation will be installed in the tailings embankment and foundation during construction and over the life of the project. The instrumentation will be monitored during the construction and operation of the TMF to assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the on-going designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise.

Geotechnical instrumentation, comprising vibrating wire piezometers, thermistors, slope inclinometers and movement (survey) monuments will be installed at selected planes along the Main Embankment and West Saddle Embankment. Groundwater wells will be installed at suitable locations downstream of the embankment.

Monitoring of civil and mechanical operational components will be a daily/shift requirement, to ensure that systems are functioning correctly. Excess noise/wear/movement/leakage/spillage etc. may indicate problems with pipelines or valves. In particular, during winter operations, ice formation may impact reclaim barge stability and operation or result in blockage of pipelines.

8.2 INSTRUMENTATION

Vibrating wire type piezometers will be installed in the embankment fill, foundations and tailings deposit to measure pore water pressures during initial placement, throughout operations and post-closure. The piezometers will be distributed throughout the various foundation and fill zones to provide a spectrum of monitoring data. Thermistors may be required to determine the temperature profile to supplement piezometer data. The piezometer and thermistor leads will be appropriately routed to read-out panels for ease of monitoring.

Movement monuments will be installed on the embankment crest following the completion of selective embankment raises to monitor deflections along the slope and crest of the embankment. Periodic surveying of the monument locations will provide early warning of movements and possible acceleration of movement which often occurs prior to failure

Groundwater monitoring/recovery wells will be installed at appropriate locations along the downstream toe of the Main Embankment. The wells will be used to recover samples for water quality monitoring.

8.3 MONITORING PROGRAM

Monitoring should be done routinely both during construction and operations. Following initial installation of the geotechnical instrumentation, measurements should be taken and analyzed on a daily basis to monitor the response of the earthfill and foundation from fill loading.

The frequency of monitoring for piezometers and inclinometers may be decreased to bi-monthly readings once the effects of initial construction have dissipated. Surface movement monuments should be surveyed twice per year during operations. Water quality and flow monitoring of the seepage through the embankment and foundation shall be monitored monthly during operations.

Pipeline and pump-station flow, wear and pressure monitoring, pump-power consumption and vibration monitoring will be ongoing requirements. During winter, heating, insulation and de-icing measures must be checked on a shift by shift basis. For all pipelines, any components required for emergency use, such as drainage, must be scheduled for inspection.

8.4 INSPECTION AND REVIEW

In addition to the routine inspections carried out by mine personnel on a shift/daily/weekly and monthly basis, the TMF should be regularly audited by a suitably qualified Geotechnical Engineer to ensure it is operating in a safe and efficient manner. Such audits should be conducted annually. Additionally, a formal dam safety review should be conducted every 5 to 10 years, depending on the dam classification assigned to the TMF embankments. For a HIGH dam classification, the frequency suggested by the CDA “Dam Safety Guidelines” (2007) is seven years. The dam classification is reviewed during the dam safety review process and should also be routinely reviewed as part of the annual audit.

9 – CLOSURE AND RECLAMATION

9.1 GENERAL

The primary objective of the closure and reclamation initiatives will be to eventually return the TMF site to a self-sustaining facility with pre-mining usage and capability. The TMF will be required to maintain long-term stability, protect the downstream environment and manage surface water. Activities that will be carried out during operations and at closure to achieve these objectives are discussed in the following sections.

The closure plan for the project is being developed by Others.

9.2 DECOMMISSIONING AND CLOSURE

Upon mine closure, surface facilities will be removed in stages and full reclamation of the TMF will be initiated. General aspects of the closure plan include:

- Selective discharge of tailings around the facility during the final years of operations to establish a final tailings surface and water pond that will facilitate post closure surface water management and reclamation (including full coverage by the water pond to ensure all PAG tailings and reactive (PAG/ML) waste rock remain in a fully saturated state).
- Dismantling and removal of the tailings and reclaim delivery systems, cyclone plant and all pipelines, structures and equipment not required beyond mine closure.
- Removal of the seepage collection system at such time that suitable water quality for direct release is achieved.
- Construction of an overflow spillway and channel to allow surface water discharge downstream of the TMF.
- Removal and regrading of all access roads, ponds, ditches and borrow areas not required beyond mine closure.
- Long-term stabilization of all exposed erodible materials.
- During the closure phase of the project, suitable topsoil and seeding will be placed on the beach surface after tailings deposition ends to promote revegetation and minimise dusting potential.

9.3 CLOSURE SPILLWAY

A spillway and downstream channel will be required at closure to facilitate control and discharge of excess water accumulation within the TMF and to provide safe passage of storm water volumes from the TMF. The water balance model developed for the TMF indicates that there will be a water surplus at closure.

The closure spillway will be located close to the west abutment of the West Saddle Embankment to provide long term protection against overtopping of the TMF during the post closure years. The spillway will be routed from the TMF to the south, ultimately terminating at a plunge pool prior to discharging to Brynelson Creek, as shown on Figure 9.1.

The spillway design flow (SDF) for the closure spillway was calculated by routing the Probable Maximum Flood (PMF) storm hydrograph through the TMF supernatant pond assuming the facility is at capacity at the time the storm occurs. Diversion ditches were assumed to have been damaged

and not functioning in this storm flood routing evaluation. The routing exercise determined the IDF hydrograph for the TMF to be 854 m^3/s. Modelling of the closure spillway indicated that a 20 meter wide spillway sill, with 2 horizontal to 1 vertical side slopes will result in a peak outflow (SDF) from the pond of approximately 45 m^3/s, with a peak water elevation of 1.1 m above the closure spillway invert.

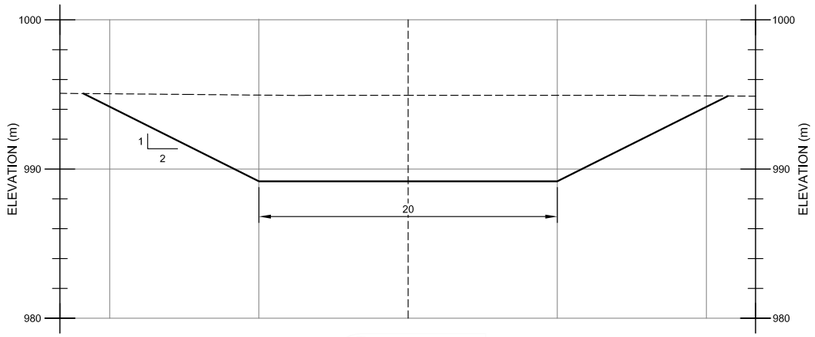
The spillway will be comprised of a 20 meter wide side sill, with 2 horizontal to 1 vertical side slopes, excavated in bedrock to an invert elevation of 3 m below the crest of the dam. The sill of the spillway will convey the SDF downstream to a discharge channel that will be aligned along an existing tributary for Brynelson Creek. This tributary will be modified to provide a channel having a minimum base width of 5 meters, and 1 (or greater) horizontal to 1 vertical side slopes. The spillway channel will ultimately terminate at an adequately sized and erosion protected plunge pool at the confluence of Brynelson Creek. Flow depths through the spillway channel have been calculated to range between 0.6 m in the steeper upper regions and 1 m in the shallower lower regions.

To satisfy post-closure water quality requirements and objectives a concrete “stop-log” system may be installed in the spillway structure to facilitate impounding of the supernatant pond. This allows downstream seepage water to be collected and returned to the pond during the winter months, and released during the summer months.

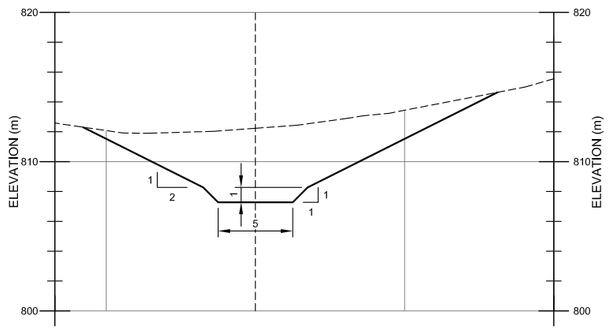
9.4 ON-GOING MONITORING REQUIREMENTS

The seepage collection ponds/sumps and recycle pumps will be retained until monitoring results indicate that any seepage from the TMF is of suitable quality for direct release to downstream waters. The groundwater monitoring wells and all other geotechnical instrumentation will be retained for use as long term monitoring devices.

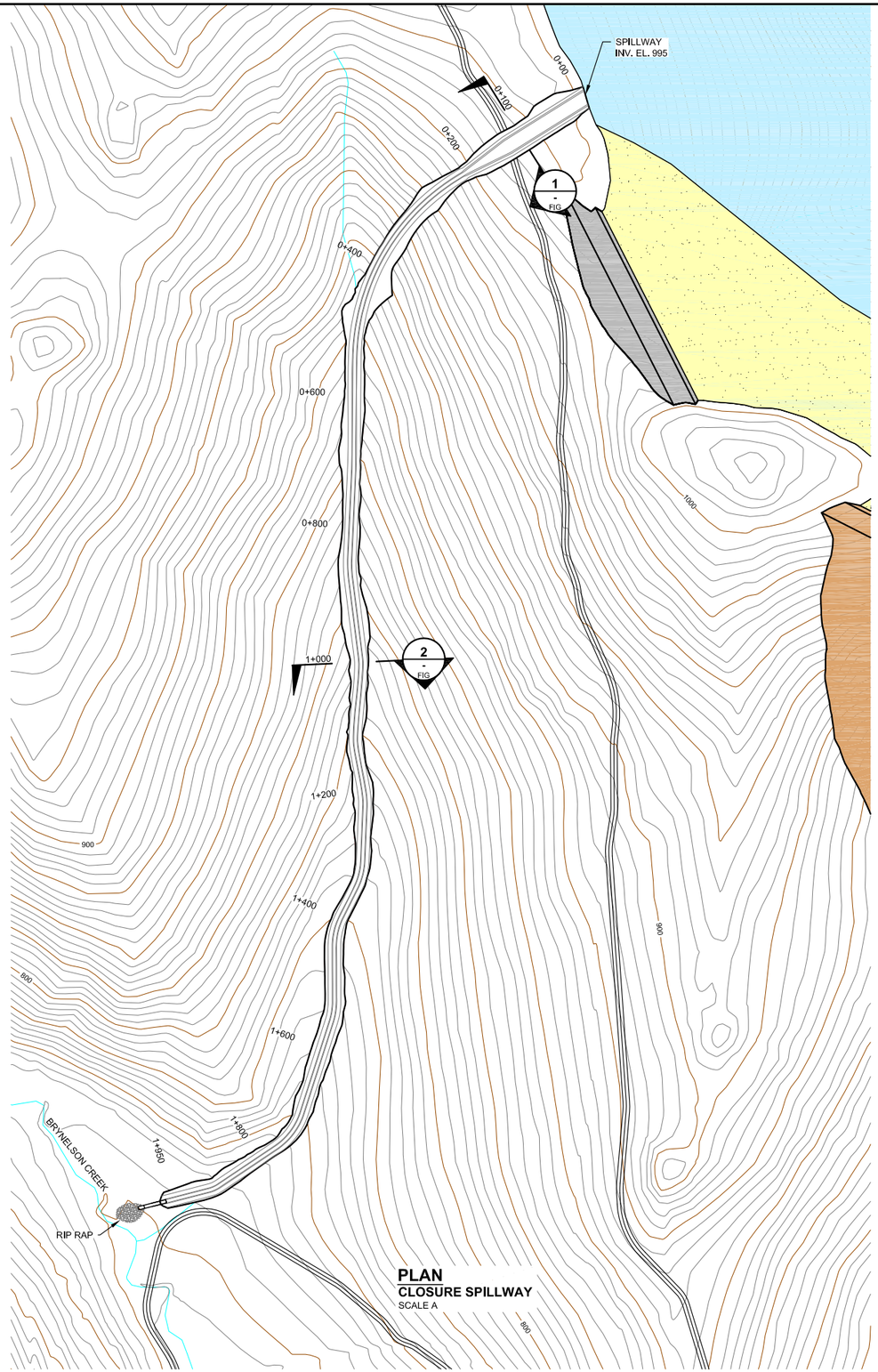
Post-closure requirements will also include an annual inspection of the TMF and an on-going evaluation of water quality, flow rates and instrumentation records to confirm design assumptions for closure.



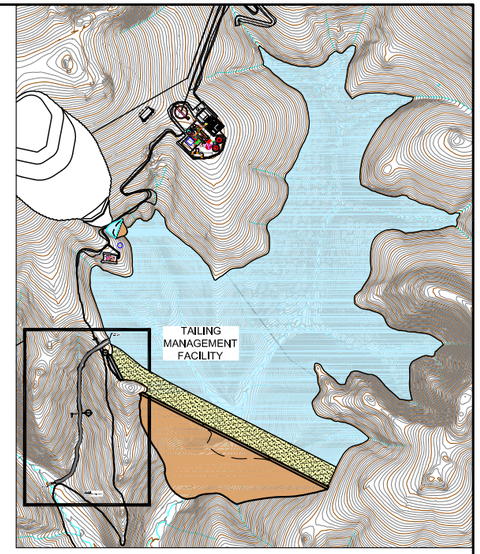
1 - FIG **SECTION**
STA. 0+100
SCALE B



2 - FIG **SECTION**
STA. 1+000
SCALE B



PLAN
CLOSURE SPILLWAY
SCALE A



KEY PLAN

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 5 METRES.
3. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION.(OCTOBER 4, 2012)

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SCALE B: 4 2 0 4 8 12 16 20 m

SCALE A: 80 40 0 100 200 300 400 mm

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CASINO MINING CORPORATION

CASINO COPPER GOLD PROJECT

TAILINGS MANAGEMENT FACILITY
CLOSURE SPILLWAY

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P/A NO. VA101-325/08

REF NO. 10

FIGURE 9.1

REV 0

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XREF FILES: (IMAGE FILES)

10 – SCHEDULE OF QUANTITIES

Quantity estimates for the materials and work items required for initial construction and for ongoing expansion and operation of the TMF are presented in Table 10.1.

Quantities have been estimated for the following components of the TMF:

- Topsoil/overburden stripping
- Foundation preparation within the embankment footprints (including excavation of unsuitable materials)
- Embankment fill placement, including seepage cut-off
- Seepage interception and collection system
- Instrumentation and monitoring, and
- Closure Spillway

The Feasibility level quantities were measured on the basis of the designs and dimensions shown on the relevant Figures of this report. These quantities have been developed to enable costing to be conducted to a level of accuracy of ± 15 percent. It is understood that the all initial and sustaining capital costs and operating costs will be carried out by Others.

The cost estimate will also need to include the following items:

- Hauling of all embankment fill materials to the embankment
- Hauling of topsoil/overburden materials to stockpiles
- Hauling of unsuitable foundation soils for disposal within TMF
- Hauling potentially reactive waste rock and overburden to the TMF, and
- Electrical power supply, instrumentation and control.

Equipment lists and quantities (material take-off lists) for the cyclone sand plant, cyclone underflow (sand) distribution system, cyclone overflow (fines) distribution system (including the bulk NAG tailings by-pass system) and associated water systems are provided in the Paterson Cooke report "Casino Project Tailings Cyclone and Transport Study – Feasibility Study Report, December, 2012). This document is included as Appendix E.

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TABLE 10.1

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
TAILINGS MANAGEMENT FACILITY SCHEDULE OF QUANTITIES

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Item Number		Description	Unit	PP Quantity	Year 1 Quantity	Year 2 Quantity	Year 3 Quantity	Year 4 Quantity	Year 5 Quantity	Year 6 Quantity	Year 7 Quantity	Year 8 Quantity	Year 9 Quantity	Year 10 Quantity	Year 11 Quantity
1		**TAILINGS MANAGEMENT FACILITY EARTHWORKS**													
		MAIN EMBANKMENT													
1.1		**Clearing and Grubbing TMF Main Embankment Foundation Footprint**	m^2	242,000	176,000	154,000	132,000	110,000	88,000	88,000	77,000	66,000	66,000	55,000	55,000
1.2		**Topsoil Stripping of TMF Main Embankment Foundation Footprint - 1 m Average**	m^3	242,000	176,000	154,000	132,000	110,000	88,000	88,000	77,000	66,000	66,000	55,000	55,000
1.3		**Excavation of Colluvial Apron under TMF Main Embankment Foundation Footprint (10 m Average)**	m^3	1,315,000	317,000	317,000	317,000	317,000	317,000	317,000	317,000	317,000	317,000	317,000	317,000
1.4		**Excavation of Core Trench in Overburden Other Than Colluvial Apron**	m^3	104,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
1.5		**Construction Dewatering - Upstream Cofferdam and Pumping**	PS	1	0	0	0	0	0	0	0	0	0	0	0
1.6		**TMF Main Embankment Construction**													
	a	Haul, Place and Compact Upstream Blanket	m^3	226,000	0	0	0	0	0	0	0	0	0	0	0
	b	Haul, Place and Compact Core Zone (Excluding Upstream Blanket)	m^3	3,046,000	0	477,000	486,000	364,000	282,000	408,000	400,000	333,000	385,000	350,000	313,000
	c	Haul, Place and Compact Filter Zone	m^3	221,000	0	94,000	96,000	72,000	55,000	81,000	79,000	66,000	76,000	69,000	62,000
	d	Haul, Place and Compact Shell Zone from Local Borrow	m^3	5,630,000	1,320,000	0	0	0	0	0	0	0	0	0	0
	e	Haul, Place and Compact Shell Zone from Open Pit	m^3	1,100,000	0	0	0	0	0	0	0	0	0	0	0
	f	Haul, Place and Compact Cycloned Sand	m^3	0	5,589,000	7,440,000	7,422,000	7,396,000	7,331,000	7,323,000	7,319,000	7,411,000	7,467,000	7,254,000	7,241,000
		WEST EMBANKMENT													
1.7		**Clearing TMF West Embankment Foundation Footprint**	m^2	41,000	0	0	0	0	0	0	0	0	0	0	0
1.8		**Stripping and Grubbing TMF West Embankment Foundation Footprint - 1 m Average**	m^3	41,000	0	0	0	0	0	0	0	0	0	0	0
1.9		**Excavation of Core Trench in Overburden**	m^3	9,000	0	0	0	0	0	0	0	0	0	0	0
1.10		**TMF West Embankment Construction**													
	a	Haul, Place and Compact Core Zone	m^3	58,000	0	0	0	0	0	0	0	0	0	0	0
	b	Haul, Place and Compact Filter Zone	m^3	19,000	0	0	0	0	0	0	0	0	0	0	0
	c	Haul, Place and Compact Shell Zone from Local Borrow	m^3	313,000	0	0	0	0	0	0	0	0	0	0	0
2		**SEEPAGE AND SURFACE WATER MANAGEMENT SYSTEM**													
		WATER MANAGEMENT POND													
2.1		**Excavation of Unsuitable Materials (Average 20 m Depth)**	m^3	591,000	0	0	0	0	0	0	0	0	0	0	0
2.2		**Backfilling/Pond Slope Construction**	m^3	33,000	0	0	0	0	0	0	0	0	0	0	0
2.3		**Liner System**													
	a	Primary Geomembrane: 60 mil (1.5 mm) LLDPE	m^2	50,000	0	0	0	0	0	0	0	0	0	0	0
	b	Leak Detection Layer/ Drainage Gravel Layer (0.3 m thick)	m^3	9,400	0	0	0	0	0	0	0	0	0	0	0
	c	Bedding Layer, 300 mm Thick (Supply, Place and Compact)	m^3	9,400	0	0	0	0	0	0	0	0	0	0	0
2.4		**Return Pipeline from WMP to TMF (HDPE DR9 700 mm)**	m	1,600	0	0	0	0	0	0	0	0	0	0	0
2.5		**Pond Spillway and Discharge Channel (Approx. 472 m Length) (Excavation and Erosion Protection)**	m^3	22,000	0	0	0	0	0	0	0	0	0	0	0
2.6		**Pump Station (313 m Head, 972 m3/hr)**	LS	1	0	0	0	0	0	0	0	0	0	0	0
2.7		**Access Road**	m	1,700	0	0	0	0	0	0	0	0	0	0	0
2.8		**Construction and Engineered Lining/Energy Dissapation (Width = 2.5 to 6 m)**	m	6,100	0	0	0	0	0	0	0	0	0	0	0
2.8		**Drainage Ditching**													
	a	Construction and Engineered Lining/Energy Dissapation (Width = 2.5 to 6 m)	m	6,100	0	0	0	5,400	0	0	0	0	0	6,900	0
	b	Upgrade to existing (widening)	m	0	0	0	0	1,300	0	0	0	0	0	800	0
		SEEPAGE COLLECTION SYSTEM													
2.9		**Gravel Collection Drainage Mat (300 mm Thickness)**	m^3	34,000	0	0	0	117,000	0	0	0	0	0	111,000	0
2.10		**Sub-Collector Header Pipes (HDPE DR7.3 150 mm)**	m	1,200	0	0	0	2,100	0	0	0	0	0	2,700	0
2.11		**Collector Header Pipes (HDPE DR7.3 150 mm)**	m	760	0	0	0	0	0	0	0	0	0	0	0
2.12		**Deep-trench Seepage Connection Pipe to Pond (HDPE DR7.3 150 mm)**	m	210	0	0	0	0	0	0	0	0	0	0	0
3		**CLOSURE SPILLWAY**													
3.1		**Stripping and Grubbing**	m^2	0	0	0	0	0	0	0	0	0	0	0	0
3.2		**Excavation of Overburden**	m^3	0	0	0	0	0	0	0	0	0	0	0	0
3.3		**Spillway Excavation - Drill and Blast Rock**													
	a	Spillway Channel	m^3	0	0	0	0	0	0	0	0	0	0	0	0
	b	Plunge Pool	m^3	0	0	0	0	0	0	0	0	0	0	0	0
3.4		**Erosion Protection at Spillway Outlet**													
	a	Erosion Protection at Spillway Outlet - Rip Rap	m^3	0	0	0	0	0	0	0	0	0	0	0	0
	b	Erosion Protection at Spillway Outlet - Geotextile Liner	m^2	0	0	0	0	0	0	0	0	0	0	0	0
3.5		**Hydroseeding of Erodible Exposed Overburden Faces**	m^2	0	0	0	0	0	0	0	0	0	0	0	0
3.6		**Spillway Surface Foundation Treatment**													
	a	Concrete	m^3	0	0	0	0	0	0	0	0	0	0	0	0
	b	Mesh	m^2	0	0	0	0	0	0	0	0	0	0	0	0
	c	Anchor Bolts #5 or #6 Rebar	m	0	0	0	0	0	0	0	0	0	0	0	0
	d	Rebar Face Plates	ea	0	0	0	0	0	0	0	0	0	0	0	0
4		**INSTRUMENTATION AND MONITORING**	PS	1	0	0	0	0	0	0	0	0	0	0	0
5		**SEDIMENT AND EROSION CONTROL BMP'S ALLOWANCE**	PS	1	0	0	0	0	0	0	0	0	0	0	0

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TABLE 10.1

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
TAILINGS MANAGEMENT FACILITY SCHEDULE OF QUANTITIES

Item Number	Description	Unit	Year 12 Quantity	Year 13 Quantity	Year 14 Quantity	Year 15 Quantity	Year 16 Quantity	Year 17 Quantity	Year 18 Quantity	Year 19 Quantity	Year 20 Quantity	Year 21 Quantity	Year 22 Quantity
1	**TAILINGS MANAGEMENT FACILITY EARTHWORKS**												
	MAIN EMBANKMENT												
1.1	**Clearing and Grubbing TMF Main Embankment Foundation Footprint**	m^2	55,000	55,000	55,000	55,000	0	0	0	0	0	0	0
1.2	**Topsoil Stripping of TMF Main Embankment Foundation Footprint - 1 m Average**	m^3	55,000	55,000	55,000	55,000	0	0	0	0	0	0	0
1.3	**Excavation of Colluvial Apron under TMF Main Embankment Foundation Footprint (10 m Average)**	m^3	317,000	317,000	317,000	317,000	0	0	0	0	0	0	0
1.4	**Excavation of Core Trench in Overburden Other Than Colluvial Apron**	m^3	7,000	7,000	7,000	7,000	0	0	0	0	0	0	0
1.5	**Construction Dewatering - Upstream Cofferdam and Pumping**	PS	0	0	0	0	0	0	0	0	0	0	0
1.6	**TMF Main Embankment Construction**												
a	Haul, Place and Compact Upstream Blanket	m^3	0	0	0	0	0	0	0	0	0	0	0
b	Haul, Place and Compact Core Zone (Excluding Upstream Blanket)	m^3	319,000	372,000	286,000	290,000	342,000	300,000	306,000	313,000	214,000	164,000	166,000
c	Haul, Place and Compact Filter Zone	m^3	63,000	74,000	56,000	57,000	67,000	59,000	60,000	62,000	42,000	32,000	32,000
d	Haul, Place and Compact Shell Zone from Local Borrow	m^3	0	0	0	0	0	0	0	0	0	0	0
e	Haul, Place and Compact Shell Zone from Open Pit	m^3	0	0	0	0	0	0	0	0	0	0	0
f	Haul, Place and Compact Cycloned Sand	m^3	7,429,000	7,492,000	7,419,000	7,320,000	7,300,000	7,253,000	2,569,000	2,569,000	2,569,000	2,000,000	1,000,000
	WEST EMBANKMENT												
1.7	**Clearing TMF West Embankment Foundation Footprint**	m^2	0	0	0	0	0	0	0	0	0	0	0
1.8	**Stripping and Grubbing TMF West Embankment Foundation Footprint - 1 m Average**	m^3	0	0	0	0	0	0	0	0	0	0	0
1.9	**Excavation of Core Trench in Overburden**	m^3	0	0	0	0	0	0	0	0	0	0	0
1.10	**TMF West Embankment Construction**												
a	Haul, Place and Compact Core Zone	m^3	0	0	0	0	0	0	0	0	0	0	0
b	Haul, Place and Compact Filter Zone	m^3	0	0	0	0	0	0	0	0	0	0	0
c	Haul, Place and Compact Shell Zone from Local Borrow	m^3	0	0	0	0	0	0	0	0	0	0	0
2	**SEEPAGE AND SURFACE WATER MANAGEMENT SYSTEM**												
	WATER MANAGEMENT POND												
2.1	**Excavation of Unsuitable Materials (Average 20 m Depth)**	m^3	0	0	0	0	0	0	0	0	0	0	0
2.2	**Backfilling/Pond Slope Construction**	m^3	0	0	0	0	0	0	0	0	0	0	0
2.3	**Liner System**												
a	Primary Geomembrane: 60 mil (1.5 mm) LLDPE	m^2	0	0	0	0	0	0	0	0	0	0	0
b	Leak Detection Layer/ Drainage Gravel Layer (0.3 m thick)	m^3	0	0	0	0	0	0	0	0	0	0	0
c	Bedding Layer, 300 mm Thick (Supply, Place and Compact)	m^3	0	0	0	0	0	0	0	0	0	0	0
2.4	**Return Pipeline from WMP to TMF (HDPE DR9 700 mm)**	m	0	0	0	0	0	0	0	0	0	0	0
2.5	**Pond Spillway and Discharge Channel (Approx. 472 m Length) (Excavation and Erosion Protection)**	m^3	0	0	0	0	0	0	0	0	0	0	0
2.6	**Pump Station (313 m Head, 972 m3/hr)**	LS	0	0	0	0	0	0	0	0	0	0	0
2.7	**Access Road**	m	0	0	0	0	0	0	0	0	0	0	0
2.8	**Drainage Ditching**	m	0	0	0	0	0	0	0	0	0	0	0
a	Construction and Engineered Lining/Energy Dissapation (Width = 2.5 to 6 m)	m	0	0	0	0	0	0	0	0	0	0	0
b	Upgrade to existing (widening)	m	0	0	0	0	0	0	0	0	0	0	0
	SEEPAGE COLLECTION SYSTEM												
2.9	**Gravel Collection Drainage Mat (300 mm Thickness)**	m^3	0	0	0	0	0	0	0	0	0	0	143,000
2.10	**Sub-Collector Header Pipes (HDPE DR7.3 150 mm)**	m	0	0	0	0	0	0	0	0	0	0	3,500
2.11	**Collector Header Pipes (HDPE DR7.3 150 mm)**	m	0	0	0	0	0	0	0	0	0	0	0
2.12	**Deep-trench Seepage Connection Pipe to Pond (HDPE DR7.3 150 mm)**	m	0	0	0	0	0	0	0	0	0	0	0
3	**CLOSURE SPILLWAY**												
3.1	**Stripping and Grubbing**	m^2	0	0	0	0	0	0	0	0	0	0	67,000
3.2	**Excavation of Overburden**	m^3	0	0	0	0	0	0	0	0	0	0	187,000
3.3	**Spillway Excavation - Drill and Blast Rock**												
a	Spillway Channel	m^3	0	0	0	0	0	0	0	0	0	0	39,000
b	Plunge Pool	m^3	0	0	0	0	0	0	0	0	0	0	1,100
3.4	**Erosion Protection at Spillway Outlet**												
a	Erosion Protection at Spillway Outlet - Rip Rap	m^3	0	0	0	0	0	0	0	0	0	0	5,500
b	Erosion Protection at Spillway Outlet - Geotextile Liner	m^2	0	0	0	0	0	0	0	0	0	0	2,800
3.5	**Hydroseeding of Erodible Exposed Overburden Faces**	m^2	0	0	0	0	0	0	0	0	0	0	55,000
3.6	**Spillway Surface Foundation Treatment**												
a	Concrete	m^3	0	0	0	0	0	0	0	0	0	0	4,400
b	Mesh	m^2	0	0	0	0	0	0	0	0	0	0	23,700
c	Anchor Bolts #5 or #6 Rebar	m	0	0	0	0	0	0	0	0	0	0	23,700
d	Rebar Face Plates	ea	0	0	0	0	0	0	0	0	0	0	23,700
4	**INSTRUMENTATION AND MONITORING**	PS	0	0	0	0	0	0	0	0	0	0	0
5	**SEDIMENT AND EROSION CONTROL BMP'S ALLOWANCE**	PS	0	0	0	0	0	0	0	0	0	0	0

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\Tables\[Table 10.1 Rev 0 - Earthworks Schedule of Quantities.xlsx]Table 10.1

NOTE:

1. PS = PROVISIONAL SUM.
2. QUANTITIES INCLUDE 10% OVERBUILD ALLOWANCE.
3. ALL VOLUME ARE IN PLACE -> BCM / CCM / LCM
4. NO CONTINGENCY ADDED TO QUANTITIES.
5. ALL ROCKFILL IS ASSUMED TO BE SOURCED FROM LOCAL BORROW SOURCES.
6. COLLUVIAL APRON IS ICE-RICH SOIL AND MORE DIFFICULT TO EXCAVATE THAN OTHER OVERBURDEN.

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11 – RECOMMENDATIONS FOR FUTURE STUDIES

The following is a list of recommendations for additional geotechnical site investigations, laboratory testing and design studies required to carry the TMF design through to final design and construction:

Geotechnical Investigations and Laboratory Testwork

- Additional geotechnical drilling and test pits in the TMF area to investigate and confirm foundation conditions (specifically the extent of the colluvial apron), permafrost characteristics and depth to bedrock.
- Additional test pits and drilling to confirm suitability and quantity of borrow materials for embankment construction (specifically low permeability soils for embankment core zone).
- Additional laboratory index testing (including compaction tests) and strength and permeability tests on potential borrow materials for embankment construction.
- Laboratory testing to confirm the physical characteristics of the cyclone sand (material classification, strength and permeability tests). This should include strength and permeability tests at very high confining stresses, representative of the large height of the Main Embankment, and testing to examine the influence of cyclone sand fines content on available percentage of sand recovery and the impact on permeability.
- Examination of the influence of cyclone underflow solids content on the compaction characteristics of in situ cyclone sand fill.
- Laboratory testing to determine the physical characteristics of the PAG tailings (material classification, slurry settling, consolidation and permeability tests).

Large scale generation of a cyclone sand sample (using a laboratory cyclone device) is recommended to provide sufficient quantity of representative sand material for laboratory testing.

Design Studies and Analyses

- Review and updates to hydrometeorological and hydrology information, incorporating on-going site data collection.
- Review and confirmation of the thermal regime in the TMF foundation using site thermistor data. Thermal modelling may also be required to predict the effect of the TMF on foundation conditions.
- Confirmation of geochemical characterisation and potential reactivity of tailings and waste rock from on-going waste characterisation studies.
- Review and confirmation of TMF seepage predictions and seepage control measures and requirements
- Development of a tailings and waste rock deposition strategy to optimize material handling, and tailings discharge line and reclaim barge locations throughout operations.
- Consideration of alternative core zone materials and options if additional characterisation and delineation of borrow sources indicates a potential shortfall of suitable low permeability material.
- Assessment of the sequencing of sand cell construction in relation to embankment raising requirements to optimise material demand and placement strategies.
- Evaluation of the potential impact of sloping sub-aerial and sub-aqueous tailings beach areas. Consideration of tailings beach configurations may result in modifications to staged embankment heights and the tailings deposition strategy.

- Review and reassessment of trade-off study for embankment construction material options (cyclone sand versus local borrow material) based on the most current design requirements and cost estimate information.

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13 – CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

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APPENDIX A

LIST OF PREVIOUS KNIGHT PIÉSOLD LTD. AND HALLAM KNIGHT PIÉSOLD REPORTS

(Pages A-1 to A-3)

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APPENDIX A

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

LIST OF KNIGHT PIÉSOLD LTD. REPORTS AND HALLAM KNIGHT PIESOLD LTD. REPORTS

1. Knight Piésold Ltd., December, 2012, 2012 Geotechnical Site Investigation Data Report Waste Management Facilities (Ref. No. VA101-325/8-14, Rev 0).

2. Knight Piésold Ltd., December, 2012, Feasibility Design of Heap Leach Facility (Ref. No. VA101-325/8-9, Rev 0).

3. Knight Piésold Ltd., December, 2012, Waste Storage Area and Stockpiles Feasibility Design (Ref. No. VA101-325/8-12, Rev A).

4. Knight Piésold Ltd., December, 2012, Report on Revised Tailings Management Facility Seepage Assessment (Ref. No. VA101-325/8-13, Rev 0).

5. Knight Piésold Ltd., December, 2012, Report on Laboratory Geotechnical Testing of Tailings Materials (Ref. No. VA101-325/8-1, Rev 0).

6. Knight Piésold Ltd., July 9, 2012, Updated Hydrometeorology Report (Ref. No. VA101-325/8-11, Rev 0).

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8. Knight Piésold Ltd., April 13, 2012, Terrain Hazards Assessment for Proposed Mine Site (Ref. No. VA101-325/8-3, Rev 0).

9. Knight Piésold Ltd., February 23, 2011, Revised Pre-Feasibility Design of the Heap Leach Facility (Ref. No. VA101-325/3-6, Rev A).

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12. Knight Piésold Ltd., February 4, 2011, Waste Storage Area and Ore Stockpiles (Ref. No. VA10-01746, Rev A).

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18. Knight Piésold Ltd., June 15, 2010, Hydrometeorology Report (Ref. No. VA101-325/3-1, Rev 0).

19. Knight Piésold Ltd., May 16, 2010, May 2010 Casino Site Visit (Ref. No. VA10-00863).

20. Knight Piésold Ltd., March 21, 2010, March 2010 Winter Low-Flow Site Visit (Ref. No. VA10-00568).

21. Knight Piésold Ltd., November 17, 2008, Heap Leach Facility Alternative Site (Ref. No. VA08-02009).

22. Knight Piésold Ltd., October 6, 2008, Geotechnical Laboratory Testing of Tailings (Ref. No. VA101-325/2-1, Rev 0).

23. Knight Piésold Ltd., August 25, 2008, Chapter 4 – Geotechnical Pre-Feasibility Design (Ref. No. VA101-325/1-3, Rev 1).

24. Knight Piésold Ltd., April 23, 2008, Pre-Feasibility Design of the Heap Leach Facility (Ref. No. VA101-325/1-1, Rev 0).

25. Knight Piésold Ltd., April 22, 2008, Conceptual Water Intake at Yukon River (Ref. No. VA08-00809).

26. Knight Piésold Ltd., April 16, 2008, Waste Storage Area and Low Grade Ore Stockpiles (Ref. No. VA08-00818).

27. Knight Piésold Ltd., March 14, 2008, Potable Water Study (Ref. No. VA08-00317).

28. Knight Piésold Ltd., February 15, 2008, Preliminary Plant Site Foundation Assessment (Ref. No. VA07-01669).

29. Knight Piésold Ltd., January 24, 2008, Preliminary Open Pit Slope Design (Ref. No. VA07-01637).

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40. Hallam Knight Piesold Ltd., November 18, 1993, Environmental Monitoring Program – Baseline Environmental and Socioeconomic Studies.

APPENDIX B

SEISMIC HAZARD ASSESSMENT

(Pages B-1 to B-8)

APPENDIX B

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

SEISMIC HAZARD ASSESSMENT

B.1 INTRODUCTION

A seismicity assessment has been carried out for the Casino Copper-Gold Project, including a review of the regional seismicity and a seismic hazard analysis. The results of the seismic hazard analysis are required to provide seismic design parameters for the design of the Tailings Management Facility and for other facilities at the project site, including the Heap Leach Facility and ore stockpiles. Design ground motion parameters provided by the seismic hazard analysis include peak ground acceleration, spectral acceleration (defining the uniform hazard spectrum) and design earthquake magnitude.

The findings of the seismicity review and the methodology and results of the seismic hazard analysis are presented in the following sections.

B.2 REGIONAL TECTONICS AND SEISMICITY

The region of the southwest Yukon Territory and northwest British Columbia is one of the most seismically active areas in Canada. The seismic hazard in the region is also influenced by the seismically active region of southeast Alaska. The coastal region has experienced many large earthquakes, including events with magnitudes in the range of magnitude 7.0 to 8.0. In 1958 a magnitude 7.9 earthquake occurred along the Fairweather fault (the northern extension of the Queen Charlotte transform fault). The most significant inland zone of seismicity follows the Dalton and Duke River segments of the Denali fault zone through the southwest Yukon. Farther inland there is only minor seismicity between the Denali and Tintina fault systems, including the region of the Casino Project site.

The southern coast of Alaska is a region of high seismicity and high seismic hazard, where earthquakes are generated by the Pacific (oceanic) plate subducting under the North American plate at an average rate of approximately 5 to 8 cm per year. Evidence shows that these tectonic plates are locking as they pass each other, building up tremendous pressure that can sometimes be released as large Magnitude 8 to 9+ earthquakes. These large interface subduction (thrust) earthquakes typically occur at shallow depths of 15 to 35 km. This seismic source region, known as the Alaska-Aleutian Megathrust, has been responsible for several of the largest earthquakes recorded globally, including the 1964 Prince William Sound Magnitude 9.2 (M9.2) earthquake. There is potential for future large interface subduction earthquakes (M8 to M9+) along the southern coast of Alaska. However, these earthquakes would occur at too great a distance from the Casino project to have any significant influence on the seismic hazard at the site, due to attenuation of ground motions over the large distance (over 400 km).

Figure B.1 shows the regional tectonics and historical seismicity of the Yukon and surrounding regions and the location of the Casino project.

B.3 SEISMIC HAZARD ANALYSIS

The seismic hazard for the Casino project has been defined using probabilistic methods of analysis. This method requires an examination of historical earthquake data and the regional tectonics to identify potential seismic sources and to determine the maximum earthquake magnitude for each seismic source. Appropriate relationships defining the attenuation of earthquake ground motion with distance are also required.

Design ground motion parameters have been determined for the project site using information provided by the probabilistic seismic hazard database of Natural Resources Canada (NRC) (http://earthquakescanada.nrcan.gc.ca/hazard-alea/zoning/haz-eng.php). The results are summarized in Table B.1 in terms of earthquake return period, probability of exceedance (for a 22 year design operating life) and the corresponding peak ground acceleration (median and mean hazard values). However, the NRC database only provides ground motion parameters up to a return period of approximately 2500 years (corresponding to a 2% probability of exceedance in 50 years). Higher return periods will need to be considered for dam design if the classification is defined as Very High or Extreme (based on the requirements of the Canadian Dam Safety Guidelines). Therefore, a probabilistic seismic hazard analysis has been conducted to provide ground motion parameters beyond 2500 years, specifically for return periods of 5000 and 10,000 years.

The methodology used to complete the site-specific probabilistic seismic hazard analysis and the results of the analysis are described in the following sections.

B.3.1 Ground Motion Attenuation

Appropriate attenuation models defining the relationship between earthquake magnitude, source to site distance and peak ground motion (acceleration) are required to carry out a probabilistic seismic hazard analysis. The ground motions experienced at the project site are dependent on the regional ground motion attenuation characteristics and the earthquake source mechanism.

For shallow crustal earthquakes a set of four ground motion attenuation models, known as the New Generation Attenuation (NGA) relations was used (Earthquake Spectra, 2008). These include the ground motion relationships of Abrahamson and Silva, Boore and Atkinson, Campbell and Bozorgnia and Chiou and Youngs. These ground motion attenuation relationships are applicable to shallow crustal earthquakes in western North American and similar tectonic regions of the world. The predicted peak ground accelerations for shallow crustal earthquakes are average values calculated using the four attenuation relationships (equal weighting).

The peak ground accelerations and spectral accelerations predicted using the attenuation relationships are for soft rock/very dense soil site conditions, assuming an average shear wave velocity in the upper 30 meters (defined as the Vs30 value) of 560 m/sec (range of 360 to 760 m/sec). This corresponds to Site Class C, as defined by the National Building Code of Canada (NBCC 2010).

B.3.2 Probabilistic Analysis

A probabilistic seismic hazard analysis is carried out to define a unique probability of occurrence for each possible level of ground acceleration experienced at a site. The methodology used for the probabilistic

analysis is based on that presented by Cornell (1968). The likelihood of occurrence of earthquakes within defined seismic source zones is determined by examining seismicity data. Using historical earthquake records for the region, magnitude-frequency recurrence relationships are established for potential earthquake source zones. The magnitude recurrence relationships are of the form derived by Gutenberg-Richter (1944):

$$\log(N) = a - b(M)$$

where, M = Earthquake magnitude
N =Annual frequency of occurrence for earthquakes exceeding magnitude M
(1/N = Return Period)

The computer program EZ-FRISK (Risk Engineering, Inc., 2008) was used to develop a seismic hazard model for the southern Yukon and the surrounding regions. The seismic hazard analysis module available with EZ-FRISK includes a database provided by Risk Engineering Inc. of faults and areal seismic sources for the pertinent regions of western Canada. Seismic sources defined in the hazard model include the regions of the southern Yukon Territory, southeastern Alaska, and the Denali and Fairweather fault systems. The project site is located within an areal seismic source that defines the seismicity in the southern Yukon. A maximum earthquake of Magnitude 7.0 was assigned to this source zone, which is characterized by shallow crustal earthquakes.

Magnitude-frequency recurrence relationships and the corresponding maximum earthquake magnitude for each seismic source are prepared by Risk Engineering from consideration of historical seismicity, fault characteristics and the regional tectonics, using information obtained from the Geological Survey of Canada and proprietary studies. For calculation of peak ground accelerations a minimum magnitude of 5.0 was used in the analysis for all seismic source zones. Earthquakes of lower magnitude are not considered to be a risk to engineered facilities. Appropriate ground motion attenuation relationships were assigned to each seismic source, as discussed in Section 2.1 above.

The seismic hazard model developed using EZ-FRISK was used to determine the relationship between peak ground acceleration and annual frequency of occurrence for the project site. Median hazard values of peak ground acceleration have been determined for return periods up to 10,000 years. Predicted values for the project site are included in Table B.1 for return periods of 5000 and 10,000 years. Predicted values for lower return periods were very similar to those provided by the NRC seismic hazard database.

The probabilistic seismic hazard analysis has also been used to calculate spectral acceleration values (5% damping). These have been used to develop site-specific uniform hazard spectra corresponding to return periods of 500, 2500 and 10,000 years. The uniform hazard spectra are shown on Figure B.2. Tabulated values of these uniform hazard spectra are provided in Table B.2.

Deaggregation of the probabilistic seismic hazard results has been carried out to provide the relative contributions of all potential seismic sources, and to more accurately define the characteristics of potential earthquakes contributing to the seismic hazard. The findings indicate that the seismic hazard for the

project site is predominantly from shallow crustal earthquakes associated with the southern Yukon region, but also from the Denali fault system.

A design earthquake magnitude of 8.0 has been selected, based on the review of regional tectonics and historical seismicity, and the findings of deaggregation off the probabilistic seismic hazard.

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TABLE B.1

CASINO MINING CORPORATION
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FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SUMMARY OF PROBABILISTIC SEISMIC HAZARD ANALYSIS

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Return Period (Years)	Probability of Exceedance[1] (%)	Peak Ground Acceleration (PGA)[2]	
		Median PGA[3,4] (g)	Estimated Mean PGA[5] (g)
100	20	0.04	0.05
500	4	0.07	0.08
1,000	2	0.08	0.10
2,500	1	0.11	0.13
5,000	0.4	0.14	0.17
10,000	0.2	0.18	0.22

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\APP B Rev 0 - Seismic Hazard Assessment\[Table B.1 - Table B.2 - Figure B.2 - Rev 0.xlsx]Deaggregation Data

NOTES:

1. PROBABILITY OF EXCEEDANCE CALCULATED FOR A DESIGN LIFE OF 22 YEARS.

   $q = 1-EXP(-L/T)$

   WHERE: q = PROBABILITY OF EXCEEDANCE
   L = DESIGN LIFE IN YEARS
   T = RETURN PERIOD IN YEARS

2. PEAK GROUND ACCELERATIONS ARE FOR SOFT ROCK/VERY DENSE SOIL (Vs_{30} = 360 - 760 M/SEC)
3. MEDIAN PEAK GROUND ACCELERATIONS FOR RETURN PERIOD UP TO 2,500 YEARS OBTAINED FROM THE SEISMIC HAZARD DATABASE OF N
4. MEDIAN PEAK GROUND ACCELERATIONS FOR RETURN PERIODS OF 5,000 AND 10,000 YEARS OBTAINED FROM SITE-SPECIFIC ANALYSIS US
5. MEAN PGA VALUES ESTIMATED AS 1.2 X MEDIAN VALUES.

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TABLE B.2

CASINO MINING CORPORATION
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UNIFORM HAZARD SPECTRA FOR 1/500, 1/2,500 AND 1/10,000 YEAR EARTHQUAKES

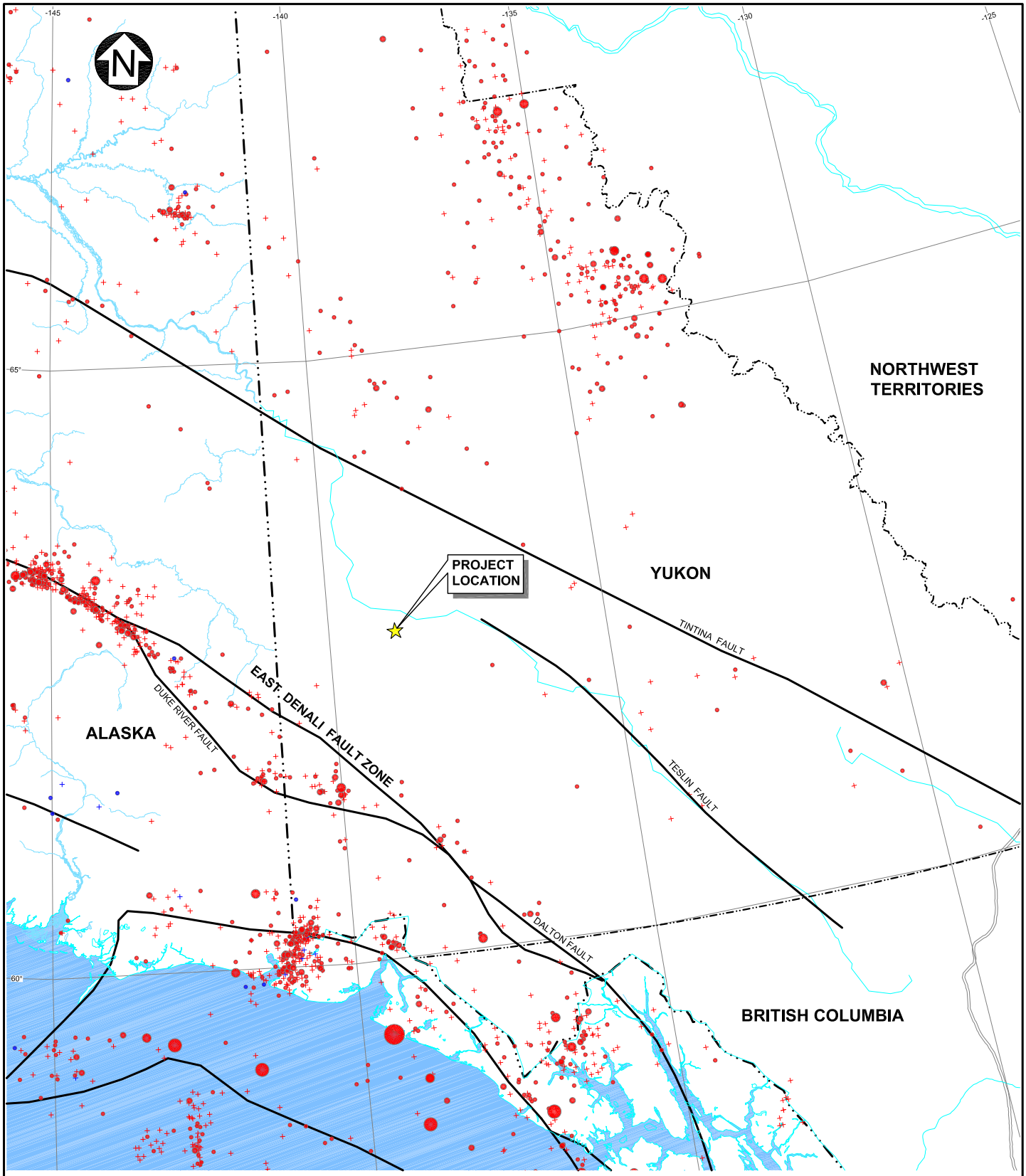
Spectral Period (seconds)	Spectral Accelerations for 1/500 Year Earthquake		Spectral Accelerations for 1/2,500 Year Earthquake		Spectral Accelerations for 1/10,000 Year Earthquake	
	Median (g)	Estimated Mean (g)	Median (g)	Estimated Mean (g)	Median (g)	Estimated Mean (g)
PGA	0.07	0.08	0.11	0.13	0.18	0.22
0.02	0.07	0.08	0.11	0.13	0.18	0.22
0.03	0.07	0.08	0.11	0.13	0.18	0.22
0.05	0.08	0.10	0.14	0.16	0.23	0.28
0.1	0.11	0.13	0.19	0.23	0.36	0.43
0.2	0.16	0.19	0.26	0.31	0.43	0.52
0.3	0.19	0.23	0.30	0.36	0.43	0.52
0.4	0.21	0.25	0.32	0.39	0.45	0.54
0.5	0.23	0.27	0.35	0.42	0.49	0.58
0.75	0.30	0.35	0.46	0.55	0.61	0.73
1.0	0.24	0.28	0.36	0.44	0.49	0.59
2.0	0.11	0.13	0.16	0.19	0.22	0.26
3.0	0.06	0.08	0.10	0.12	0.13	0.15
4.0	0.04	0.05	0.07	0.08	0.09	0.11

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\APP B Rev 0 - Seismic Hazard Assessment\[Table B.1 - Table B.2 - Figure B.2 - Rev 0.xlsx]UHS Table B.2

NOTES:

1. SPECTRAL ACCELERATIONS ARE MEAN HAZARD VALUES FOR SOFT ROCK/ VERY DENSE SOIL SITE CONDITIONS (Vs_{30} = 360 - 760 m/sec).
2. ESTIMATED MEAN VALUES ESTIMATED AS 1.2 X MEDIAN VALUES.

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SYMBOL SIZE PROPORTIONAL TO MAGNITUDE

- 3.5 - 3.9
- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- 8.0 - 8.9
- 9.0 +

NOTES:

1. GLOBAL COORDINATE SYSTEM IS UTM WITH NAD83 DATUM, ZONE 10 m, CENTRAL MERIDIAN.
2. HISTORICAL EARTHQUAKE DATA FROM NRCAN, USGS, AND NGDC DATABASES.
3. INCLUDES RECORDED EARTHQUAKES FROM 1600 TO 1973 (MAGNITUDE > 6.0) AND FROM 1973 TO SEPTEMBER 2012 (MAGNITUDE > 3.5).

SCALE A: 50 25 0 50 100 150 200 250 km

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REGIONAL TECTONICS AND HISTORICAL SEISMICITY

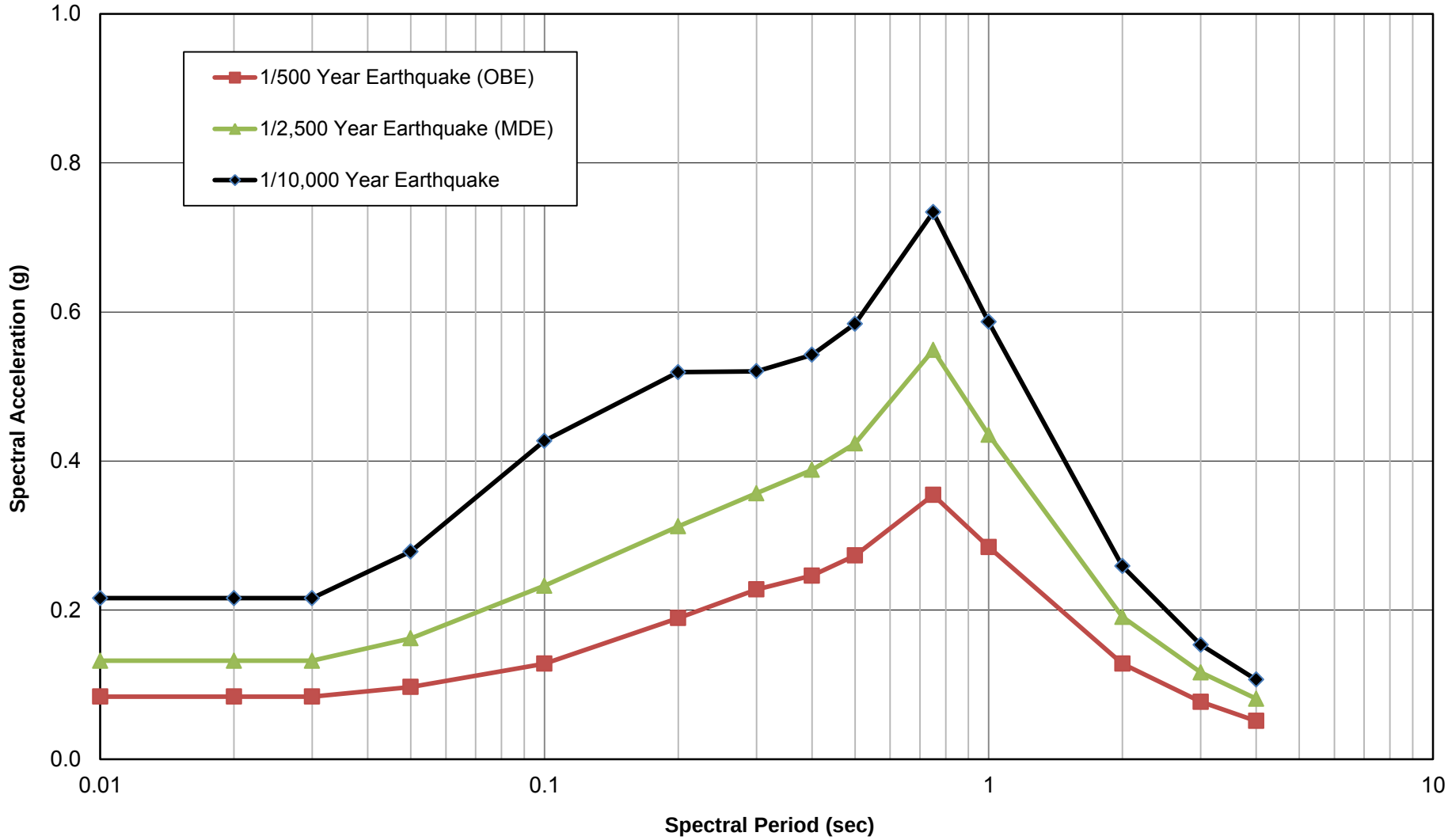
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FIGURE B.1

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NOTES:

1. SPECTRAL ACCELERATIONS ARE MEAN HAZARD VALUES FOR SOFT ROCK/ VERY DENSE SOIL SITE CONDITIONS (Vs30 = 360 - 760 m/sec).

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CASINO MINING CORPORATION

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UNIFORM HAZARD SPECTRA FOR 1/500, 1/2,500 AND 1/10,000 YEAR EARTHQUAKES

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FIGURE B.2

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APPENDIX C

EMBANKMENT STABILITY ANALYSES

(Pages C-1 to C-7)

APPENDIX C

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

EMBANKMENT STABILITY ANALYSES

C.1 GENERAL

Embankment stability analyses were carried out to investigate the stability of the Main Embankment under both static and seismic loading conditions. These comprised checking the stability of the embankment arrangement for each of the following cases:

- Static conditions during operations and post-closure;
- Earthquake loading from the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE); and
- Post-earthquake conditions using residual (post-liquefaction) tailings strengths.

The stability analyses were based on the maximum cross-section through the Main Embankment for the final TMF with a supernatant pond elevation of 995 m and an embankment crest elevation of 998 m.

The stability analyses were carried out using the limit equilibrium computer program SLOPE/W. In this program a systematic search is performed to obtain the minimum factor of safety from a number of potential slip surfaces. Factors of safety have been computed using the Morgenstern-Price method.

In accordance with international recommendations (ICOLD, 1995) and standard industry practice, the minimum acceptable factor of safety for the tailings embankment under static conditions is 1.3 for short-term operating conditions and 1.5 for long-term (steady-state and post-closure) of the TMF. A factor of safety of less than 1.0 is acceptable under earthquake loading conditions provided that calculated embankment deformations resulting from seismic loading are not significant and that the post earthquake stability of the embankment maintains a factor of safety greater than 1.2, implying there is no flow slide potential. The TMF would be expected to function in a normal manner after the OBE. Limited deformation of the tailings embankment is acceptable under seismic loading from the MDE, provided that the overall stability and integrity of the TMF is maintained and that there is no release of stored tailings or water (ICOLD, 1995). Some remediation of the embankment may be required following the MDE.

The seismic stability assessment of the TMF has included estimation of seismically induced deformations of the dam from the OBE and MDE events. The OBE has been defined as the 1 in 500 year earthquake with a mean Peak Ground Acceleration (PGA) of 0.08g and design earthquake magnitude of 8.0. The MDE corresponds to the 1 in 2,500 year earthquake with a mean PGA of 0.13g and design earthquake magnitude of 8.0. To demonstrate the robustness of the embankment design to seismic loading the 1 in 10,000 year earthquake has also been considered. The PGA for the 1 in 10,000 year event is 0.22g.

The design PGA values are for very dense soils and soft (weathered) rock ground conditions. This is consistent with the foundation conditions beneath the Main Embankment. To account for the potential

amplification of ground motions as seismic waves propagate through the foundation soils and embankment, an amplification factor of 1.5 has been assumed to estimate the average PGA along a potential slip surface through the embankment. This amplification factor is based on consideration of the expected embankment foundation conditions and fill materials (density and stiffness). This results in an estimated average PGA within the embankment of 0.13g for the OBE, 0.2g for the MDE and 0.32g for the 1 in 10,000 year earthquake.

C.2 MATERIAL PARAMETERS AND ASSUMPTIONS

The following parameters and assumptions were incorporated into the stability analyses:

- Bulk unit weights for the Stage 1 embankment materials, low permeability core zone, and foundation materials were based on typical values for similar materials and the results of laboratory testing. The unit weights are listed in Figure C.1.
- A bulk unit weight of 18 kN/m^3 was used for the cyclone sand embankment fill, based on the results of compaction and triaxial testing of a laboratory prepared sample (representing cyclone underflow) and report density values for existing large cyclone sand dams.
- An undrained shear strength was adopted to represent the tailings material strength for the static, seismic and post-earthquake cases, as described by the following relation:

  Su/p' = 0.20 (static and seismic loading)

  Su/p' = 0.10 (post liquefaction residual strength)

  where, Su = undrained shear strength

  p' = effective vertical stress;
- An average effective friction angle of 35 degrees was adopted for the sand-gravel foundation soils based on laboratory test results conducted in 2010;
- Effective strength parameters for the embankment core zone material and low permeability upstream blanket were estimated based on typical values for similar materials. An average effective friction angle of 33 degrees was used;
- The shear strength for rockfill (Stage 1 dam shell zones) was defined using a conservative strength function that defines the variation with shear strength with normal stress. This strength function is based on published information on the shear strength properties of rockfill (Leps, 1970);
- Cyclone sand fill is assumed to remain well drained (unsaturated and therefore not potentially liquefiable);
- A strength function for angular sand (Leps, 1970), similar to that for rockfill, was adopted for the cyclone sand embankment fill, based on the results of shear strength testing of a laboratory prepared sample. The results of the testing are shown on Figure C.2. Details of the shear strength testing and results are provided in the KPL document ""Report on Laboratory Geotechnical Testing of Tailings Materials" (Ref. No. VA101-325/8-1, December, 2012); and
- The predicted phreatic surface from TMF seepage modelling (see Section 5.10) was used in the stability analysis for the Main Embankment.

The stability model developed for the Main Embankment is shown on Figure C.1.

C.3 RESULTS OF STABILITY ANALYSES

The potential slip surface through the final Main Embankment (Crest El. 998 m) is shown on Figure C.1.

For static stability conditions, the minimum factor of safety calculated is 2.2. This exceeds the minimum factor of safety for short-term operating conditions and for long-term (post-closure) conditions.

Embankment stability during earthquake loading has been assessed by performing a pseudo-static analysis, whereby a horizontal force (seismic coefficient) is applied to the embankment to simulate earthquake loading to determine the critical acceleration required to reduce the factor of safety to 1.0. Deformation of the embankment is predicted to occur if the critical acceleration is lower than the predicted average PGA along the potential slip surface from the design earthquake.

Potential deformations under earthquake loading have been estimated using the simplified methods of Newmark (1965) and Makdisi-Seed (1977). These two methods estimate displacement of the potential sliding mass based on the average maximum ground acceleration and the yield acceleration. The yield acceleration corresponds to the seismic coefficient required to initiate movement of the sliding mass. The yield acceleration was determined by iterative stability analyses. For the Main Embankment, the estimated yield acceleration is approximately 0.3g. Predicted embankment deformations from the OBE and MDE are negligible, as the calculated yield acceleration exceeds the estimated average PGA for these events. Calculated average embankment displacements are also minor (approximately 0.01 m) for the 1 in 10,000 year earthquake.

The more recently published method of Bray (2007) was also used to predict seismically induced slide displacement of the embankment. In addition to the yield acceleration, this method considers the predominant period of response (T_s) of the embankment under seismic loading and the corresponding spectral ground acceleration (Sa). The predominant period is related to the stiffness characteristics of the embankment fill and to the height of the embankment. Spectral acceleration values were provided by the uniform hazard spectrum defined for each design earthquake event. The uniform hazard spectra for the 1 in 500 (OBE), 1 in 2,500 (MDE) and 1 in 10,000 year earthquakes were defined from the results of a site specific probabilistic seismic hazard analysis (see Section 3.5) and are provided on Figure C.3. Maximum displacements of approximately 0.02 m and 0.01 m were predicted for the 1 in 10,000 year earthquake and MDE respectively, based on the stiffness of the embankment fill and predominant period of the embankment under seismic loading (estimated to be in the range of about 1.5 seconds). Predicted embankment displacement for the OBE is negligible (< 0.01 m). The predominant period of the embankment is long due to the embankment height (maximum of approximately 286 m). Spectral accelerations from the design earthquakes are lower in the longer period range. This results in the predicted displacement being lower than would typically be calculated for a lower height dam with the same yield acceleration.

Some deformation of the embankment is expected to result from settlement of the fill materials during earthquake shaking. Potential settlement of the embankment crest has been estimated using the empirical relationship provided by Swaisgood (2003). This relationship was developed from an extensive review of case histories of embankment dam behaviour due to earthquake loading. Required inputs to the relationship are the earthquake magnitude, the peak ground acceleration on rock at the site, the depth

to rock (overburden thickness) and the embankment height. The predicted maximum crest settlements for the Main Embankment section are approximately 0.2 m for the OBE, 0.25 m for the MDE and less than 0.4 m for the 1 in 10,000 year earthquake.

Maximum embankment deformations and settlements calculated for the design earthquakes are less than 0.5 m and do not have a significant impact on the available embankment freeboard (minimum of 3.0 m) or result in any loss of embankment integrity. Predicted embankment deformations from the OBE are negligible and would not impact on-going operations at the TMF.

The post earthquake condition that conservatively assumes complete liquefaction of the tailings deposit was also analysed, using a post-liquefaction residual tailings strength. The calculated factor of safety is the same as the static factor of safety as the critical potential slip surface does not pass through the liquefied tailings deposit. This indicates that the embankment is not dependent on tailings strength for downstream stability and is not susceptible to a flow slide or large deformations resulting from earthquake-induced liquefaction of the tailings deposit.

The stability of the Main Embankment can be increased further by placement of non-reactive waste rock, or suitable borrow material against the downstream face of the dam. However, this is not a requirement in providing appropriate embankment stability and minimum factors of safety, based on the strength parameters adopted for this study.

The on-going increase in tailings strength and reduction in pore water pressures as the tailings consolidate will only improve the overall stability and integrity of the embankment after closure.

C.4 REFERENCES

Bray, J.D.& Travasarou, T., 2007, Simplified Procedure for Estimating Earthquake-induced Deviatoric Slope Displacement, doi 10.1061/(ASCE)1090-0241(2007)133:4(381).

ICOLD - International Commission on Large Dams, 1995, Tailings Dams and Seismicity: Review and Recommendations, Bulletin 98.

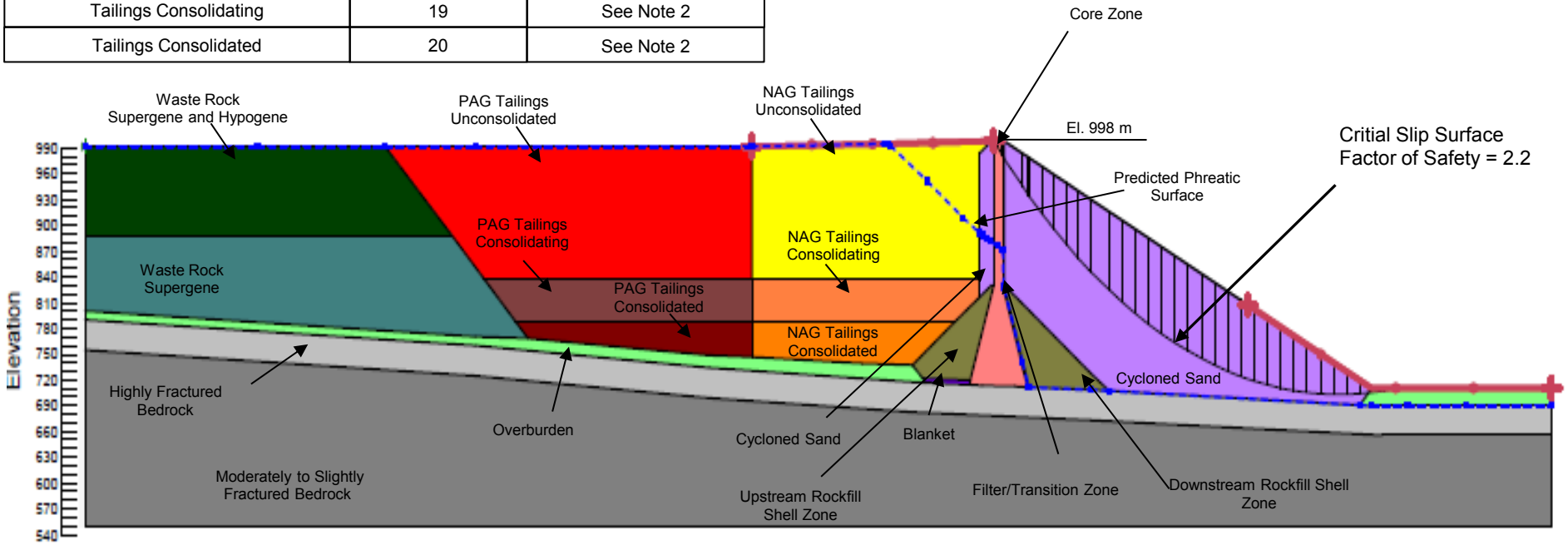
Leps, T.M., 1970, Review of Shearing Strength of Rockfill, Journal of the Soil Mechanics and Foundations Division, Vol. 96 pp 1159 – 1170.

Makdisi, F.I., and Seed, B.H., 1977, A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments, Earthquake Engineering Research Center Report No. UCB/EERC-77/19, University of California, Berkeley, California.

Newmark, N.M., 1965, Effects of Earthquakes on Dams and Embankments, Vol. 15 No. 2 pp 139 – 159.

Swaisgood, J.R., 2003, Embankment Dam Deformations Caused by Earthquakes, 2003 Pacific.

Material	Unit Weight (kN/m^3)	Effective Friction Angle (deg)
Cycloned Sand & Blanket	18	See Note 3
Rockfill Shell Zones	22	See Note 3
Core Zone	21	33
Filter/Transition Zone	21	33
Overburden	20	35
Bedrock	N/A	Impenetrable
Tailings Unconsolidated	17	See Note 2
Tailings Consolidating	19	See Note 2
Tailings Consolidated	20	See Note 2



NOTES:

1. LOCATION OF PHREATIC SURFACE PREDICTED FROM STEADY STATE SEEPAGE ANALYSIS.
2. A RELATIONSHIP FOR SHEAR STRESS AND EFFECTIVE NORMAL STRESS (SU/P') WAS USED TO MODEL THE TAILINGS STRENGTH.
3. RELATIONSHIPS FOR FRICTION ANGLES AND EFFECTIVE STRESS WERE DEVELOPED BASED ON LEPS (1970).

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CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY
MAIN EMBANKMENT
STABILITY ASSESSMENT

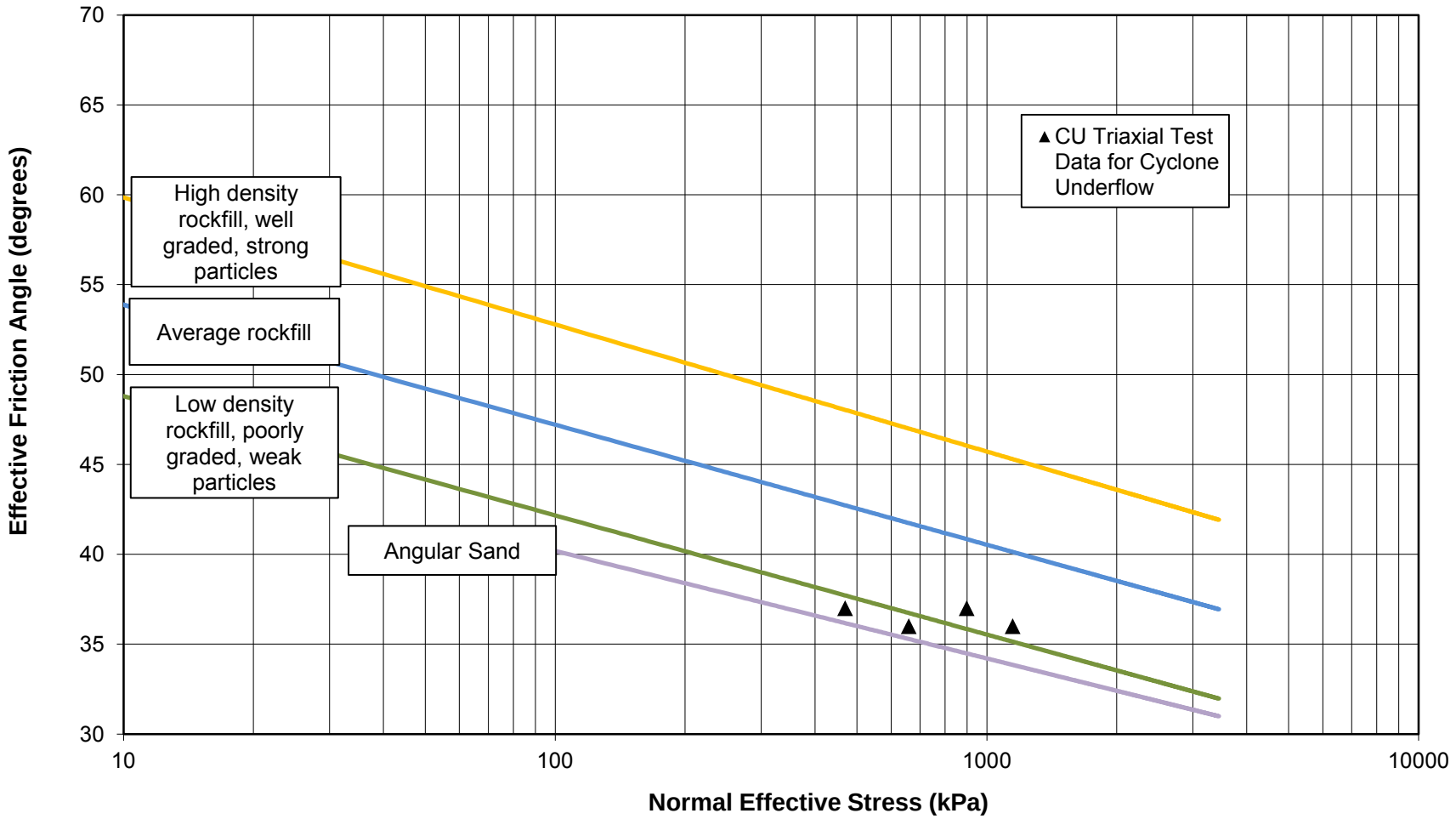
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FIGURE C.1

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NOTE:
1. RESULTS PRESENTED WITH THE RELATIONSHIP BETWEEN NORMAL STRESS ACROSS THE FAILURE PLANE OF ROCKFILL AND FRICTION ANGLE (SHOWN AS FOUR RELATIONSHIPS FOR 1) HIGH DENSITY, WELL GRADED, STRONG PARTICLES; 2) AVERAGE ROCKFILL; 3) LOW DENSITY, POORLY GRADED, WEAK PARTICLES; AND 4) ANGULAR SAND) AFTER LEPS, 1970.

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CASINO COPPER-GOLD PROJECT

RELATIONSHIP BETWEEN EFFECTIVE FRICTION ANGLE AND NORMAL EFFECTIVE STRESS FOR MANUFACTURED CYCLONE UNDERFLOW

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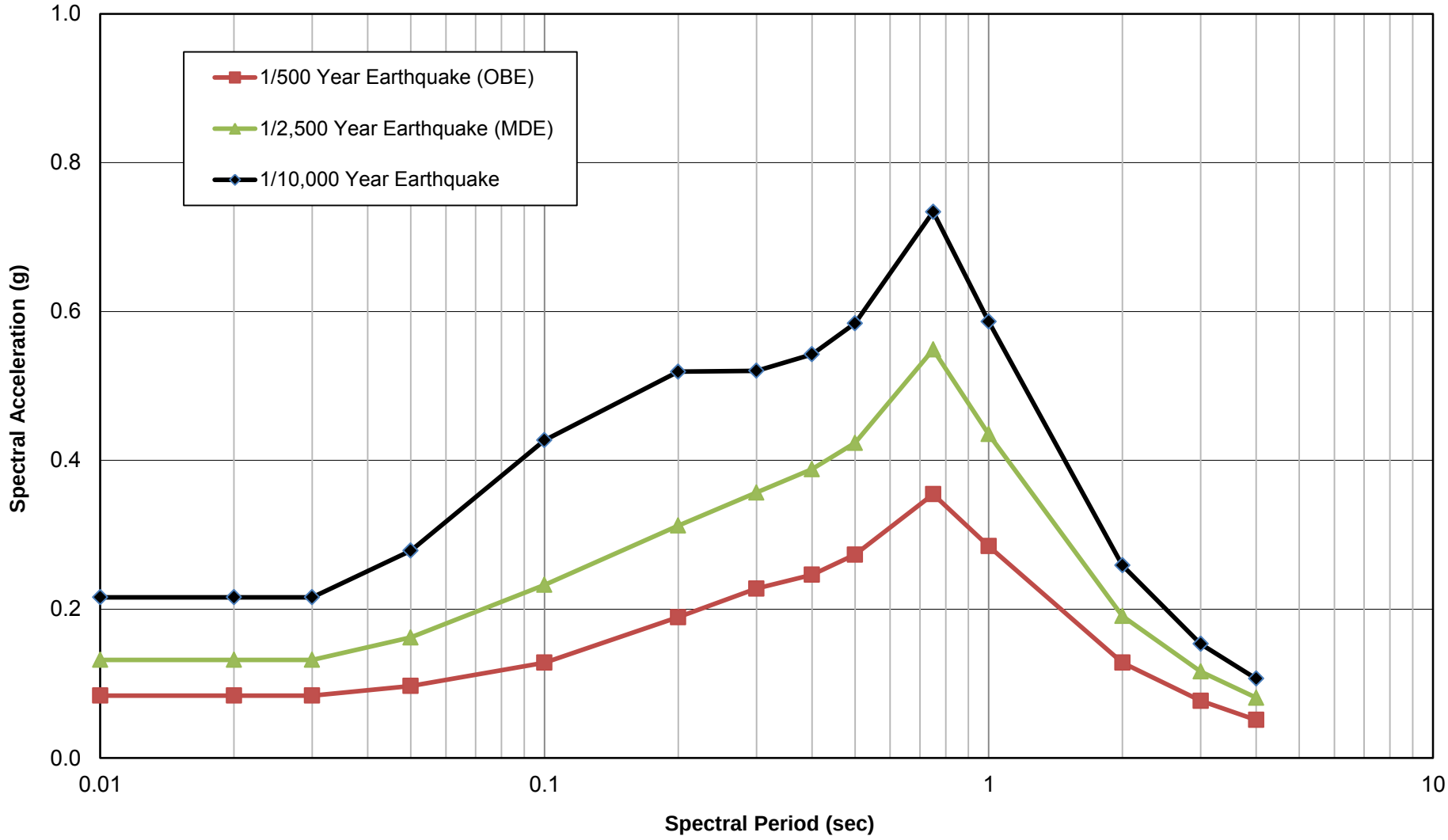
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FIGURE C.2

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NOTES:
1. SPECTRAL ACCELERATIONS ARE MEAN HAZARD VALUES FOR SOFT ROCK/ VERY DENSE SOIL SITE CONDITIONS (Vs30 = 360 - 760 m/sec).

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CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

UNIFORM HAZARD SPECTRA FOR 1/500, 1/2,500 AND 1/10,000 YEAR EARTHQUAKES

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REF NO. 10

FIGURE C.3

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APPENDIX D

OPERATIONAL MONTHLY STOCHASTIC WATER BALANCE MODEL

(Pages D-1 to D-4)

APPENDIX D

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

OPERATIONAL MONTHLY STOCHASTIC WATER BALANCE MODEL

D.1 GENERAL

A stochastic analysis was carried out on the base case monthly operational mine site water balance using the GoldSim© software package. The intent of the modelling was to estimate the magnitude and extent of any water surplus and/or deficit conditions in the Tailings Management Facility (TMF), based on a range of possible climatic conditions. The modelling timeline included two pre-production years (Year -2 and Year -1), and 22 years of operation (Year 1 to 22) at a nominal rate of 125,000 dry metric tonnes per day. The model is shown schematically on Figure D.1 and incorporates the following major project components:

- Open Pit
- Mill Site
- Tailings Management Facility (TMF)
- Cyclone Sand Plant, and
- Low Grade Ore Stockpiles.

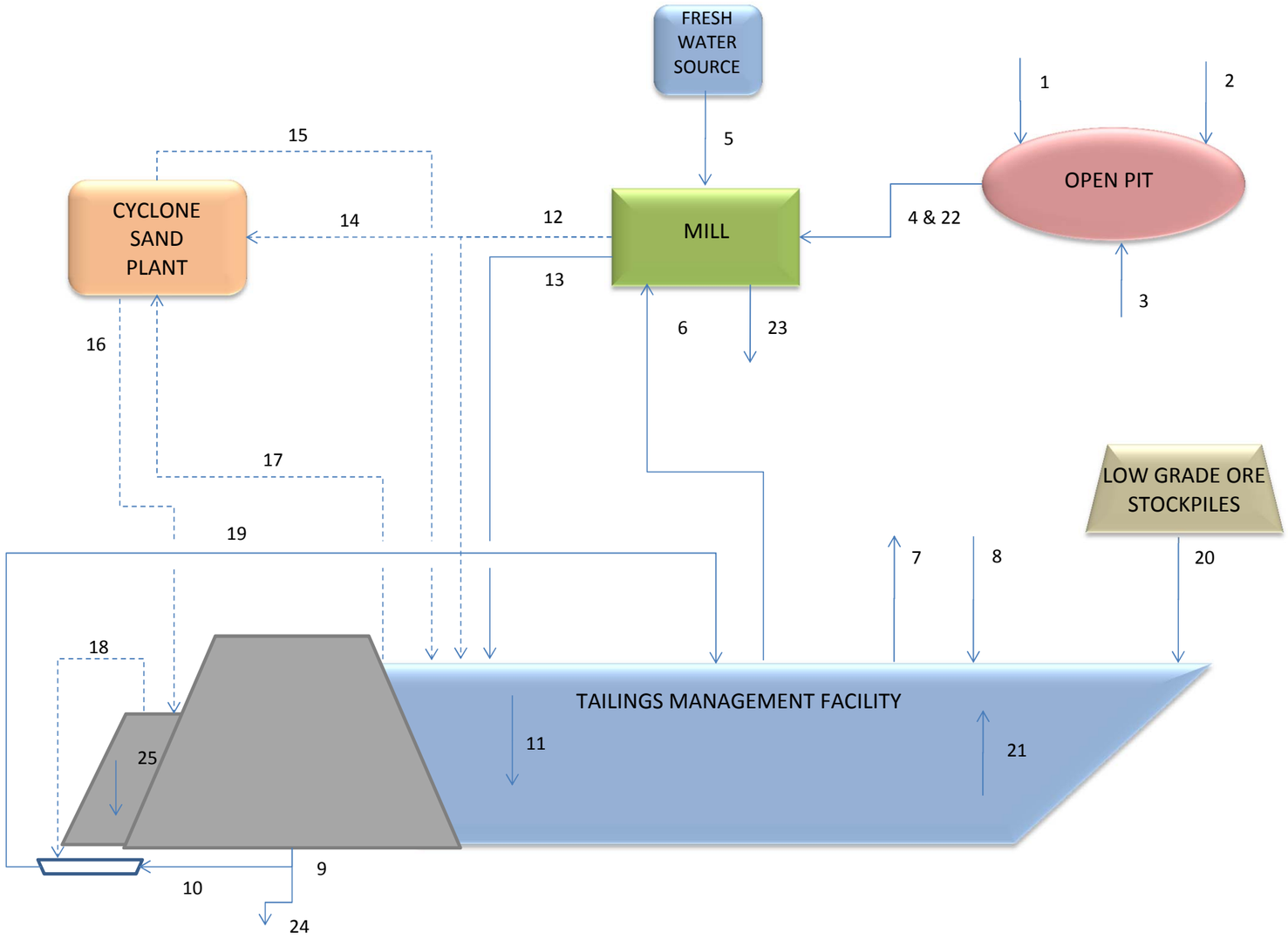
The model assumptions and parameters are discussed in the following sections and summarized in Table D.1.

D.2 MODEL ASSUMPTIONS

D.2.1 Average Hydrometeorological Conditions

The base case monthly operational water balance model was developed using average estimated values for runoff and precipitation. The mean annual unit runoff (MAUR) for undisturbed basins in the project area was estimated to be approximately 183 mm and the mean annual precipitation was estimated to be 510 mm. The annual average long-term potential evapotranspiration for the project site was estimated to be 300 mm. The mean monthly values for precipitation, runoff, and lake evaporation are summarized in Table D.2. Complete details of the derivation of the climate and hydrology inputs for the project site are outlined in the Hydrometeorology Report (Knight Piésold, 2012a).

The available runoff from the undisturbed catchment areas and ore stockpiles (within the TMF catchment) were modelled on the basis of the long-term runoff estimates for Casino Creek at hydrology station W4, as summarized in Table D.2. Natural runoff values are not directly applicable for mine disturbed areas because of the substantial changes in runoff caused by altering the ground cover. Therefore, the water (runoff/infiltration) generated from the mine affected areas and open water (TMF supernatant pond) was estimated on the basis of rainfall and snowmelt estimates. The available precipitation is summarized in Table D.2 and the runoff coefficients are given in Table D.5.



Number	Description
1	Direct Precipition on the Open Pit
2	Open Pit Catchment Runoff
3	Groundwater Inflows to Open Pit
4	Pit Dewatering
5	Fresh Water Make-up
6	Reclaim Water from TMF
7	TMF Pond Evaporation
8	TMF Catchment Runoff and Direct Precipitation
9	TMF Embankment Seepage
10	TMF Seepage Embankment Collection in Seepage Ponds
11	Water trapped in the Tailings and Waste Rock Voids
12	NAG Tailings Slurry Water from Mill
13	PAG Tailings Slurry Water to TMF (All year-round)
14	NAG Tailings Slurry Water to Sand Plant
15	Cyclone Overflow Slurry Water to TMF pond
16	Cyclone Sand Underflow Slurry Water to TMF embankment
17	Process Water to Sand Plant
18	Water Recovered from Sand Cells
19	TMF Seepage Pond Recycle to TMF pond
20	Ore Stockpile Runoff
21	Tailings Consolidation Seepage Recovery
22	Water in Ore
23	Water retained in Concentrate
24	TSF Embankment Seepage lost to deep groundwater
25	Water retained in Sand Cells

NOTES:

1. DASHED LINES ILLUSTRATE WATER FLOW PATHS DURING SAND PLANT OPERATION.
2. DURING THE MONTHS WHEN ALL THE TAILINGS ARE DIRECTED TO THE TMF, THERE ARE DEPOSITED AS 80% BULK TAILINGS AND 20% PYRITIC TAILINGS.

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TAILINGS MANAGEMENT FACILITY WATER BALANCE SCHEMATIC

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REF NO. 10

FIGURE D.1

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TABLE D.1

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CASINO COPPER-GOLD PROJECT

WATER BALANCE INPUT PARAMETERS

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Component	Assumption
Mean Annual Unit Runoff (mm) - undisturbed areas	183
Mean Annual Precipitation (mm)	510
Mean Annual Lake Evaporation (mm)	300
Total Tailings production (million tonnes)	955.6
Nominal Daily Ore Production (dry metric tonnes)	125,000
Mine Life (years)	22
Mill Fresh water requirement (m^3/hr)[1]	134
Tailings initial settled dry density (tonnes/m^3)	1.1
NAG tailings (80% by weight)	
NAG tailings solids content (% by weight)	55%
NAG tailings specifc gravity	2.7
Cyclone Sand (NAG tailings)	
Inflow Cylone sand slurry solids content (% by weight)	55%
Sand fraction (cyclone underflow) used for embankment construction (65% solids content by weight)	50%
Fine Tailings fraction (cyclone overflow) to TMF (25% solids content by weight)	50%
Sand cells water recovery (recycled to TMF pond)	90%
PAG tailings (20% by weight)	
PAG tailings solids content (% by weight)	55%
PAG tailings specific gravity	3.0
Waste Rock (PAG deposited in TMF Year -1 to 19)	
Waste Rock dry density (tonnes/m^3)	2.0
Waste Rock specific gravity	2.8
Main Embankment Seepage (L/s)	
Year 1	5
Year 10	20
Year 22	39
West Embankment Seepage (L/s)	
Year 22	1
Embankment Seepage Recycle rate	90%
Tailings mass consolidation seepage (L/s) (contributes to TMF pond)	
Year 1	140
Year 2-22	140-400
Groundwater inflows to Open Pit (L/s)	
Year -1	2
Year 4	20
Year 11	30
Year 17	36

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NOTES:

1. THE MILL FRESH WATER REQUIREMENT WAS ASSUMED TO BE SUPPLIED FROM AN OUTSIDE SOURCE AND WILL BE DIRECTED TO THE TMF ONCE IT HAS BEEN USED IN THE MILL PROCESS.
2. THE TAILINGS MASS CONSOLIDATION SEEPAGE RATE FOR YEARS 2 TO 22 WAS LINEARLY INTERPOLATED BETWEEN 140 L/S (YEAR 1) TO 400 L/S (YEAR 22)

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Table D.2 Average Hydrometeorological Inputs

Parameter	Monthly Value (mm)												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(mm)
Precipitation	32	24	19	17	37	62	91	67	47	38	43	33	**510**
Rainfall	0	0	0	8	37	62	91	67	47	18	0	0	**330**
Snowfall	32	24	19	9	0	0	0	0	0	20	43	33	**180**
Sublimation	5	5	5	5	0	0	0	0	0	5	5	5	**40**
Snowmelt	0	0	0	25	115	0	0	0	0	0	0	0	**140**
Available Precipitation	0	0	0	33	152	62	91	67	47	18	0	0	**470**
Lake Evaporation	0	0	0	0	49	69	75	66	41	0	0	0	**300**
Available Runoff	0.5	0.3	0.3	3	45	25	33	31	27	15	2	1	**183**

NOTES:
1. THE PRECIPITATION VALUES WERE ESTIMATED FOR ELEVATION 1200 m.
2. THE MONTHLY RUNOFF VALUES ARE SUMMARIZED FOR LOWER CASINO CREEK AT HYDROLOGY STATION W4.

D.2.2 Stochastic Inputs

The potential variability of surface water runoff was addressed with a stochastic version of the water balance model that uses Monte Carlo simulation techniques. Monthly runoff parameters were modelled as probability distributions rather than mean values. The year-to-year variability of monthly runoff was quantified using coefficient of variation (C_v) values that were derived using the long-term regional stream flow record for the Water Survey of Canada (WSC) station at Big Creek (station ID 09AH003). The monthly C_v values for runoff, along with the monthly mean and corresponding standard deviation values are listed in Table D.3. The monthly mean and standard deviation values were used to develop the monthly probability distributions required for a Monte Carlo simulation. The Monte Carlo simulations were run with 10,000 iterations enabling nearly every conceivable combination of wet, dry and average months and years of runoff to be considered. Each iteration resulted in distributions of possible results for each month in each year, from which probabilities of occurrence were assessed.

Table D.3 Stochastic Monthly Inputs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Runoff (mm)	0.5	0.3	0.3	3	45	25	33	31	27	15	2	1
Std. Dev. (mm)	0.4	0.2	0.2	6	29	4	21	18	17	7	1	0.8
Coefficient of Variation (C_v)	1.0	0.9	0.9	2.0	0.7	0.5	0.6	0.6	0.6	0.5	0.6	0.9

NOTES:
1. COEFFICIENT OF VARIATION = STANDARD DEVIATION / MEAN

D.2.3 Tailings

The TMF design is based on the assumption that approximately 80% of the tailings will be Non-Acid Generating material (NAG) following pyrite separation and removal. The remaining 20% of the tailings comprises Potentially Acid Generating (PAG) tailings that will be discharged by a separate pipeline and contained within the central region of the TMF, remote from the embankments.

D.2.4 Cyclone Sand Plant

The NAG tailings (80% of total tailings by weight) will be used to produce cyclone sand for embankment fill, over a period of approximately 9 months each year (typically from about February to November). Cycloning operations are assumed to be suspended or significantly reduced during the coldest winter months (in particular December and January). Cyclone sand production can reduce during the last few years of TMF operations, when the demand for sand fill for embankment construction reduces.

The NAG tailings will be directed to the cyclone sand plant as a slurry at 55% solids by weight. The cyclone underflow (sand fraction) will be discharged from the sand plant as a slurry at 65% solids (by weight) to construction cells along the upstream and downstream shells of the TMF embankment. The cyclone overflow material (fine fraction) will be discharged directly to the TMF impoundment as slurry at approximately 25% solids by weight. Water will be recovered from the sand cells to the extent possible and pumped back to the TMF pond. Residual moisture draining from the fill in the sand construction cells will be collected in the downstream seepage collection system and pumped back to the TMF pond. Water required for operation of the sand plant will be supplied from the TMF pond. The sand plant is assumed to operate for 90% of the time during the period when it is active. Bulk NAG tailings will be

directed to the TMF impoundment when the sand plant is not in operation. The assumed months of sand plant operation during each year of the mine life are summarized in Table D.4.

Table D.4 Cyclone Sand Plant Operation

Year	Operating Months
1 to 17	9 months: February to October
18 to 20	4 months: May to September
21 to 22	3 months: June to August

D.2.5 Mill Water Requirements

Water requirements at the mill are calculated based on the specified mill production rate and the expected solids content (% by weight) of the tailings. The mine production rate used in the water balance model is approximately 125,000 tpd (less for Years 1 and 22). PAG) and Metal eaching (ML) waste rock will be placed into the TMF, starting in Year -1 (pre-production) and continuing until Year 19. The waste rock will be stored in the upper (northern) area of the TMF. The water balance indicates that the waste rock will become partially submerged by the TMF supernatant pond as of Year 1 and fully submerged by Year 20, approximately one year following the end of waste rock placement in the TMF.

The majority of the process water will be supplied by the TMF reclaim system and open pit dewatering. The mill requires 134 m^3/hr of fresh water in addition to the process water reclaimed from the TMF.

D.2.6 Open Pit Dewatering System

The water pumped from the open pit by the dewatering system includes pit wall runoff, undisturbed pit catchment runoff, and groundwater inflows. This water will be pumped to the mill for use as process water make-up.

D.2.7 Catchment Areas

The TMF catchment areas and corresponding runoff coefficients used in the water balance are summarized in Table D.5. The ore stockpile areas are included in the TMF undisturbed area, as summarized in Table D.5.

Table D.5 Facility Catchment Areas

Facility	Catchment Area (km^2)						Runoff coefficient
	Year 1	Year 5	Year 10	Year 15	Year 20	Year 23	
Open pit footprint	0.3	0.8	1.4	2.0	2.5	2.8	0.9
Undisturbed area in OP catchment	7.7	7.5	7.2	7.0	6.7	6.6	-
LG ore stockpile	0.1	0.6	1.2	1.7	2.2	0.0	0.8
HLF footprint	0.9	1.2	1.2	1.2	1.2	1.2	-
TMF beach	0.1	0.3	0.5	0.7	0.9	0.9	0.7
TMF pond	1.3	3.1	4.8	6.4	8.0	8.3	1.0
TMF undisturbed area	34	31	28	25	23	24	-

NOTES:
1. OP = OPEN PIT; HLF = HEAP LEACH FACILITY; LG = LOW GRADE; TMF = TAILINGS MANAGEMENT FACILITY
2. THE ESTIMATED RUNOFF FOR ALL FACILITY FOOTPRINTS WITH THE EXCEPTION OF UNDISTURBED AREAS AND SOIL STOCKPILES IS CALCULATED BY MULTIPLYING THE MONTHLY AVAILABLE PRECIPITATION VALUE BY THE RUNOFF COEFFICIENT.
3. UNDISTURBED AND SOIL STOCKPILE RUNOFF IS ESTIMATED BASED ON THE MONTHLY AVAILABLE RUNOFF VALUES, WHICH IS A DIRECT INPUT TO THE MODEL.

D.2.8 Heap Leach Facility

The Heap Leach Facility (HLF) will be constructed prior to mill operations (during Year -3) and will operate until approximately Year 15. For the purpose of the TMF water balance model, it was assumed that all water needed for the heap leach process is managed separately from the TMF water balance. Water supplied to the HLF will come from direct precipitation on the HLF footprint and recycled water from the HLF process, with make-up water sourced from a freshwater reservoir until Year 1. As of Year 1, the freshwater reservoir will be decommissioned and a pipeline from the Yukon River will supply the makeup water requirements from both for both the HLF and TMF. Details of the water balance model for the HLF are outlined in the Feasibility Design of the Heap Leach Facility report (Knight Piésold, 2012b).

D.2.9 Water Retained in Tailings and Waste Rock Voids

The amount of water retained in the tailings and potentially reactive waste rock (PAG and ML) voids is a function of the mine production schedule and the dry density and specific gravity of both the tailings and waste rock. The initial settled dry density values for the tailings and waste rock were assumed to be 1.1 t/m^3 and 2.0 t/m^3, respectively, as shown in Table D.1. Water released due to consolidation of the tailings mass was estimated based on tailings consolidation modelling. The resulting tailings consolidation water release rates are:

- 140 L/s in Year 1
- Increasing linearly each year up to a maximum of 400 L/s in Year 22

D.2.10 Reclaim Water

The volume of water available for reclaim to the mill was estimated using the TMF water balance.

The primary TMF inflows are:

- Water being pumped to the TMF from the mill as part of the tailings slurry
- Pit dewatering
- Direct precipitation on and runoff to the TMF, which includes runoff from the upslope catchments and ore stockpiles
- Tailings settling and consolidation seepage
- Cyclone sand cell water recovery, and
- Embankment seepage recycle.

The primary TMF outflows, excluding reclaim to the mill, are:

- Water retained in the tailings and waste rock voids
- Evaporation, and
- Seepage not intercepted by the embankment seepage collection and recycle system.

The water available for process use is assumed to be 100% of the difference between these inflows and outflows.

D.2.11 Fresh Water Requirements

The assumed total fresh water requirements at the project site are:

- Mill (operations) – 134 m^3/hr
- Potable water for the camp – 5 m^3/hr during operations

D.3 RESULTS

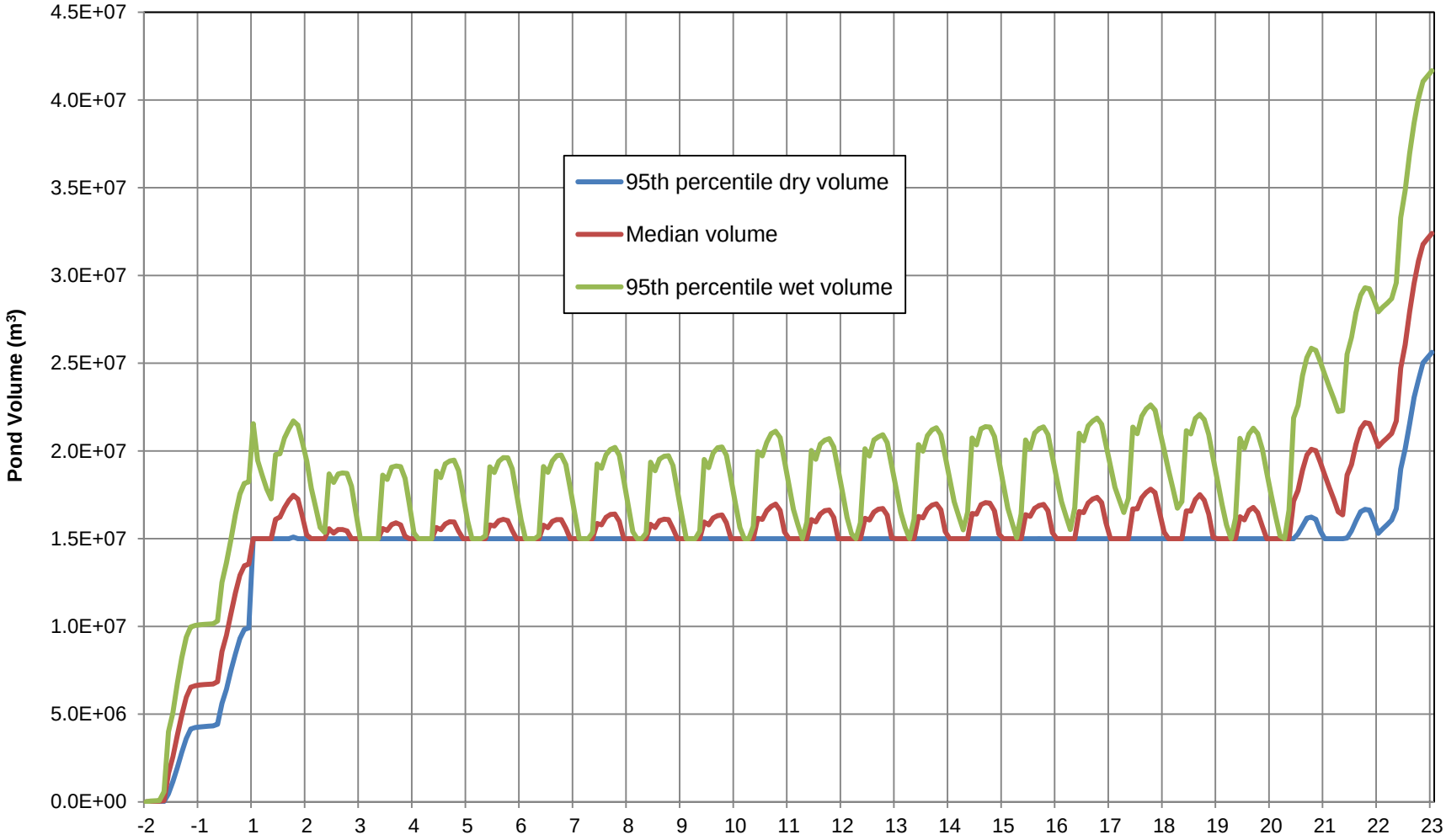
D.3.1 Model Results

The model results were used to determine the likelihood of having a surplus or deficit for the mine site, as illustrated on Figure D.2. The TMF pond is assumed to have a minimum pond volume of 15 million m^3 (approximately 3 months of slurry water requirements) in all months throughout operations. Therefore, a deficit condition is defined as when the TMF pond volume is at the minimum volume of 15 million m^3 and that the system (including the TMF, open pit, and contributing catchments) is not able to supply enough water to meet the mill process water requirements, thereby indicating the need for make-up water. Figure D.2 presents the range of possible cumulative pond volumes that in the TMF over the life of the mine, as defined by the 95th percentile wet and dry values (5% and 95% chance of being equalled or exceeded in any year, respectively). This range of volumes can also be thought of as the required active, or “live”, storage capacity of the TMF pond for a reasonably large range of anticipated climatic conditions. It was

assumed that a TMF start-up pond would be allowed to accumulate over two freshet seasons rather than one, thereby increasing the potential start-up water volume.

The TMF is able to accumulate a start-up pond volume of at least 15 million m^3 by the start of Year 1 for all climatic conditions. The stored water in the pond from Year 1 onward is slowly consumed by void spaces in the tailings and waste rock and the TMF pond volume is at the minimum of 15 million m^3 during some months in each year. During these months, the system operates in a deficit condition and requires additional makeup water, under the range of climatic conditions represented in the modelling. The process make-up water requirements from an outside source, for the range of modelled scenarios, are presented in Table D.6. The 5^{th} percentile and 95^{th} percentile scenarios shown correspond to the 95^{th} percentile wet and dry scenarios on Figure D.2, respectively. The maximum annual makeup water requirement occurs in Year 3. This is due to an increase in the volume of waste rock saturated by the TMF pond in that year, resulting in more water being lost to the waste rock voids.

It should be noted that the water balance results are very sensitive to the input values, which are best estimates based on the currently available information.



NOTES:

1. TMF MINIMUM POND VOLUME IS ASSUMED TO BE 15 MILLION m^3 (3 MONTHS PROCESS WATER REQUIREMENT).

CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

TAILINGS MANAGEMENT FACILITY
POND VOLUME
STOCHASTIC RESULTS

Knight Piésold CONSULTING

P/A NO. VA101-325/8

REF NO 10

FIGURE D.2

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	07DEC'12	ISSUED FOR REPORT	ER	DF	KJB

Knight Piésold CONSULTING

TABLE D.6

CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

PROCESS MAKE UP WATER REQUIREMENTS
STOCHASTIC WATER BALANCE MODEL RESULTS

Print Dec/21/12 9:37:25

Year	95th percentile dry (m^3/yr)	Median (m^3/yr)	95th percentile wet (m^3/yr)
-2	0	0	0
-1	0	0	0
1	10,222,442	6,112,242	2,724,257
2	11,855,399	8,282,767	3,127,817
3	11,883,946	8,844,134	5,496,621
4	11,368,726	8,221,608	5,327,931
5	10,640,326	7,478,545	4,471,525
6	10,861,930	7,563,539	4,547,847
7	9,774,109	6,501,697	3,889,269
8	11,057,015	7,594,240	4,244,122
9	10,350,310	6,913,418	4,095,385
10	8,768,455	5,237,647	2,729,210
11	9,457,520	5,660,757	1,912,569
12	9,473,898	5,785,776	2,435,046
13	8,761,706	5,007,519	1,687,382
14	8,541,347	4,697,132	923,048
15	9,057,148	5,136,426	1,230,971
16	7,979,760	4,559,087	634,911
17	6,716,788	3,802,565	0
18	9,366,564	5,176,772	0
19	11,643,677	7,416,224	2,640,693
20	5,704,723	5,158,938	1,480,843
21	2,722,223	0	0
22	0	0	0

\\VAN11\Prj_file\1\01\00325\08\A\Report\10 - TMF Feasibility Design Report\Rev 0\APP D Rev 0 - WBM\[Fig D.1-Fig D.2-Tab D.1-Tab D.6-Rev 0 - Casino WBM_20_FS_rev A.xlsx]Tab D.6-Stochastic_ta

NOTES:

1. TMF MINIMUM OPERATING POND ASSUMED TO BE 15 MILLION m^3 (3 MONTHS PROCESS WATER REQUIREMENT).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	07DEC'12	ISSUED FOR REPORT VA101-325/8-10	ER	DF	KJB

APPENDIX E

CYCLONE SAND DESIGN (PATERSON AND COOKE)

(Pages E-1 to E-153)

Knight Piésold CONSULTING

Knight Piésold

Casino Project Tailings Cyclone and Transport Study

Feasibility Study Report

Report Number: KPV-5277 R02 Rev 0

December, 2012

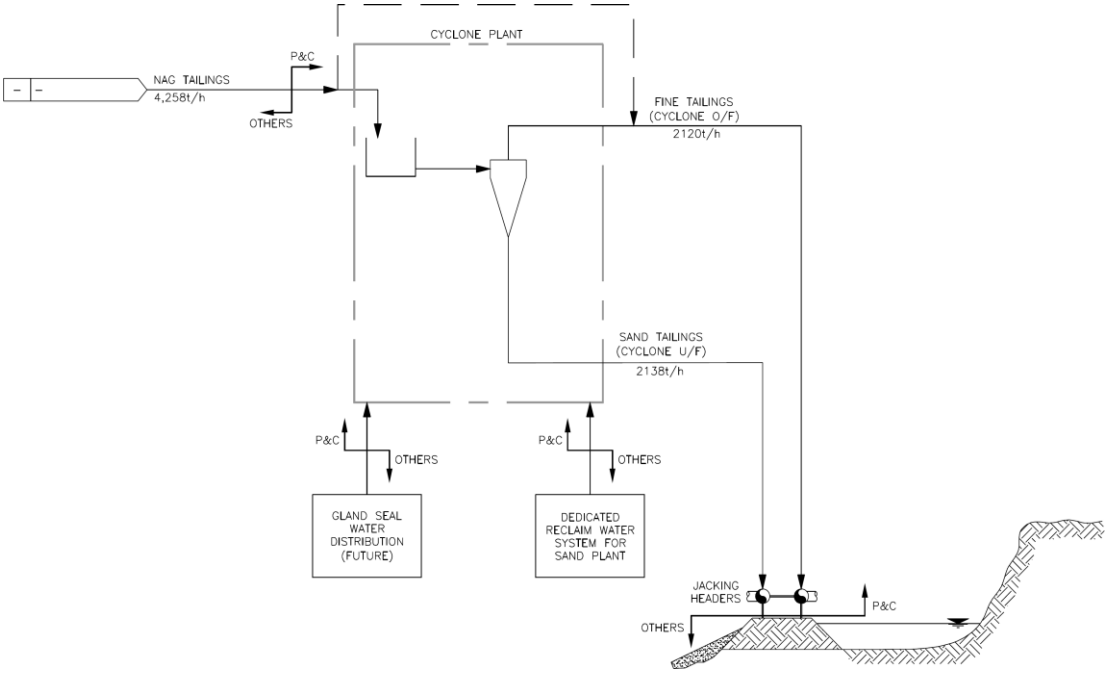
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EXECUTIVE SUMMARY

This document presents the feasibility study (FS) design for tailings cyclone and transport developed for Knight Piésold (KP) for the Casino mine project. The design has been prepared to a level appropriate for the development of capital costs to an accuracy of +15/-15%.

Paterson & Cooke (P&C) compiled aterial take-offs (MTOs) and power consumption estimates to support the development of the capital and operating cost estimates by others. The MTOs and power consumption estimates are presented in Appendix E and Appendix F respectively of this document.

Overall schematic of the proposed system is presented on the diagram.



Sand recovery in the cyclone plant is 50.2%, which was agreed with a cyclone vendor. The cyclone plant will be generating 2,138t/h (42,950tpd) or 11,75mln t/y of sand. This is based on:

- 120,000tpd run of mine (ROM)
- 1% of ROM as concentrate
- 80% of all tailings are NAG tailings feeding the cyclone plant
- 9 out 12 months of the cyclone plant operation
- 93% process plant availability
- 90% cyclone plant availability.

At a late stage of the study, a new production schedule was issued. The new throughput (46,249,000 tpy or 126,700tpd) is approximately 5% (5.6%) higher than the old throughput used by P&C (43,800,000 tpy or 120,000tpd). The new production rate is within the design factor of 15%. Consequently the cyclone plant design is capable of handling the new throughput.

High level summary for the system is presented in the following table.

TAILINGS CYCLONE AND TRANSPORT SYSTEM	
System overview	The thickened non-acid generating (NAG) tailings (nominal process values: 4,258 tph, 5,064 m^3/h, 55%m) flow by gravity from the mill to the cyclone plant. For approximately nine months of each year, the NAG tailings are processed in a single stage of cyclones to produce sand as cyclone underflow for the Tailings Storage Facility (TMF) embankment construction. The cyclone overflow material (fine tailings) is discharged directly into TMF on the upstream impoundment side of the dam. During the three winter months (and when the cyclone station is offline), the tailings bypass the cyclone plant and are deposited directly into TMF through the cyclone overflow pipeline. In order to feed the cyclones at optimum solids concentration for solids separation, dilution water is required at the cyclone plant. This dilution water is pumped directly from the TMF pond by barge and intermediate pumps (by others) to a water header tank located at the cyclone feed tank. Two jacking headers are provided; one for the cyclone underflow and the second for the cyclone overflow pipe line to match the piping lift rate with the rise rate of the dam crest. In the beginning of operation both sand and fines flow under gravity from the cyclone plant to the jacking header on the dam. Ten (10) ceramic orifices are required to slow down sand slurry in the downhill pipe. Orifices are gradually removed with the dam build up. As the dam further rises, centrifugal pumps are progressively added for pumping sand and fines to the dam.
Sand (Cyclone U/F) distribution	Year 1 to 5 – no pumps, gravity flow, pipe with ceramic orifices for energy dissipation Year 6 to 11 – 1 stage pumping Year 12 to 18 – 2 stage pumping Year 19 to 22 – 3 stage pumping.
Fines (Cyclone O/F) distribution	Year 1 to 12 – no pumps, gravity flow, no ceramic orifices Year 13 to 22 – 1 stage pumping.
Major equipment	Cyclones: Weir Cavex or similar One cyclone cluster with 10 operating plus 2 standby 800mm diameter cyclones Pumps Cyclone U/F: Warman 16x14 AHP or similar with 671kW motors and VFDs Operating/standby sets Pumps Cyclone O/F: Warman 650L or similar with 2000kW motors and VFDs Operating/standby set Orifices: 10pcs, cyclone U/F distribution in year 1 to 5 ID=254 mm (10”) on 18” pipe, 8m head loss per orifice
Pipelines	Cyclone U/F: 18” CS with ceramic liner for first 250m of pipe (slack flow conditions) 18” CS sch 80 for reminder pipe section (full pipe flow conditions) Cyclone O/F: 36” HDPE DR 11 for first 850m of pipe on the sloped section 32” CS std sch for jacking header section This pipe carries also the cyclone bypass during the three winter months in each year and during times when the cyclone plant is by-passed.
Key assumptions and considerations	▪ The mass balance was developed based on nominal process plant feed of 120,000 metric tons per day

TAILINGS CYCLONE AND TRANSPORT SYSTEM	
	▪ Design factors are +15/-10% from nominal plant feed ▪ Life of Mine (LOM) is 22 years ▪ NAG tailings solids concentration: 55%m ▪ The turn down requirement is 60% of nominal throughput ▪ Weather conditions, stringent sand quality and sand yield specifications necessitated the use of a central cyclone station instead of mobile cyclone rigs on the crest ▪ Due to high cost, cyclone plant is not considered to be relocated over LOM ▪ The cyclones are fed by gravity from an elevated feed tank to eliminate pumping ▪ The cyclone underflow pipes special protection (lined pipe, ceramic orifices) ▪ The slurry pipelines are not insulated and are to be drained to prevent freezing ▪ The high crest rise rate and high flow rates necessitates the use of jacking headers across the crest. ▪ Dam construction is by cell fill and mechanical compaction.
Risks and mitigation plans	▪ Lack of slurry rheology data. This was mitigated using conservative safety factors and historical data from similar copper operations. ▪ High pipeline wear in sloped sections (slack flow). This was resolved through the use of ceramic orifices to dissipate energy and reduce slack flow section lengths and ceramic lined pipes on remaining slack flow pipe section. ▪ Maximized plant availability; standby pumps provided, standby cells for sand deposition ▪ Sanding of the cyclone underflow pipeline. Mitigated through proper design and flush water availability along the whole sand pipe ▪ Large turn down ratio requirement to 60% of nominal plant throughput. This risk was eliminated through the use of a smaller diameter sand pipeline to the midslope ▪ Freezing of pipeline contest. Water pipelines are fitted with heat tracing and insulation. Slurry pipelines must be drained for shutdowns longer than two hours ▪ Valve malfunction due to freezing. Mitigated through insulation and heat tracing ▪ Pipeline failure. Drainage construction to ensure that all spillage are directed to the tailings pond.
Alternatives investigated	▪ Single versus two stage cycloning ▪ Various pipes materials for cyclone overflow and underflow to reduce wear ▪ Relocation of the cyclone plant over life of mine to higher elevation ▪ Location of the cyclone plant upstream of the saddle dam.
Future work	▪ Slurry testing is required to confirm hydraulic performance, particularly for cyclone underflow system ▪ Pipeline support analysis (including a seismic stress analysis)

TERMS OF REFERENCE

This work has been conducted by Paterson & Cooke for Knight Piésold under Order Number #9063. The proposal for this work was presented in P&C Proposal KPV-5277 C01 rev B dated June 14th 2012 and change notices CN01 Rev A dated June 26th and CN02 Rev A dated July 13th, 2012.

DOCUMENT DISTRIBUTION, REVISION AND APPROVAL HISTORY

Rev	Date	Distribution / Revisions	Prepared	Reviewed	Client Approval
A	Nov. 1st, 2012	For Review	YK	CK	SB
0	Dec 10th, 2012	Final FS Report	YK		

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Appendix D – EQUIPMENT LIST D.1

Appendix E – MATERIAL TAKE-OFF LISTS E.1

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Appendix H – CYCLONE U/F PIPELINE MATERIAL SECTION – VALUE ENGINEERING H.1

1. INTRODUCTION

1.1 Background

The Knight Piésold (KP) from Vancouver office commissioned Paterson&Cooke (P&C) to prepare feasibility study (FS) level designs for Tailings Cyclone and Transport for the Casino Project. The designs have been prepared to a level appropriate for the development of capital and operating expenditure estimates to an accuracy of +15/-15%.

Paterson & Cooke compiled material take-offs (MTOs) and power consumption estimates to support the development of the capital and operating cost estimates by others. The MTOs and power consumption estimates are presented respectively in Appendix F and Appendix G of this document.

This report presents a technical description of the designed system.

1.2 Reference Documents

Document	Abbreviation
P&C Design Criteria Document, R01 Rev C, November 1, 2012.	P&C R01

1.3 Scope of Work

The design scope of work is shown in the table below.

Discipline	Description
Mechanical	The specification of mechanical equipment within the process battery limits is **included.**
Piping	The specification of piping within the process battery limits is **included.**
Tanks & Platework	The specification of tanks and plate work within the process battery limits is **included.**
Civil & Structural	Civil design (grading) for cyclone plant building and tanks benches is **included**. Jacking header structural design is **included**. *Note: P&C uses a sub-contractor in the compilation of the structural component MTOs.* Structural steel design and concrete for cyclone plant building and tanks is **excluded**.
HVAC, fire protection	Heating, ventilation and fire protection is **excluded**. Diesel or propane (non-electrical system) is used for cyclone plant heating.
Electrical	All electrical work within the process battery limits is **excluded.**

Discipline	Description
	Power consumption (kWh) for the cyclone plant and tailings distribution systems is **included**.
Control and instrumentation	Instrumentation requirements within the process battery limits are indicated on P&ID drawings. Higher level control (connection, programming) at the overall plant control system is **excluded.**
Costing	Costing is **excluded** for all items within the scope of work described above. The operating costing is **excluded.** Power consumption is **included**. Labor costing is **excluded**. *Note: P&C provided Material Take-Offs (MTOs) for the cost estimate.*
Services	Services (dilution water, clean water) outside battery limit are **excluded**.
Compressed Air	Compressed air system for cyclone plant operation is **included**.

The process battery limits are detailed in the table below:

Stream	Battery Limits
NAG Tailings Feed	At the inlet to the cyclone feed tank.
Cyclone U/F	At the discharge points on the tailing storage facility.
Cyclone O/F	At the discharge points on the tailing storage facility.
Dilution/Flush water (Reclaim water)	At the discharge of the reclaim water into the dilution water head tank. Reclaim water pumping and piping is the scope by others.

1.4 Appendices

Appendix	Description
A	Design Criteria
B	Paterson & Cooke Drawings
C	Hydraulic Grade Line Plots
D	Equipment List
E	Material Take-Offs
F	Power Consumption
G	Report for Structural Design of Jacking Headers
H	U/f Pipeline Material Selection – Value Engineering

1.5 Units

Metric units are used for this project. Pipes and valves sizes are reported in inches.

1.6 Abbreviations

The following abbreviations are used in this report:

amsl	above mean sea level
CS	carbon steel
FS	feasibility study
HDPE	high density polyethylene
KP	Knight Piésold
LOM	life of mine
m^3/h	cubic meters per hour
MTOs	material take-offs
NPV	net positive value
NAG	Non-acid generating (tailings)
O/F	overflow
P&C	Paterson & Cooke
PD	positive displacement
PSD	particle size distribution
RL	rubber lined
Sch	schedule
Std	standard
TMF	tailings storage facility
U/F	underflow
t/h	metric tons per hour
VFD	variable frequency drive
%m	solids percentage by mass.

2. CYCLONE FEED

2.1 Overview

Thickened NAG tailings from processing plant at solids concentration of 55%m report to the cyclone feed tank, which also receives pond reclaim water to dilute the slurry feed stream to an optimum solids concentration of 36%m for classification in the cyclones. Tailings after dilution flow under gravity from the tank to the cyclones for processing.

The baffles and valving arrangements around the cyclone feed tank allow bypassing of the cyclones and discharging of undiluted NAG tailings upstream of the dam through the cyclone O/F

distribution system. The tank has an emergency overflow into the emergency spillage pipeline to the nearest point of the TMF.

In case of upset condition in the concentrator, which could result in a turndown to 60% of nominal NAG tailings production, the tailings are diluted to 36%m at the process plant. As a result no dilution in the cyclone feed tank is required.

2.2 Key Assumptions and Consideration

The following considerations played a role in the design:

- The feed tank is elevated above the cyclone plant to allow feed the cyclones by static head from the cyclone feed tank therefore eliminating pumping of the high volume cyclone feed stream.

2.3 System Description and Operation

2.3.1 Cyclone Feed Tank

The tank is presented in Appendix A on P&C's Drawing #5277-1-304, "Cyclone Feed Tank General Arrangement". The tank elevation was established based on hydraulic calculations for the cyclone feed pipe, which operates under static head from the tank and the required cyclone feed pressure. Hydraulic performance of the system is presented in Appendix C on P&C's Drawing #5277-1-201, "Cyclone Feed Hydraulic Grade Line Plot".
The concrete tank has four compartments. The NAG tailing stream and dilution water report to the first compartment, where mixing, stilling and de-aeration occur. The diluted slurry flow over a baffle to feed the cyclone cluster through a rubber lined 38" carbon steel pipe. The overflow compartment has a total height of 6.0m, or 5.0m above the top of the feed pipe. As a result, 5 meter is available for level fluctuation for slurry feeding the cyclones.

Should the cyclones have to be bypassed, the 38" cyclone feed pipe can be isolated with a knife gate valve. The slurry level increases in the overflow compartment, until it reaches an overflow weir. Slurry overflows this weir to a bypass compartment piped through the cyclone plant to the cyclone overflow distribution system for deposition on the upstream side of the tailings dam. In addition, a 24" gate, flush with the cyclone feed tank bottom, provides a connection between the main and bypass tank compartments. The gate is opened during the bypass operation, allowing settling solids to report to the bypass, as the overflow weir is 6 m above the tank bottom.

The tank has also another overflow weir, 1 m above the first one, which takes all tank overflows and spillage in emergency situations to the fourth overflow compartment. The emergency

overflow feeds into the 42" emergency spillage line, which takes the spillage to the nearest location of the tailings pond.

2.3.2 Pipelines

The following piping is used for cyclones feed:

38" CS pipe std schedule with 6mm rubber lining, 100m long.

2.3.3 Valves

All slurry valves are knife gate slurry Clarkson KGD, KGA or equivalent. Valves 8" and above are fitted with air actuators.

2.4 Risks and Mitigation Plans

- All valves located outdoors are insulated and heat traced.
- The cyclone feed pipe is insulated. A drain valve, located within the cyclone plant, is provided to allow drainage of the cyclone feed line.
- Any spillage is carried to the tailings pond through a 42"emergency spillage pipe.

2.5 Alternatives Considered

P&C considered locating the feed tank at the same location as the cyclone plant, using a feed pump instead static head for feeding the cyclones. This option was discarded as more costly and complex.

2.6 Future Work

More detailed hydraulic calculations should be done for cyclone feed system, when slurry rheology data is available.

3. CYCLONE PLANT

3.1 Overview

The NAG tailings are diluted to 36%m before classification by single stage cycloning. Cyclone U/F (sand) is collected in the U/F tank and reports to the sand distribution system on the tailings dam. The cyclone O/F (fines) reports to the O/F tank and are further carried to the fines distribution system on the tailings dam.

The cyclone U/F solids concentration is around 74%m. This sand material is diluted to 65%m for ease of hydraulic transportation. As a result, dilution water is added the cyclone cluster U/F collection launder to control solids concentration for the sand. The water addition control valve is in control loop with a sand slurry density meter, located on a sample circulation loop.

Cyclone O/F is disposed through its piping to the dam as is.

During winter months (3 months/year) the sand construction activities cease. The cyclone section is by-passed entirely during that time. The undiluted whole stream NAG tailings report to the cyclone O/F tank and are discharged to the TMF through the same piping used for cyclone O/F distribution. The cyclone section is also by-passed during planned and unplanned non-availability of the cyclone section or lack of sand demand.

As the dam grows over LOM, slurry pumps for cyclone U/F and O/F are added, when required. The pumps are located in the cyclone plant building.

In addition, the cyclone plant is provided with a sand sampling system, gland water for slurry pumps, compressed air system and HVAC system.

3.2 Key Design Assumptions and Considerations

The following considerations played a role in the design:

- Early calculations showed that the sand quality and sand yield required for the sand construction can be achieved in a single cyclone stage. This reduces the capital and operating cost of a cyclone sand construction options significantly.
- A central cyclone station was chosen to ensure sand product quality and yield even during adverse weather conditions.
- The cyclone section is placed in a building to promote reliable and consistent cyclone control even during poor weather conditions, thus promoting an extended sand construction season.
- Due to the high cost of relocation of a complete building in a remote location the option of staged locations for the cyclone feed tank and cyclone plant was not considered.
- Sand recovery in the cyclone plant was verified with the cyclone vendor and is used throughout the design as 50.2%.
- Cyclone plant availability is assumed to be 90%.

3.3 System Description and Operation

3.3.1 Building

A pre-engineered building is provided for the cyclone plant.

The building is constructed in two phases. In the first phase the building is of LxWxH of 34x26x20m. In year 5, when the first set of sand pumps are added, the building to be expanded by 2 bays and the total length to be 46m.

The building contains the following features:

- A 15 metric ton overhead crane, sufficient for maintenance of the large slurry pumps
- A drive through maintenance bay within the building
- A 5% sloped floor to a sump to contain spillage
- Diesel (propane) heating, ventilation (out of P&C's scope, to be sized and selected by others)
- A leveled pad, filled with gravel, around the building for storage, trucks and maintenance equipment maneuvering.

It is anticipated that electrical rooms are in separate structures attached to the cyclone plant building (out of P&C's scope, to be sized and selected by others).

3.3.2 Cyclone Cluster

The relatively coarse grind makes possible the use of large diameter cyclones. The advantage of larger diameter cyclones is that a single cluster is sufficient which results in a smaller building. The cyclone cluster consists of twelve 800mm diameter Weir CAVEX cyclones. Ten cyclones are required to handle the design tailing tonnage of 4,258t/h. Two spare cyclones have been provided for maintenance and surge flows.

Through automatic control the cyclones can be switched into and out of operation. This and the ability to vary are the primary control parameters to ensure that a correct cyclone feed pressure are maintained.

The plant turn down to 60% of capacity is achieved by switching off cyclones to maintain the necessary feed pressure to the remaining operating cyclones.

3.3.3 Process Tanks

Cyclone U/F Tank.

Features	Description
Function	Collecting classified sand from cyclone U/F launder, 45deg sloped floor, feed tank for pumps
Material	Concrete
Location	Inside the cyclone plant building
Dimensions	LxWxH of 4.0x3.2x4.0m
Insulation	None
Retention time	40 seconds for nominal conditions.

Cyclone O/F Tank.

Features	Description
Function	Collecting fines from cyclone O/F launder, 45deg sloped floor, feed tank for pumps
Material	Concrete
Location	Inside the cyclone plant building
Dimensions	LxWxH of 6.2x5.5x5.0m
Insulation	None
Retention time	40 seconds for nominal conditions.

3.3.4 Slurry Process Pumps

During the initial years of operation, the elevation difference between the cyclone plant and the dam, there is enough static head to push by gravity cyclone U/F and O/F to the deposition points. Starting in year 5, due to dam development, pumps are gradually added to transfer sand and fines to the deposition points.

The pumps are described in the tables below:

Description	Cyclone U/F (sand)
Model	Warman 16x14AHP or similar heavy duty centrifugal pump with gland seal water
Duty point	2,236m^3/h @ 43m (flow sheet flow rate x 1.15)

Description	Cyclone U/F (sand)
Motor	671kW with VFD
Installation schedule	year 1 to 5 no pumps, gravity flow year 6 to 11 1 stage pumping year 12 to 18 2 stage pumping year 19 to 22 3 stage pumping
Standby	One operating train + standby train

Description	Cyclone O/F (fines) or thickened NAG tailings
Model	Warman 650L or similar heavy duty centrifugal pump with gland water
Duty point	8.748m^3/h @ 60m (flow sheet flow rate x 1.15)
Motor	2,000kW with VFD
Installation schedule	year 1 to 12 no pumps, gravity flow year 13 to 22 1 stage pumping
Standby	One operating pump + standby pump

3.3.5 Sand Sampling

The cyclones generate U/F with a solids concentration of 74%m. Dilution water is added at a controlled rate to keep target solids concentration of 65%m for deposition. A nuclear density meter installed on cyclone U/F sample circulation pipe is used to control the dilution water.

The sand sample pump draws sand slurry from the bottom of cyclone U/F tank and pump back to the top of the same tank. A density meter is installed on the 2" pump discharge piping. In addition, a sand sample port is available.

An air operated 1 ½" diaphragm pump is envisaged as sand sample pump.

3.3.6 Compressed Air System

Compressed air is used for instrumentation and the running of the sand sample pump. The air is dried in a desiccant air type dryer to prevent freezing of moisture in the compressed air system.

The compressed air package consists of:

- 11kW compressor providing 100m^3/h of air at 780kPa (110psig)
- Desiccant air dryer sized for 100m^3/h
- An air receiver.

3.3.7 Piping

The table below describes main pipes used in the cyclone plant:

Description	Pipe Size	Pipe Spec	Notes
Cyclone O/F to O/F tank	40”	CS std, 6mm RL	Partially filled pipe
Cyclone U/F to U/F tank	32”	CS std, 6mm RL	Partially filled pipe
Cyclone bypass (undiluted tailings)	32”	CS std, 6mm RL	Full pipe flow
Main spillage header from the cyclone plant	42”	HDPE DR 17	Partially filled pipe
Cyclone U/F to tailings dam	See section 4.0 of this document		
Cyclone O/F to tailings dam	See section 5.0 of this document		
Sand sample	2”	CS std sch, 6mm RL	-
Water distribution piping	See section 6.0 of this document		
Gland water piping	See section 6.0 of this document		
Compressed air piping	1” to 2” SS316 welded		

3.3.8 Valves

The following valves are used in the cyclone plant.

Slurry:

All slurry valves are knife gate slurry Clarkson KGD or KGA or equivalent. All valves 8” and above are air actuated.

Water:

See Section 6 of this document.

3.4 Risks and Mitigation Plans

- Spillage in the plant - 5% sloped floor, large sump and 42” spillage pipe to TMF
- Pipe plugging – flow velocities above deposition conditions, flushing water system available, wash stations
- Arctic conditions – heated building, dried compressed air
- Equipment failure – standby cyclones and pumps provided to keep the plant running
- Components wear – rubber lined piping, standby equipment, heavy duty pumps and valves.

4. CYCLONE U/F (SAND) DISTRIBUTION SYSTEM

4.1 Overview

Sand, at 65%m solids concentration, is to be deposited through a piping system on the downstream embankment side of the tailings dam. The system consists of four sections:

- A 18" downhill pipe
- A 18" horizontal pipe on the sand jacking header
- 14" downhill pipes – from jacking header
- 14" downhill pipe – jacking header bypass for high turn down throughput requirements.

The 18" sand pipeline initially follows the 15% site gradient down towards the dam. At the tailings dam the pipe continues on a jacking header. 14" take off valves every 100m from the main pipeline for deposition. Each take-off valve is connected to a mobile 14" HDPE DR 11 pipe, running downhill on the dam to 100 m by 20 m sand deposition cells. Each 14" individual branch pipe is capable of transporting the full sand plant production to fill a cell at a time.

4.2 Key Assumptions and Considerations

The following considerations played a role in the design:

- Slurry piping is not insulated. Only flush water pipe is insulated and heat traced.
- The cyclone U/F piping will experience high wear. P&C scaled wear rates for carbon steel piping from similar copper tailings applications and the summary is presented in the table below.

Description	Average slurry velocity, m/s	Estimate wear mm/1000h
Cyclone U/F in slack flow	11.0	9.16
Cyclone U/F in full pipe flow	3.7	1.5

4.3 System Description and Operation

The hydraulic performance for the sand distribution system for years 1, 3, 6, 12, 19 and 22 is shown in the Appendix C.

4.3.1 Downhill Pipeline

In the first years of operation, due to high elevation difference between the cyclone plant and the dam, the static head pushes the cyclone U/F to the deposition points. The upper section of the

pipe, with a slope of 15%, operates in slack flow (partially filled pipe) regime. For example, in the first year of the project the slack flow section is estimated to be on the first 600m of the sand pipe. In the following years, slack flow section is shortened, as backpressure builds up due to the dam growth. Eventually, by year 5, all extra head and associated slack flow disappears. Pumps are added to transfer sand to the deposition points.

Slack flow and associated high sand slurry velocities, up to 11m/s, creates very high wear in the sand piping. P&C estimates that 18" carbon steel pipe of Schedule 80 has to be rotated roughly every 100 days and replaced once a year. A value engineering trade off study for optimum pipe material selection was done. The full trade-off study is presented in the Appendix H.

The main findings from the trade-off study are presented in the table below:

Option for sand pipe material on the sloped section	**NPV**
Option 1: CS Sch 80 pipe, no orifices, no ceramic lining	$4,1mln
Option 2: CS Sch 80 pipe, orifices, no ceramic lining	$2.0mln
Option 3: no orifices, ceramic lined pipe	$1,3mln
Option 4: orifices, ceramic lined pipe	**$0.8mln**

P&C selected option 4, as it represents lowest cost for the project.

In the trade-off study P&C did not consider HDPE pipe, as CS outperforms HDPE for slurries with coarse particles.

Overall the recommended sand pipe configuration on the downhill section is as follows:

- Ceramic orifices.
  Orifices keep backpressure in the pipe to minimise the slack flow. Initially, 10 orifices are installed, one every 50m, on the downhill section of the pipe. Each orifice provides a head dissipation of 8m, which is equivalent of 55 m pipe on 15% slope. As the dam rises, one orifice should be removed from the system for every 8m of dam build up, to maintain the hydraulic performance of the system. All orifices are selected with openings of 254mm in 450mm (18") pipe and all of them should be removed from the pipe by year 5.
- Ceramic lined CS pipe.
  P&C recommends using ceramic lined CS pipe in the top section (250m) of the 15% sloped sand pipeline. This is the section, which by design has to be exposed to slack flow and high wear. This pipe section provides a safe margin preventing the sand slurry pipeline from backing up and overflowing to the cyclone plant. Pressure transmitters along the sloped pipe monitor the location of the transition between the slack flow and full bore flow. Once the sand pipe is backing up too close to the cyclone plant an orifice is removed from the pipe.

- CS pipe Sch 80
  The lower section of the sloped pipe is not exposed to slack flow and associated high wear. As a result a schedule 80 carbon steel pipe is sufficient. The same pipe schedule is used on the jacking header.

After year 5, when all orifices have been removed and sand pumps have to be installed progressively, the downhill pipe operates at full flow regime with velocity of around 4 m/s. Pipe wear is not be substantial, but of course should still be monitored. The pipe needs to be rotated to extend its life.

The downhill pipe on the ground is gradually lifted and placed on the expanding dam and jacking header.

4.3.2 Pipe on Jacking Header

A flexible slurry hose serves as transition piece between the downhill pipeline and pipeline on the jacking header. The sand pipeline on the jacking header is 18" CS Sch 80, non-insulated pipe. P&C evaluated using CS sch 40 pipe or ceramic lined pipe, but in both cases the NPV was higher than for CS Sch 80 pipe.

Overall, the sand pipe on the jacking header is provided with:

- 14" take-off valves, every 100m for individual deposition pipes
- 10" flush water connections with 10" water valves
- 18" shut-off valves to isolate sand pipe sections and be able to flush them with water
- Pressure gauges to monitor sand pipe performance
- 300# flanges to provide better pipe stiffness during jacking header lifting.

The pipe and jacking header is expanding over LOM, as the dam length grows.

The table below shows jacking header lengths for some typical years:

End of Year	Crest/Jacking Header Length (m)
Initial (-1)	868
1	868
3	1,450
5	1,610
7	1,832
12	2,061

End of Year	Crest/Jacking Header Length (m)
19	2,363
22	2,460

The sand pipeline on the jacking header is configured to run to the middle of the dam without any tees, further from the dam center, it branches to the two opposite directions of the dam ends. The take-off valves to the sand deposition cells are located after the main splitting tee. As a result, the sand pipe is longer, but because the system is symmetric, has more stable hydraulic performance. This scheme is indicated on P&ID #5277-2-103, "Cyclone Sand Distribution" in the Appendix A.

4.3.3 Downhill Piping off the Jacking Header

Sand deposition to individual cells is through pipes branching off the 18" main pipe on the jacking header. The branches are every 100 m with 14" knife gate valves hydraulically actuated. A manual pinch valve is located downstream of the knife gate valve to allow the adjustment of the flow.

Each 14" take-off pipe is capable of handling the full cyclone plant sand production. These pipes are laid at the same slope of the dam (3:1). Consequently the pipes are exposed to high wear. The pipes are constantly relocated, to suit sand deposition requirements. It is recommended that at all time, at least one pipe/cell set is kept available as standby to maintain a high system availability. After every sand placement campaign, the downhill pipe should be flushed with water.

4.3.4 Downhill Pipe – Jacking Header Bypass for Upset Conditions

In case of a concentrator upset condition, which could result in a throughput turn down to 60% of nominal NAG tailings production, the jacking header pipe cannot be used, as the horizontal pipe would plug because of low flow velocities. In such a case the sand tailings are diverted, before jacking header, to a 14" HDPE DR 11mid slope pipe. Solids deposition does not occur; as the pipe is continuously sloped, running downhill to the embankment's mid slope areas. This downhill pipe is capable of transporting the normal sand production to the mid slope, when the jacking header is down. This means that sand is conserved, even in upset conditions.

4.3.5 Structure for Sand Tailings Jacking Header

The jacking header is a structure on piles, which is hydraulically lifted as the dam rises. Lifting is achieved with hydraulic power packs, which are connected to hydraulic jacks located on each pair of piles. Jacking header piles is spaced every 15m.

The jacking header consists of:

- 12" carbon steel pipe piles on concrete foundation

- 18" sand pipe
- 12" flush water pipe
- Supporting structure
- 1m wide walkway with handrails
- Power cable tray
- Lights
- Hydraulic jacks, on each pair of piles, spaced every 15 m
- Take-off valves, every 100m typically.

5 mobile power packs provide lifting capacity for 5 hydraulic jacks (5 towers, or 60m of pipe) at any time. Each hydraulics pack has a lifting capacity up to 30 metric tons. The hydraulic power packs are moved and shared with the O/F jacking header.

As the dam expands the jacking header is expanded too; new piles (pipes) with support structure are added. Vertical pipes are extended by welding on of new sections. Materials for the header expansion are captured in MTOs.

The jacking header was designed by SMRC Structural Engineers, who were sub-contracted to P&C. More detailed description for the jacking header, drawings and MTOs are presented in the Appendix G.

4.4 Risks and Mitigation Plans

- Freezing of valves - all valves located outdoors are insulated and heat traced
- Plugging of the sand pipe – provision of a flush water pipe on the jacking header
- Freezing of the flush water pipe – provision of insulation and heat tracing
- Horizontal sand pipe plugging on the jacking header during process plant upset conditions (lower throughput) – provision of bypass piping, continuously sloping to prevent solids settling.

4.5 Alternatives Considered

Various pipe materials were considered for sand piping, see Appendix H for details.

4.6 Future Work

- More detailed hydraulic calculations.
- More detailed operation strategy should be evaluated, which may affect features of the pipeline.
- Weather enclosure may be considered for jacking header.

5. CYCLONE O/F (FINES) DISTRIBUTION SYSTEM

5.1 Overview

This system handles the cyclone O/F stream as well as the undiluted NAG tailings stream when the cyclone station is by-passed.

The system consists of three sections:

- A 36" HDPE DR 11 downhill pipe
- A 32" CS Std Sch horizontal pipe on jacking header
- 16" HDPE DR 17 take-off pipes from the jacking header.

The cyclone O/F pipeline initially follows the 15% site gradient down to the dam. On the tailings dam the pipe is laid on a hydraulically raised jacking header, which is a separate structure from the sand jacking header. 16" take-offs with valves are placed every 100m. Each take-off valve is connected to a 16" HDPE DR 17 pipe running down from the jacking header onto the beach of the impoundment of the tailings storage facility.

In case of a concentrator upset condition, which could result in a throughput turn down to 60% of nominal tailings production, this piping system can still handle the cyclone O/F. Fine solids are not as sensitive to settling, even at lower velocities. However, when the cyclones are bypassed, it is recommended that either the cyclone plant emergency spillage system is used to dump the undiluted NAG tailings at the nearest point of the tailings pond, or the NAG tailings are diluted in the overflow box to eliminate risk of plugging of 32" CS pipe on the horizontal jacking header with undiluted NAG tailings.

5.2 Key Assumptions and Considerations

The following considerations played a role in the design:

- The slurry piping is not insulated.
- P&C scaled wear rates for carbon steel piping from similar copper tailings applications and the summary is presented in the table below.

Description	Average slurry velocity, m/s	Estimated CS pipe wear mm/1000h of operation
Cyclone O/F in slack flow	12.6	N/A, thick wall HDPE pipe used on project

Description	Average slurry velocity, m/s	Estimated CS pipe wear mm/1000h of operation
Cyclone O/F in full pipe flow	4.2	0.01
Cyclone bypass in slack flow	11.0	N/A, Thick wall HDPE pipe used on project
Cyclone bypass in full pipe flow	2.8	0.1

5.3 System Description and Operation

Hydraulic performance for the system handling cyclone O/F for years 1, 13, and 22 are shown in the Appendix C.
Hydraulic performance for the system handling cyclone bypass for years 1, and 22 are also shown in the Appendix C.

5.3.1 Downhill Pipeline

In the first 12 years of operation, due to elevation difference between the cyclone plant and the dam, there is enough head for gravity flow. It is estimated that slack flow occurs on the first 750m of the downhill pipe in the first year of operation. Gradually, by year 13, all extra head and slack flow disappears, and at that point a pump is required to transfer fines and/or bypass to the deposition points.

Slack flow and associated high velocities, up to 10 to 12m/s, create high pipe wear of the pipe. The wear is not that substantial, as in the sand system however. 36" HDPE DR 11 pipe, which has wall thickness of 83mm, is recommended therefore for the downhill section. Thick wall combined with frequent pipe rotation is the most economical solution. The pipe wall thickness should be monitored however.

The downhill section of the pipeline gradually reduces and is replaced by expanding jacking header during LOM.

5.3.2 Pipe on Jacking Header

A flexible hose provides the transition between the downhill pipe section and pipe on the jacking header. The pipe on the jacking header is 32" carbon steel standard schedule and non-insulated. Low wear rates do not justify using thicker wall piping. HDPE cannot be used on the jacking header, as the carbon steel flanged piping provides the jacking heading rigidity. Flush water piping for the cyclone O/F system is not required.

The cyclone O/F pipe on the jacking header is be provided with:

- 16" take-off valves, every 100m for individual deposition pipes
- 32" shut-off valves on the main pipe to isolate sections and redirect the flow to the spigots
- Pressure gauges to monitor pipeline performance
- 300# flanges to ensure stiffness

The pipe and jacking header is expanded over LOMs as the dam grows.

The table below shows the jacking header lengths for some typical years.

End of Year	Dam/Jacking Header Length (m)
Initial (-1)	868
1	868
3	1,450
5	1,610
7	1,832
12	2,061
19	2,363
22	2,460

The piping on the cyclone O/F jacking header is routed as "run through" with the take-off valves and tees. The schematic is given on P&ID #5277-3-103, "Cyclone Overflow Distribution" in the Appendix A.

5.3.3 Deposition Piping off the Jacking Header

The cyclone O/F and cyclone bypass deposition is through 16" HDPE DR 17 pipes from the 32" pipe on the jacking header. Branching is every 100m with 16" hydraulically actuated knife gate isolation valves.

During normal operation 2 to 3 take off valves are open at a time. Each 16" take off valve/pipe set is capable of transporting 50% of cyclone O/F production or 50% of undiluted NAG tailings during the cyclone bypass.

5.3.4 Cyclone O/F Tailings Jacking Header

The jacking header is a structure on piles which is hydraulically lifted as the dam rises. Lifting is achieved with mobile hydraulic power packs which are connected to hydraulic jacks located on

each pair of piles. Jacking header piles are spaced every 15m. The cyclone O/F jacking header is a separate structure from the sand system jacking header.

The cyclone O/F jacking header consists of:

- 10" steel pipe piles on concrete foundation
- 32" CS overflow pipe
- A power cable tray
- Hydraulic jacks, spaced every 15m on each pair of piles
- Valves where required, every 100m typically.

No walkway is provided on the cyclone O/F jacking header. Access to the take off valves is through a manlift.

As the dam expands the jacking header is extended; new piles (pipes) with support structure are added. Vertical pipes are extended by welding. Materials for the header expansion are captured in MTOs.

The jacking header was designed by SMRC structural engineers, who were sub-contracted to P&C. More detailed description for the jacking header, drawings and MTOs are presented in the Appendix G.

5.4 Risks and Mitigation Plans

- All valves located outdoors are insulated and heat traced.

5.5 Alternatives Considered

Various pipe materials were considered for cyclone O/F piping.

5.6 Future Work

- More detailed hydraulic calculations.
- More detailed operation strategy should be evaluated, which may affect features of the pipeline.

6. WATER SYSTEMS

6.1 Overview

Water is used in the following applications:

- Dilution, to control the cyclone feed solids concentration for optimum cyclones performance.
- Dilution, to control solids concentration of the sand for deposition.
- Gland seal for process pumps, after year 6.
- Flushing for sanded pipes, housekeeping, etcetera.

Water supply is by others to the battery limits of P&C scope of work. The battery limit is defined as the top of the dilution water head tank. Distribution system downstream of this point is scope of this study.

Table below shows water system main features:

Main function	**Nominal/Maximum Water Flow (m^3/h)**	**Notes**
Dilution water for cyclone operation	4,088/4,699	• Feed by gravity from dilution water head tank • Dilution NAG tailings from 55%m to 36%m
Dilution water for sand slurry placed on the dam	400/460	• Feed by gravity from water buffer tank • Dilution sand from 74%m to 65%m
Gland water supply	7.2	• Gland water tank in the cyclone plant • PD gland water pumps • One gland water pump for each slurry pump
Flush water	525	• Feed by gravity from water buffer tank • Flow based on 2m/s in 12" delivery pipe
Total water demand @ battery limit	4,493/5,166[1]	

Note 1: Water for flushing is excluded from this number; storage tanks provide capacity for flushing.

6.2 Key Assumptions and Considerations

The following considerations played a role in the design:

- Available water quality is assumed to be as "reclaim water from a typical copper mine", that contains some fine particles.

6.3 System Description and Operation

6.3.1 Dilution Water for Cyclone Operation

It is necessary to dilute the plant NAG tailings from 55%m to 36%m, which is optimum solids concentration for the cycloning process. Water is supplied by gravity from the dilution water header tank to the cyclone feed tank. The water addition is controlled according to nuclear density measurement on the cyclone feed pipe.

Dilution Water Head Tank
The dilution water header tank is located around 1,300 m from the cyclone feed tank on a leveled pad at elevation of 1,035 meter above mean sea level. The tank location/elevation was established based on minimum elevation required to provide gravity flow from this tank to the cyclone feed tank.

Tank features are presented in the table below:

Description	**Water buffer tank**
Material	CS plate, 8 and 6mm
Location	Outdoor, P&C dwg #5277-0-301, "Cyclone Feed and Plant, Site Plan"
Dimensions	DxH 12.5x12.5m
Insulation	50mm polyurethane
Volume	1,530m^3
Retention time	20min for nominal conditions.

6.3.2 Dilution Water for Sand

The cyclone U/F is generated at a solids concentration of 74%m. This stream has to be diluted to 65%m, which is required solids concentration for sand deposition on the dam. Dilution water for the sand deposition is supplied by gravity from the water buffer tank. The water addition is controlled according to the nuclear density measurement on the sand sampling loop.

6.3.3 Flush Water System

This system provides water for housekeeping, flushing plugged slurry pipes, sand jacking header, washing tanks, pumps etcetera. Water is supplied from the water buffer tank. The water pressure is boosted to 500kPa (75psig) by a flush water pump. The tank is located next to the cyclone feed tank. The pump is located in the cyclone plant building.
Tank features are presented in the table below:

Description	Water buffer tank
Material	CS plat, 6mm
Location	Outdoor, P&C dwg #5277-0-301, "Cyclone Feed and Plant, Site Plan"
Dimensions	DxH, 6.1x9.0m
Insulation	50mm polyurethane
Volume	263m^3
Retention time	20min for full capacity of flushing pump.

Flush water pump description is presented in the table below:

Description	Flush water pump
Model	8x10 centrifugal pump with mechanical seal
Duty point	525m^3/h @ 40m
Motor	80kW, no VFD
Installation schedule	year 1
Location	Inside the cyclone plant building
Standby	No standby required.

6.3.4 Gland Water System

The process slurry pumps require clean gland seal water. The gland water system is installed in year 6, along with installation of the first pair of slurry pumps. Each process slurry pump is paired with a dedicated gland seal water pump. In this configuration, the system availability is maximized. Water for the gland seal water service comes from the dilution water system.

The system consists of:

- Filters
  The water is filtered to remove particles larger than 25 microns from dilution water feeding gland water system. The filters are two stage, double basket type with differential pressure transmitters to switch over between dirty and clean filter.
- Gland water tank
  The gland water tank has the following features:

Description	Water buffer tank
Material	CS plate, 6mm
Location	In the cyclone plant building
Dimensions	DxH 3.5x9.6m
Insulation	None
Volume	$92m^3$
Retention time	12h for supplying gland water for all operating slurry pumps (4 in total).

- Gland water pumps

Gland water pump description is presented in the table below:

Feature	Description
Type	Positive displacement, plunger type (similar are used in pressure washers), FMC or equivalent
Duty point	$1.8m^3/h$ @ 2,100kPa ($213mH_20$)
Motor	5kW fixed speed
Installation schedule	year 1 to 5 no pumps year 6 to 11 2 pumps year 12 to 13 4 pumps year 12 to 18 6 pumps year 19 to 22 8 pumps.

6.3.5 Piping

The following piping is required for the water system:

Description	Pipe Size	Pipe Specification	Length (m)	Notes
Dilution water for cyclone feed	36”	HDPE DR 11	1,300	By gravity
Dilution water for cyclone U/f (Sand)	8”	HDPER DR 11	100	By gravity
Gland seal water	1”	CS	~50m in total	Pressure
Flush water	Vary, 12” and	CS	Vary, following	Pressure

Description	Pipe Size	Pipe Specification	Length (m)	Notes
	down		jacking header over LOM	

6.3.6 Valves

The following valves are used for water:

2" and below: manual ball valves

3" to 8": manual butterfly valves

10" and above air actuated butterfly valves.

6.4 Risks and Mitigation Plans

- All valves located outdoors are insulated and heat traced.
- The 12" flush water pipe for the sand distribution system is insulated and heat traced.

6.5 Alternatives Considered

None.

6.6 Future Work

Overall more detailed design for all water systems.

Yarek Koziura, PEng, PE
Project Manager
December 10th, 2012

Christian Kujawa
Manager Process

APPENDIX A – DESIGN CRITERIA

Knight Piésold CONSULTING

Knight Piésold

Casino Project Tailings Cyclone and Transport Study

Design Criteria Document

Report Number: KPV-5277 R01 Rev 0

December 10, 2012

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TERMS OF REFERENCE

This work has been conducted by Paterson & Cooke for the Knight Piésold under Order Number #9063. The proposal for this work was presented in P&C Proposal KPV-5277 C01 Rev B dated June 14, 2012 and Change Notices: CN01 Rev A dated June 26, 2012 and CN02 Rev A dated July 13, 2012.

DOCUMENT DISTRIBUTION, REVISION AND APPROVAL HISTORY

Rev	Date	Distribution / Revisions	Prepared	Reviewed	Client Approval
A	July 4, 2012	For Client Review	MJ/YK	CK	
B	September 11, 2012	For Client Review	MJ/YK	CK/RC	SB
C	November 1st, 2012	For FS Report	YK		
0	December 10, 2012	For FS Report	YK		SB

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1. INTRODUCTION

1.1 Background

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Mr. Graham Greenaway of Knight Piésold Vancouver (KPV) requested that Paterson & Cooke (P&C) to carry out a study for the tailings cyclone and transportation system feasibility level design for Casino Mining Corporation for their Casino Project in the Yukon Territory, Canada.

This report presents the design criteria used in this project.

1.2 Reference Documents

Document	Abbreviation
P&C Project Proposal, C01 Rev B, June 14, 2012.	P&C C01
P&C Change Notice CN01 Rev A, June 26, 2012.	P&C CN01
P&C Change Notice CN02 Rev A, July 13, 2012.	P&C CN02
Updated TMF Pre-Feasibility Design Rev 0 (reduced for P&C review)	KP-01
Casino Particle Size Distribution Report	KP-02
TMF - Waste Deposition Strategy - Year 1	KP-03
TMF - Waste Deposition Strategy - Year 23	KP-04
TMF – Production and Filling Schedule Curves dated Sept 28, 2012	KP-05
TMF – Summary of Design Basis and Operating Criteria	KP-06
"Casino-Process Plant", Email dated June 28, 2012 by Graham Greenaway.	KP-07
"RE: Casino-Process Plant design info", Email dated June 29, 2012 by Graham Greenaway.	KP-08
"Re: Casino – updated basis of design." Email dated July 30, 2012 by Sanne Brinkman	KP-09
"Re: Casino - required cyclone sand recovery" Email dated August 8, 2012 by Sanne Brinkman	KP-10
Minutes for Project meeting #6, August 29th 2012	KP-11
RE: Casino: comments on Design Basis and updated Filling Schedule, *Email dated September 28, 2012 by Sanne Brinkman*	KP-12

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1.3 Units

The main inputs and outputs of the project are in customary SI metric units.

1.4 Abbreviations

USD	United States of America Dollar
CAD	Canadian Dollar
FS	feasibility study
LOM	life-of-mine
U/F	cyclone underflow
O/F	cyclone overflow
PSD	particle size distribution
PAG	potentially acid generating
NAG	non-acid generating
TMF	tailings management facility
t/h	metric tonne per hour
t/d	metric tonne per day
t/m^3	metric tonne per cubic metre
m^3/h	cubic metres per hour
%m	solids percentage by mass
%v	solids percentage by volume
μ_{mf}	carrier fluid viscosity
amsl	above mean sea level
cP	centipoise

2. GENERAL

2.1 Process Description

The tailings from the process are split into two dedicated streams: potentially acid generating (PAG) stream (20% by distribution) and non-acid generating (NAG) stream (80% by distribution). This design criteria document applies only to the NAG tailings.

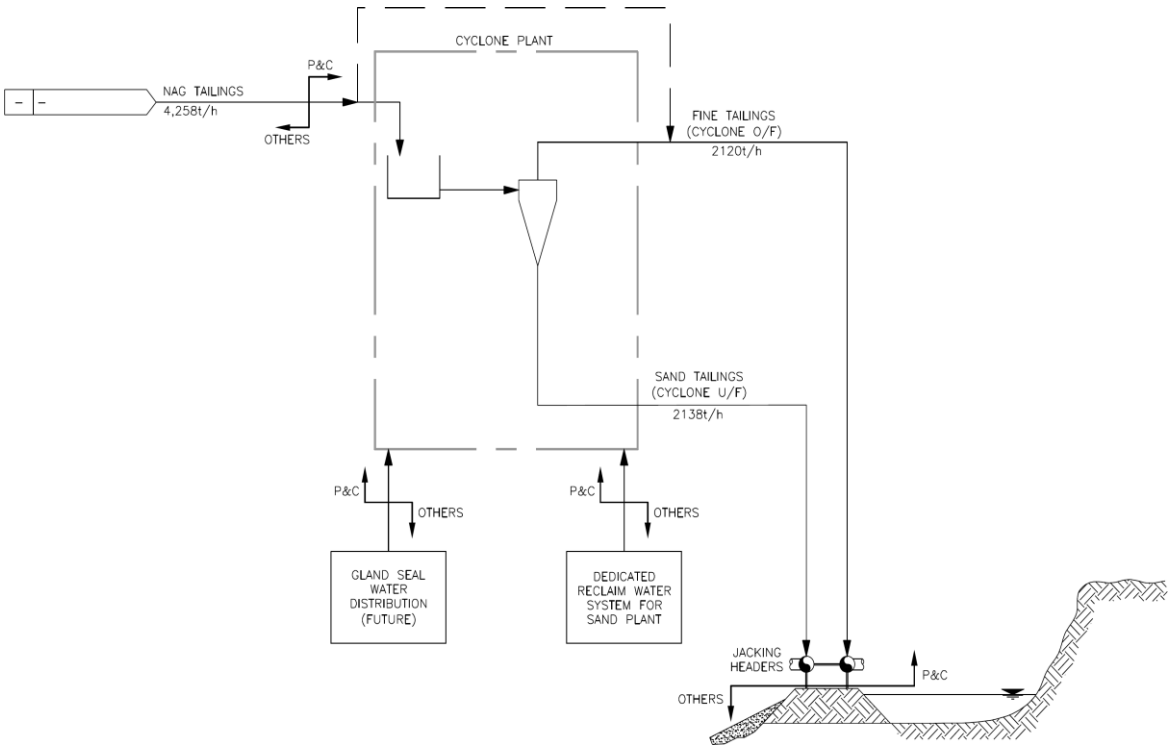
Rev C

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The NAG tailings from the milling process will be delivered from the mill to the Cyclone Plant. For approximately nine months of each year, the NAG tailings will be processed in one stage of cyclones to produce sand for the Tailings Management Facility (TMF) embankment construction. The cyclone overflow material (fine tailings) will be discharged directly into TMF impoundment on upstream side of the dam. During the three winter months (and when the cyclone station is offline), the tailings will bypass the Cyclone Plant and be deposited directly into TMF impoundment through the combined cyclone overflow pipeline. In order to feed the cyclones at optimum solids concentration for solids separation, dilution water is required at the Cyclone Plant.

Jacking headers are required for the cyclone underflow and the combined cyclone overflow pipelines to match the piping lift rate with the rise rate of the dam crest.

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2.2 Study Level

The design is prepared at the feasibility study level of ±15% accuracy.

2.3 System List

System Name	System Description
Cyclone plant	Consists of cyclone feed box(es), cyclone feed pump(s), 1 stage cyclones, feed conditioning, water dilution system and interconnecting piping
Sand tailings	Consists of collection box, pump(s) and sand distribution pipelines
Fine tailings	Consists of collection box, fine tailings distribution piping and cyclones bypass arrangement.

Rev C

2.4 Process Battery Limits

The process battery limits are detailed in the table below:

Stream	Battery Limits
NAG Tailings Feed	At the inlet to the cyclone station feed box
Cyclone U/F	At the discharge point on the tailings storage facility
Cyclone O/F	At the discharge point on the tailings storage facility
Process water	Top of the dilution water head tank (Process water may be required for flushing, gland seal water or control aspects, such as dilution)

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3. SITE AND ENVIRONMENTAL

Item	Value / Description	Source / Comments
Location	Dawson Range Mountains of Yukon Territory, approximately 300 km northwest of Whitehorse 613,000 E 6,955,000 N	KP-1
Elevation	Sand plant elevation ~1,006 m amsl Crest elevation (year 1) 830 m amsl Crest elevation (year 23) 998 m amsl	P&C estimate KP-12 KP-12
Mean Annual Precipitation	510 mm	KP-12
Site Temperature	-50 ºC minimum	KP-012

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Item	Value / Description	Source / Comments
	+30 ºC maximum	
Seismic conditions	Operating Basis Earthquake (OBE)=1/500 - Mean maximum firm ground acceleration = 0.08g, magnitude = 8.0 Maximum Design Earthquake (MDE)=1/2,500 - Mean maximum firm ground acceleration = 0.13g, magnitude = 8.0	KP-01

4. PROCESS REQUIREMENTS

4.1 Mine

Item	Value / Description	Source / Comments
Total ore milled	975.8 Million tonne	KP-09
Normal throughput	120,000 tpd	KP-09
Mine life	22 year	KP-01
Cyclone plant operation	9 months in each year	KP-01

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Rev 0

4.2 Whole NAG Tailings

Item	Value / Description	Source / Comments
Medium description	Copper/gold flotation tailings	KP-01
Mill total tailings production	120,000*(1-0.01)=118,800 t/d where 0.01 is concentrate production	KP-06
NAG tailings fraction	80% of total tailings	KP-06
Concentrator availability	93%	KP-07
NAG tailings production	118,800*0.8=95,040t/d 95,040/0.93/24=4,258t/h	KP-06
NAG tailings concentration	Nominal 55%m Maximum 60%m Minimum 50%m	KP-06, KP-08

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Item	Value / Description	Source / Comments
Design factor	+15%, -10% 60% of nominal tonnage expected occasionally	KP-08
TR tailings tonnage	Nominal 4,258 t/h @ 55%m Maximum (+15%) 4,258*1.15=4,896 t/h @ 55%m Minimum (-10%) 4,258*0.90=3,832 t/h @ 55%m	KP-06, KP-08

4.3 Cyclone Plant

4.3.1 Cyclone Station Feed

Rev C

Item	Value / Description	Source / Comments
Cyclone station capacity	100% of NAG tailings production, 9 months of each year	KP-01
Design Factor	+15%, -10% 40% of nominal tonnage expected occasionally	KP-06, KP-08
Cyclone station feed rate	Normal 95,040t/d or 4,258 t/h at 55%m Maximum (+15%) 4,896 t/h at 55%m Minimum (-10%) 3,832 t/h at 55%m	KP-06, KP-08
Cyclone station location	Cyclone station in a heated building (by others), at a location to be determined by P&C. Cyclone Plant relocation during LOM will be minimized.	P&C design
Cyclone station availability	90% during 9 month period	KP-09
Solids density	2,695 kg/m^3	KP-02
Liquid density	1,000 kg/m^3 (water)	Assumption

4.3.2 Cyclone Station

Item	Value / Description	Source / Comments
Cyclone type	Conventional	P&C design
Feed concentration	36% (diluted from 55% as supplied by process plant)	P&C design
Dilution water source	Reclaim water provided by others	P&C design
Cyclone feed pressure requirement	72.4 kPa	P&C design

Item	Value / Description	Source / Comments
Feed mix box retention time	40 seconds	P&C design
O/F box retention time	40 seconds, cyclone O/F piped directly to TMF	P&C design
U/F box retention time	40 seconds	P&C design
Number of spare cyclones	2	P&C design

4.3.3 Dilution Water Head Tank

Item	Value / Description	Source / Comments
Tank bottom elevation	1035m asl	P&C design
Tank height	12.5m	P&C design
Tank diameter	12.5m	P&C design
Tank retention Time	20 minutes	P&C design

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4.4 Cyclone Overflow

Item	Value / Description	Source / Comments
Medium description	Cyclone overflow	
Design concentration	23.7%m	P&C design
Pipeline route	As defined in P&C corridor drawings	KP-03 and KP-04
Pipeline design factor for friction losses	10% above calculated to cover minor losses and slurry model accuracy	P&C assumption

4.5 Sand (Cyclone Underflow)

Item	Value / Description	Source / Comments
Medium description	Cyclone underflow	

Cyclone plant sand recovery	50.2%	P&C design and KP-10
Cyclone sand production	Nominal 4,258t/d*0.502=2,138t/d 2,138t/d*0.93*0.9*(9/12)*24*365=11.76mln t/year	P&C calculation
Cyclone sand (U/F) quality	12% passing 74 µm	KP-10
Cyclone U/F solids mass concentration (before dilution)	74%	P&C simulation
Solids mass concentration after dilution for dam construction	65%	KP-09
Pipeline route	As defined on site corridor drawings	KP-03 and KP-04
Design factor for friction losses	15% above calculated to cover minor losses and slurry model accuracy	P&C assumption

Rev 0

5. SLURRY PROPERTIES

5.1 NAG Bulk Tailings – Sand Plant Feed

Item	Value / Description		Source / Comments
Size distribution	**Size (µm)**	**Percent passing**	KP-02
	853	100.0%	
	422	99.9%	
	251	94.1%	
	152	66.4%	
	75	42.0%	
	43.5	33.2%	
	31.7	28.1%	
	20.7	22.4%	
	12.3	16.7%	
	6.3	11.0%	
	3.2	7.9%	

Item	Value / Description		Source / Comments
	1.3	5.4%	
Slurry class	Class 3		ANSI/HI 12.1 -12. 6 Service Duty Chart
Solids specific gravity	2,695 kg/m^3		KP-02
d_{50}	100 µm		From PSD
Percent fines (-44µm)	33.3%		From PSD
d_{85} coarse (+74 µm)	241 µm		From PSD
d_{50} coarse (+74 µm)	168 µm		From PSD
C_{bmax}	52 %v		P&C data base
Flocculants or reagents added to medium	n/a		KP-01
Medium temperature	5 to 10ºC		P&C assumption
Slurry flow behavior	NAG tailings and corresponding carrier fluid (-44 µm fraction) are mixed regime (combination of settling and non-settling characteristics.		P&C design
Slurry rheology @ C=55%m	τ_y (Pa)	8.7	P&C assumption based on similar tailings
	K_B (mPa.s)	16	
Carrier fluid rheology @ C=55%m	τ_y (Pa)	0.5	P&C assumption based on similar tailings
	K_B (mPa.s)	4.4	

5.2 Cyclone Overflow (Fine Tailings)

Item	Value / Description		Source / Comments
Size distribution	**Size (µm)**	**Percent passing**	P&C simulation
	2000	100.0	
	1000	100.0	
	850	100.0	

Item	Value / Description		Source / Comments
	600	100.0	
	420	100.0	
	300	100.0	
	212	99.9	
	150	96.8	
	100	85.8	
	75	73.2	
	53	64.4	
	45	60.1	
	38	55.5	
	20	39.6	
	15	34.0	
	10	27.0	
	7	21.5	
Slurry class	Class 2		ANSI/HI 12.1 -12. 6 Service Duty Chart
Solids specific gravity	2,695 kg/m^3		KP-02
d_{50}	30 µm		From PSD
Percent fines (-44µm)	60.1 %		From PSD
C_{bmax}	45%		P&C assumption
Flocculants or reagents added to medium	n/a		KP-01
Medium temperature	5 to 10 ºC		P&C assumption
Slurry flow	The fine tailings are assumed to be non-settling slurry.		P&C assumption

Item	Value / Description	Source / Comments
behavior		
Slurry carrier fluid viscosity	μ_{mf}=1.4cP for solids concentration by weight C_w=23.7% and fines concentration by weight C_{mf}=23.7%	P&C assumption

5.3 Cyclone Underflow (Sand Tailings)

Item	Value / Description		Source / Comments
Size distribution	**Size (µm)**	**Percent passing**	P&C simulation
	2000	100.0	
	1000	100.0	
	850	100.0	
	600	99.9	
	420	99.7	
	300	92.2	
	212	69.8	
	150	35.2	
	100	18.4	
	75	11.1	
	53	8.6	
	45	7.6	
	38	6.8	
	20	4.6	
	15	3.9	
	10	3.0	
	7	2.4	
	3	1.5	
Slurry class	Class 3		ANSI/HI 12.1 -12. 6 Service Duty Chart

Item	Value / Description	Source / Comments
Solids specific gravity	2,695 kg/m^3	KP-02
d_{50}	174 µm	From PSD
Percent fines (-44µm)	7.6%	From PSD
C_{bmax}	50%	P&C assumption
Flocculants or reagents added to medium	n/a	KP-01
Medium temperature	5 to 10ºC	P&C assumption
Slurry flow behavior	The sand tailings are assumed to be fast settling slurry with small carrier fluid component.	P&C assumption
Slurry carrier fluid viscosity	μ_{mf}=1.3cP for solids concentration by weight C_w=65% and fines concentration by weight C_{mf}=18.2%	P&C assumption

6. EMBANKMENT DATA

Item	Value / Description				Source / Comments
Operation	100% of sand production, 9month per year, continuous 24 hour per day				KP-01
Construction mode	Cell construction with compaction				KP-01
Availability	90%, matching sand plant availability				P&C design
Embankment crest width	30 m				KP-09
Dam Elevations & Sand Requirements	**Year**	**Crest Elevation**	**Crest Length (m)**	**Required Sand mt/y**	KP-12
	-1	830 amsl	868	0	
	1	830 amsl	868	9.2	
	2	849 amsl	1,308	12.3	
	3	865 amsl	1,450	12.2	
	4	876 amsl	1550	12.2	
	5	884 amsl	1,610	12.1	
	6	894 amsl	1,754	12.1	
	7	904 amsl	1,832	12.1	
	12	942 amsl	2,061	12.3	
	13	950 amsl	2,109	12.4	
	19	988 amsl	2,363	4.6	
	20	992 amsl	2,400	4.6	
	22	998 amsl	2,460 Main 333 West Dam	1.7	
Pond Elevation Below Crest	11m in year 1 5 to 6m in years 3 to 13 4 to 3m in years 14 to 22				KP-12

Rev C
General update of the table

7. IMPOUNDMENT

The NAG whole tailings, sand plant by-pass and combined cyclone overflow use the same pipeline and jacking header across the dam crest.

7.1.1 Non-Reactive Tailings Disposal (Sand Plant Bypass)

Item	Value / Description	Source / Comments
Operation	Continuous for 3 months per year, 24 hours per day, 100% of NAG flotation tailings during winter months, also when cyclone station is by-passed	KP-01
Discharge	Take off valves at 100 m spacing. One take off valve open at any time. Each take off valve/pipe branch set sized to carry 100% of full cyclone u/f.	P&C assumption
Availability	90%, matching sand plant availability	P&C assumption

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7.1.2 Combined Cyclone Overflow Disposal

Item	Value / Description	Source / Comments
Operation	Continuous for 9 months per year, 24hours per day, 100% of combined cyclone overflow	KP-01
Discharge	Take off valves every 100 m spacing. 2 to 3 valves open at any time. Each take off valve/pipe branch set sized to carry 50% of full cyclone O/f or bypass.	P&C assumption
Availability	90%, matching sand plant availability	P&C assumption

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8. MECHANICAL

Item	Value / Description	Source / Comments
Equipment size/types	Only equipment proven on similar operation will be considered	P&C assumption

8.1 Pumps

Item	Value / Description	Source / Comments
Standby	All pumps to be in operating/standby sets to maximize sand plant availability	P&C assumption

Item	Value / Description	Source / Comments
Centrifugal slurry pump lining material	High-head pumps: metal lining Low-head, low-duty slurry pumps: rubber lining	P&C assumption
Centrifugal slurry pump – seal arrangement	All slurry pumps equipped with gland flush seal arrangement	P&C assumption
Centrifugal slurry pump efficiency	Pump efficiency: from pump curve and duty point Variable frequency direct gearbox drive efficiency: 95%	P&C assumption
Centrifugal slurry pump – maximum impeller tip speed	Class 2 slurry with rubber lining: 28 m/s Class 2 slurry with metal lining: 38 m/s Class 3 slurry with rubber lining: 33 m/s Class 3 slurry with metal lining: 26 m/s	P&C assumption, ANSI/HI 12.1 -12. 6 slurry design code

8.2 Jacking Headers

Item	Value / Description	Source / Comments
Header type	Hydraulically operated 1 header for cyclone overflow and/or NAG whole stream tailings 1 header for sand stream	Industry standard
Average rate of rise	8 m per year	KP-02
Jack load	Sand tailings (cyclone u/f): 269kN (27 tonnes) Fine tailings (cyclone o/f): 169kN (19 tonnes)	P&C design
Wind load	Not available	

Rev C

9. PIPING

9.1.1 Steel piping

Steel piping used for all main pipelines.

Item	Value / Description	Source / Comments
Dimensional standard	ASME B31.10	P&C assumption
Steel grade	ASTM A53, API 5L X42 or higher	P&C assumption
Flange/couplings	Victaulic type preferred	P&C assumption

Item	Value / Description	Source / Comments
Internal lining	6 mm rubber lining within cyclone plant	P&C assumption
External coating	Painted, epoxy coating to provide life for pipes ~23 years	P&C assumption
Corrosion / wear allowance	2.1mm/1000h for NAG bulk tailings in slack flow 0.1mm/1000h for NAG bulk tailings in full pipe flow 0.1mm/1000h for cyclone O/F in slack flow 0.01mm/1000h for cyclone O/F in full pipe flow 9.1mm/1000h for cyclone U/F in slack flow 1.5mm/1000h for cyclone U/F in full pipe flow	P&C assumption
Support system	Above ground on sleepers, plinths	P&C assumption

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9.1.2 High Density Polyethylene Piping

Rev C

HDPE piping used for cyclone o/f on the ground and branch piping off jacking header to deposition points.

Item	Value / Description	Source / Comments
Dimensional standard	ASTM F714	P&C assumption
Material grade	PE4710	P&C assumption
Flange/couplings	Victaulic style 995 or similar	P&C assumption

10. CIVIL

By others.

11. STRUCTURAL

By others.

12. ELECTRICAL AND INSTRUMENTATION

By others.

13. DESIGN CODES AND STANDARDS

Item	Value / Description	Source / Comments
Pipeline design	ANSI/ASME Code for Pressure Piping B31.11 Slurry	Industry standard

Item	Value / Description	Source / Comments
	Transportation Piping Systems	
Cyclone plant piping	ANSI/ASME Process Plant Piping B31.3	Industry standard
Slurry pumps	ANSI/HI 12.1-12.6 2011	Industry standard

14. COSTING

Costing will be done by others. P&C will provide MTOs to support a cost estimate of ±15% accuracy level.

15. KEY DESIGN ISSUES AND DECISIONS

None.

16. UNAGESOLVED ISSUES

16.1 None.

Mazyar Jalayer
Project Engineer
November 1st, 2012

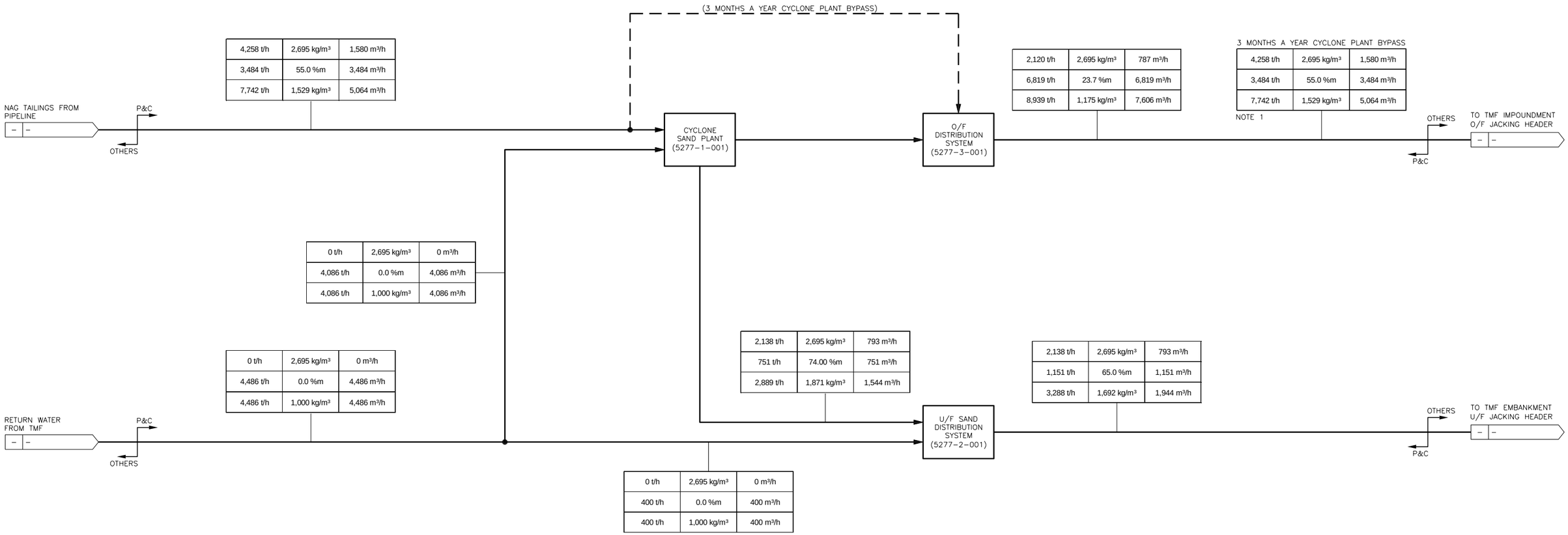
Yarek Koziura
Project Manager

Christian Kujawa
Manager Process

APPENDIX B – PATERSON&COOKE DRAWINGS

SOLIDS t/h	SOLIDS SG	SOLIDS m³/h
LIQUID t/h	%m SOLIDS	LIQUID m³/h
SLURRY t/h	SLURRY SG	SLURRY m³/h

NOMINAL TONNAGE



NOTES

1. NAG TAILINGS TO BYPASS CYCLONE SAND PLANT AND BE TRANSPORTED THROUGH CYCLONE OVERFLOW PIPELINE THREE MONTHS OF THE YEAR.

PRELIMINARY

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	27 AUG 12	ISSUED FOR REVIEW	MJ	TF	YK
B	25 OCT 12	ISSUEDFOR APPROVAL	MJ	TF	YK
C	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET ###

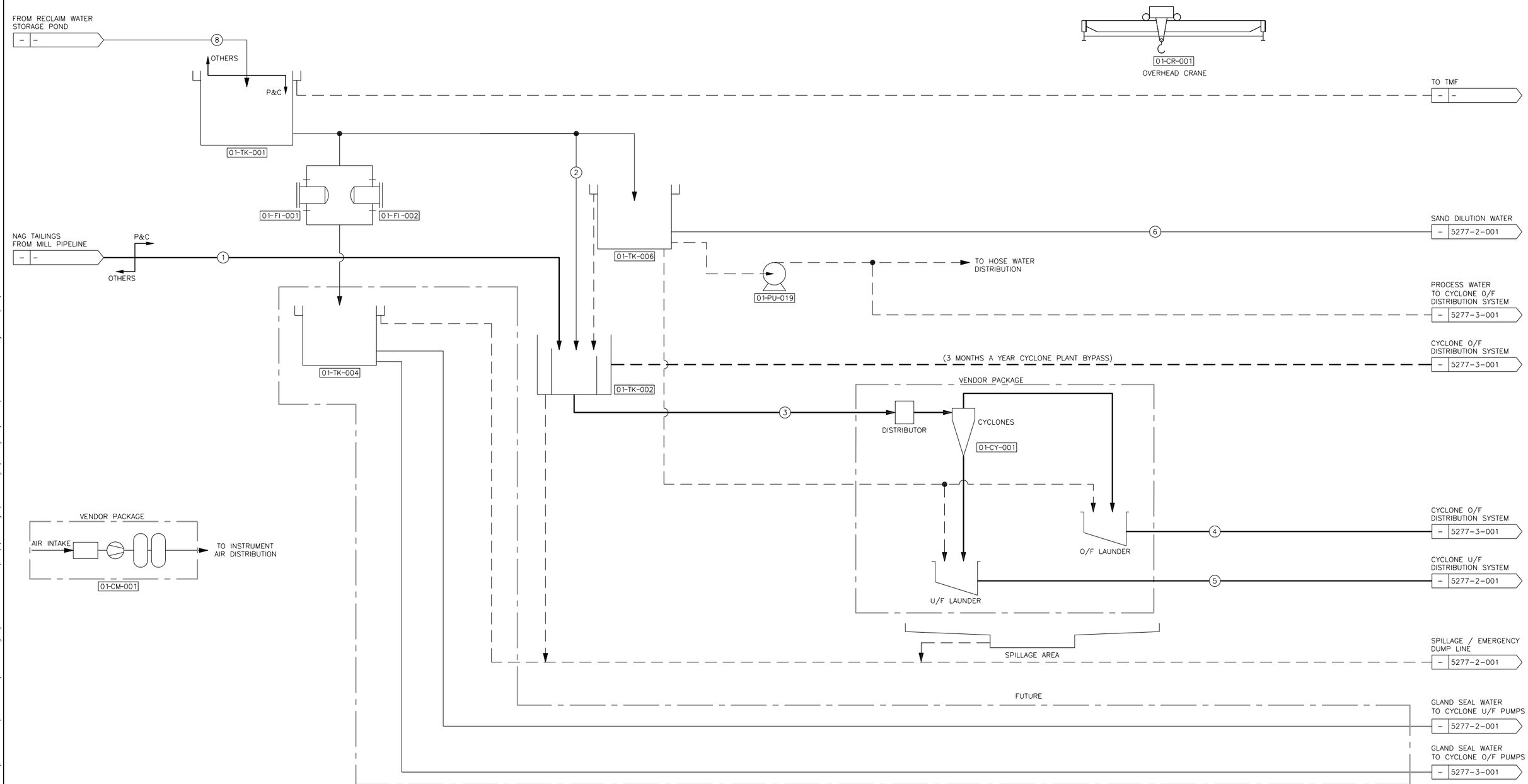
BLOCK PROCESS FLOW DIAGRAM

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	27-AUG-12	DRAWING NUMBER	REV
DRAWN	TF	27-AUG-12	5277-0-001	0

Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-0-001.dwg – 12/10/2012 2:57 PM

STREAM NUMBER	1		2		3		4		5		6		8	
DESCRIPTION	NR TAILINGS		Dilution Water		Cyclone Feed		Cyclone Overflow		Cyclone Underflow		Sand Dilution Water		Combined Cyclone Dilution Water	
SCENARIO	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL
SOLIDS (t/h)	4 897	4 258	-	-	4 897	4 258	2 439	2 120	2 458	2 138	-	-	-	-
WATER (m^3/h)	4 006	3 484	4 699	4 086	8 705	7 570	7 842	6 819	864	751	460	400	5 159	4 486
TOTAL MIXTURE (m^3/h)	5 823	5 064	4 699	4 086	10 522	9 150	8 746	7 606	1 776	1 544	460	400	5 159	4 486
MIXTURE DENSITY (t/m^3)	1.53	1.53	-	-	1.29	1.29	1.18	1.18	1.87	1.87	-	-	-	-
VOLUME CONCENTRATION (%)	31.2%	31.2%	-	-	17.3%	17.3%	10.3%	10.3%	51.4%	51.4%	-	-	-	-
MASS CONCENTRATION (%)	55.0%	55.0%	-	-	36.0%	36.0%	23.7%	23.7%	74.0%	74.0%	-	-	-	-
SOLIDS DENSITY (t/m^3)	2.70	2.70	-	-	2.70	2.70	2.70	2.70	2.70	2.70	-	-	-	-
COMMENT														

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET
01-TK-001	DILUTION WATER HEAD TANK	DxH, 12.5 m x 12.5 m			INSTALLED YEAR -1	
01-TK-002	CYCLONE FEED TANK	HxWxL, 8m x 7.7m x 8m			INSTALLED YEAR -1	
01-TK-004	GLAND SEAL WATER TANK	DxH, 3.5m x 9.6m			INSTALLED YEAR 6	
01-TK-006	WATER BUFFER TANK	DxH, 6.1m x 9m			INSTALLED YEAR -1	
01-CY-001	CYCLONE CLUSTER(S)	CLUSTER OF 12 x 800mm Dia., CAVEX CYCLONE			INSTALLED YEAR -1	
01-CR-001	OVERHEAD CRANE	15tonne	20kW		INSTALLED YEAR -1	
01-PU-019	FLUSH WATER PUMP	525 m^3/hr @ 40m	80 kW	8x10	INSTALLED YEAR -1	
01-CM-001	AIR COMPRESSOR PACKAGE	106 m^3/hr at 780 kPa	11kW	ATLAS COPCO GA11-8.5 W/DESICCANT AIR DRYER	INSTALLED YEAR -1	
01-FI-001	GSW FILTER - STANDBY	28.8 m^3/hr			INSTALLED YEAR -1	
01-FI-002	GSW FILTER - STANDBY	28.8 m^3/hr			INSTALLED YEAR -1	



PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	26 SEP 12	ISSUED FOR REVIEW	MJ	TF	YK/CK	5277-0-001	BLOCK PROCESS FLOW DIAGRAM
B	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-2-001	CYCLONE SAND DISTRIBUTION, PROCESS FLOW DIAGRAM, CYCLONE U/F DISTRIBUTION
C	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-3-001	CYCLONE OVERFLOW DISTRIBUTION, PROCESS FLOW DIAGRAM, CYCLONE O/F DISTRIBUTION
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET 1 ###

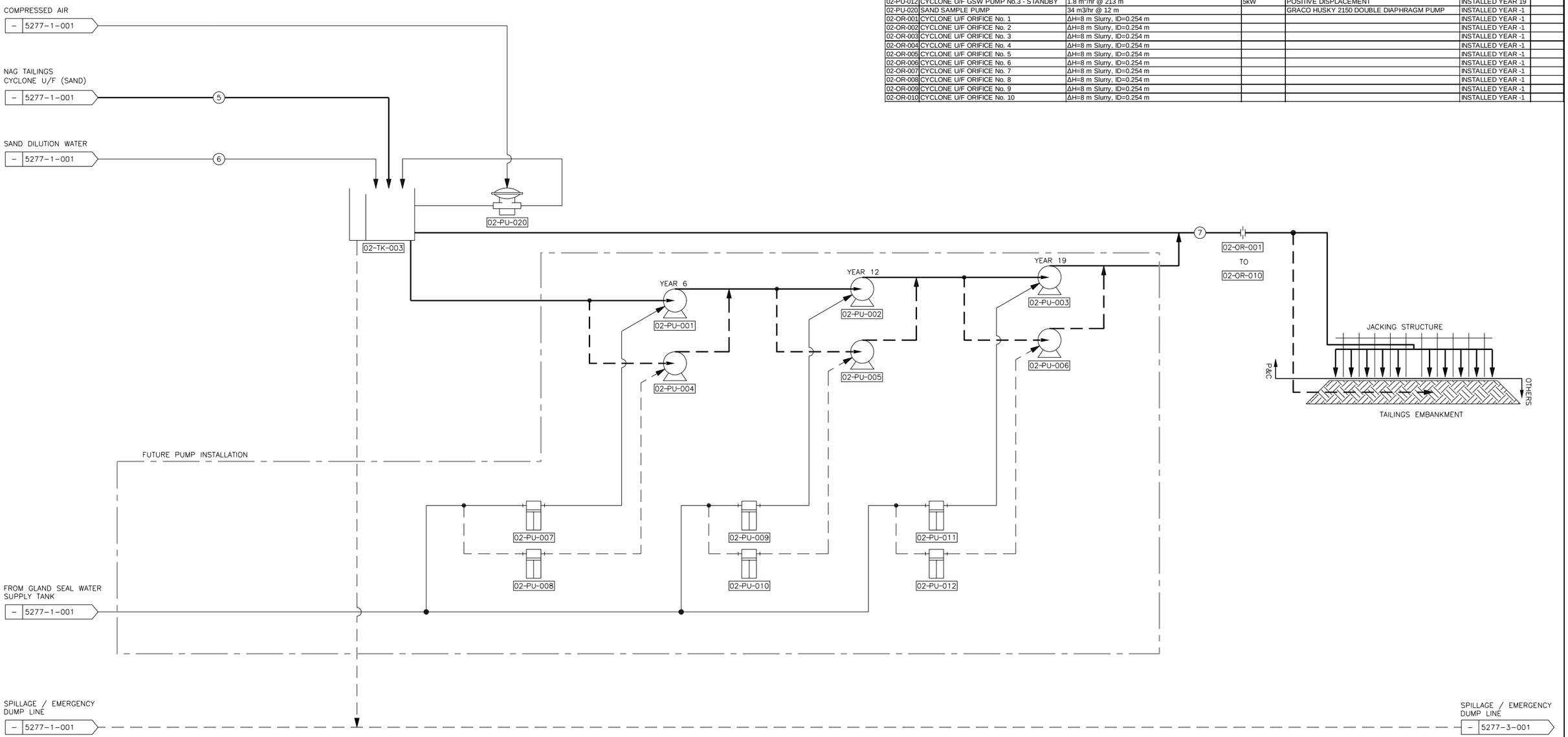
CYCLONE PLANT
PROCESS FLOW DIAGRAM

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	27-AUG-12	DRAWING NUMBER	REV
DRAWN	TF	27-AUG-12	5277-1-001	0

Tom Figas - P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-1-001.dwg - 12/10/2012 2:59 PM

STREAM NUMBER	5		6		7	
DESCRIPTION	Cyclone Underflow		Sand Dilution Water		Final Sand	
SCENARIO	MAX	NOMINAL	MAX	NOMINAL	MAX	NOMINAL
SOLIDS (t/h)	2 458	2 138	-	-	2 458	2 138
WATER (m^3/h)	864	751	460	400	1 324	1 151
TOTAL MIXTURE (m^3/h)	1 776	1 544	460	400	2 236	1 944
MIXTURE DENSITY (t/m^3)	1.87	1.87	-	-	1.69	1.69
VOLUME CONCENTRATION (%)	51.4%	51.4%	-	-	40.8%	40.8%
MASS CONCENTRATION (%)	74.0%	74.0%	-	-	65.0%	65.0%
SOLIDS DENSITY (t/m^3)	2.70	2.70	-	-	2.70	2.70
COMMENT						

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET
02-TK-003	CYCLONE U/F TANK	HxLxW, 4 m x 3.2 m x 4 m			INSTALLED YEAR -1	
02-PU-001	CYCLONE U/F PUMP No. 1	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 6	
02-PU-002	CYCLONE U/F PUMP No. 2	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 12	
02-PU-003	CYCLONE U/F PUMP No. 3	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 19	
02-PU-004	CYCLONE U/F PUMP No. 1 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 6	
02-PU-005	CYCLONE U/F PUMP No. 2 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 12	
02-PU-006	CYCLONE U/F PUMP No. 3 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 19	
02-PU-007	CYCLONE U/F GSW PUMP No.1	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 6	
02-PU-008	CYCLONE U/F GSW PUMP No.1 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 6	
02-PU-009	CYCLONE U/F GSW PUMP No.2	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 12	
02-PU-010	CYCLONE U/F GSW PUMP No.2 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 12	
02-PU-011	CYCLONE U/F GSW PUMP No.3	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 19	
02-PU-012	CYCLONE U/F GSW PUMP No.3 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 19	
02-PU-020	SAND SAMPLE PUMP	34 m3/hr @ 12 m		GRACO HUSKY 2150 DOUBLE DIAPHRAGM PUMP	INSTALLED YEAR -1	
02-OR-001	CYCLONE U/F ORIFICE No. 1	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-002	CYCLONE U/F ORIFICE No. 2	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-003	CYCLONE U/F ORIFICE No. 3	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-004	CYCLONE U/F ORIFICE No. 4	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-005	CYCLONE U/F ORIFICE No. 5	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-006	CYCLONE U/F ORIFICE No. 6	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-007	CYCLONE U/F ORIFICE No. 7	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-008	CYCLONE U/F ORIFICE No. 8	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-009	CYCLONE U/F ORIFICE No. 9	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	
02-OR-010	CYCLONE U/F ORIFICE No. 10	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1	



PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	26 SEP 12	ISSUED FOR REVIEW	MJ	TF	YK/CK	5277-0-001	BLOCK PROCESS FLOW DIAGRAM
B	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-1-001	CYCLONE PLANT, PROCESS FLOW DIAGRAM, CYCLONE STATION
C	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-3-001	CYCLONE OVERFLOW DISTRIBUTION, PROCESS FLOW DIAGRAM, CYCLONE O/F DISTRIBUTION
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET 1 ###

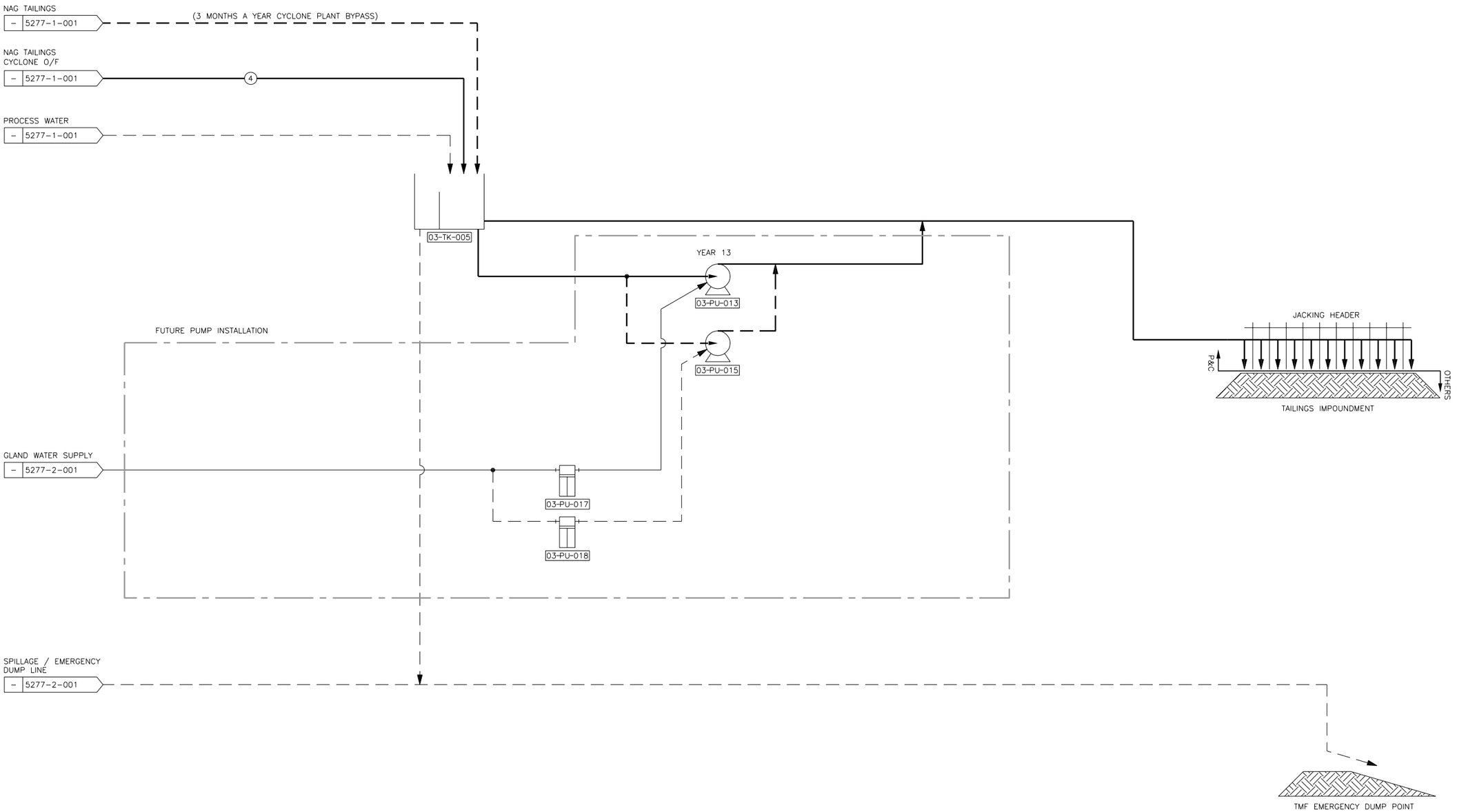
CYCLONE SAND DISTRIBUTION
PROCESS FLOW DIAGRAM

SCALE N.T.S. | PROJECT NUMBER KPV-5277 | SIZE D
DESIGNED MJ 27-AUG-12 | DRAWING NUMBER 5277-2-001 | REV 0
DRAWN TF 27-AUG-12

Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-2-001.dwg – 12/10/2012 3:02 PM

STREAM NUMBER	4	
DESCRIPTION	Cyclone Overflow	
SCENARIO	MAX	NOMINAL
SOLIDS (t/h)	2 439	2 120
WATER (m³/h)	7 842	6 819
TOTAL MIXTURE (m³/h)	8 746	7 606
MIXTURE DENSITY (t/m³)	1.18	1.18
VOLUME CONCENTRATION (%)	10.3%	10.3%
MASS CONCENTRATION (%)	23.7%	23.7%
SOLIDS DENSITY (t/m³)	2.70	2.70
COMMENT		

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET
03-TK-005	CYCLONE O/F TANK	HxWxL, 5 m x 5.5 m x 6.2 m			INSTALLED YEAR -1	
03-PU-013	CYCLONE O/F PUMP	8,746 m^3/hr @ 60 m	2000kW VFD	WEIR 650L	INSTALLED YEAR 13	
03-PU-015	CYCLONE O/F PUMP - STANDBY	8,746 m^3/hr @ 60 m	2000kW VFD	WEIR 650L	INSTALLED YEAR 13	
03-PU-017	CYCLONE O/F GSW PUMP	1.8 m^3/hr @ 75 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 13	
03-PU-018	CYCLONE O/F GSW PUMP - STANDBY	1.8 m^3/hr @ 75 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 13	



PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	26 SEP 12	ISSUED FOR INTERNAL REVIEW	MJ	TF	YK/CK	5277-0-001	BLOCK PROCESS FLOW DIAGRAM
B	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-1-001	CYCLONE PLANT, PROCESS FLOW DIAGRAM, CYCLONE STATION
C	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-2-001	CYCLONE SAND DISTRIBUTION, PROCESS FLOW DIAGRAM, CYCLONE U/F DISTRIBUTION
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET 1 ###

CYCLONE OVERFLOW DISTRIBUTION
PROCESS FLOW DIAGRAM

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	27-AUG-12	DRAWING NUMBER	REV
DRAWN	TF	27-AUG-12	5277-3-001	0

Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-3-001.dwg – 12/10/2012 3:05 PM

DILUTION WATER FROM DILUTION WATER HEAD TANK
– | 5277-1-102
HDPE(DR11)-PW
(1.3km)

NAG TAILINGS
– | –
P&C
OTHERS
32"-CS(STD)6mmRL-PS

O/F FROM 01-TK-006
– | 5277-1-102
18"-HDPE(DR17)-PW

36"-CS(STD)-PW
26"
FE
FI
8"-CS(STD)-PW
LI
LE
HS
12"-CS(STD)-PW
6"
FIC
HS
ZIC
ZIO
HS
ZIC
ZIO
NOTE 2 TYP.
EL. 1013.3m
O/F
24" N.C.
N.C.
01-TK-002
CYCLONE FEED TANK

4"-CS(STD)-PW
(INSULATED & HEAT TRACED OUTDOORS)
TO GLAND SEAL WATER SYSTEM
– | 5277-1-103

01-CR-001
OVERHEAD CRANE

32"-CS(STD)6mmRL-PS
NAG TAILINGS BYPASS TO 03-TK-005
– | 5277-3-101

DENSITY SIGNAL FROM SAMPLER OR INLINE DENSITY METER (YEAR 6)
– | 5277-2-101/102

HS
DIC
FI
DI
PI
PI
PI
PIT
LC
HS
VENDOR PACKAGE
FQI
FI
FIC
FE
DE
M
40"-CS(10)-PS
38"-CS(STD)6mmRL-PS
01-CY-001
12 CYCLONE CLUSTER
TO CYCLONE O/F TANK 03-TK-005
40"-CS(10)6mmRL-PS
– | 5277-3-101/102
HS
16" N.C.
DILUTION WATER
– | 5277-1-102
8"-CS(STD)-PW
M
6"
8"
TO CYCLONE U/F TANK 02-TK-003
32"-CS(10)6mmRL-PS
– | 5277-2-101/102
6"
6"
FLUSH WATER FOR CYCLONE U/F & O/F LAUNDER
– | 5277-2-102
6"-CS(STD)-PW
O/F FROM GSW TANK 01-TK-004
– | 5277-1-103
12"-CS(STD)-PW
22"-CS(STD)-PW
SPILLAGE AREA
SPILLAGE / EMERGENCY DUMP LINE
– | 5277-2-101/102
42"-HDPE(DR17)-PW

NOTE:
1. ALL ACTUATED KNIFE GATE VALVES TO BE SUPPLIED WITH OPEN/CLOSE POSITION SWITCH AND DCS INDICATION.

PRELIMINARY

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION

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TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET 1 ###
CYCLONE STATION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 1 OF 3

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	16-AUG-12	DRAWING NUMBER	REV
DRAWN	TF	16-AUG-12	5277-1-101	0

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FROM RECLAIM WATER STORAGE POND
– | –

P&C

OTHERS

36"–CS(STD)–PW

HS – | HS – | 6" | LIC – (H/L) | LE – | 8" | 8"

O/F

40"–HDPE(DR17)–PW
(500m TO TSF)

TMF

TO CYCLONE FEED DILUTION WATER SYSTEM
– | 5277–1–101

36"–HDPE(DR11)–PW
(1.3km TO CYCLONE PLANT)

EL. 1035m

01-TK-001
DILUTION WATER HEAD TANK

8"–HDPE(DR17)–PW

6" | 6" | LIC – | LE – | LI – (H/L) | PIC – | PIT – | 4" | 6"–HDPE(DR11)–PW

TO HOSE WATER DISTRIBUTION

8"–CS(STD)–PW

TO CYCLONE O/F FLUSH WATER SYSTEM
– | 5277–3–101

12"–CS(STD)–PW

TO CYCLONE U/F FLUSH WATER SYSTEM
– | 5277–2–101

12"–CS(STD)–PW

O/F

14"–HDPE(DR11)–PW
(100m TO CYCLONE PLANT)

01-PU-019
FLUSH WATER PUMP

HDPE — CS

TO SAND DILUTION SYSTEM
– | 5277–1–101

8"–HDPE(DR11)–PW
(100m TO CYCLONE PLANT)

HDPE — CS

TO CYCLONE LAUNDER
– | 5277–1–101

6"–HDPE(DR11)–PW
(100m TO CYCLONE PLANT)

EL. 1013.3m

01-TK-006
WATER BUFFER TANK

VENDOR PACKAGE

AIR INTAKE

2"–CS(STD)–IA

TO INSTRUMENT AIR SERVICE

01-CM-001
AIR COMPRESSOR PACKAGE

18"–HDPE(DR17)–PW

TO CYCLONE FEED TANK
– | 5277–1–101

TO SAND SAMPLE PUMP
– | 5277–2–101

PRELIMINARY

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION

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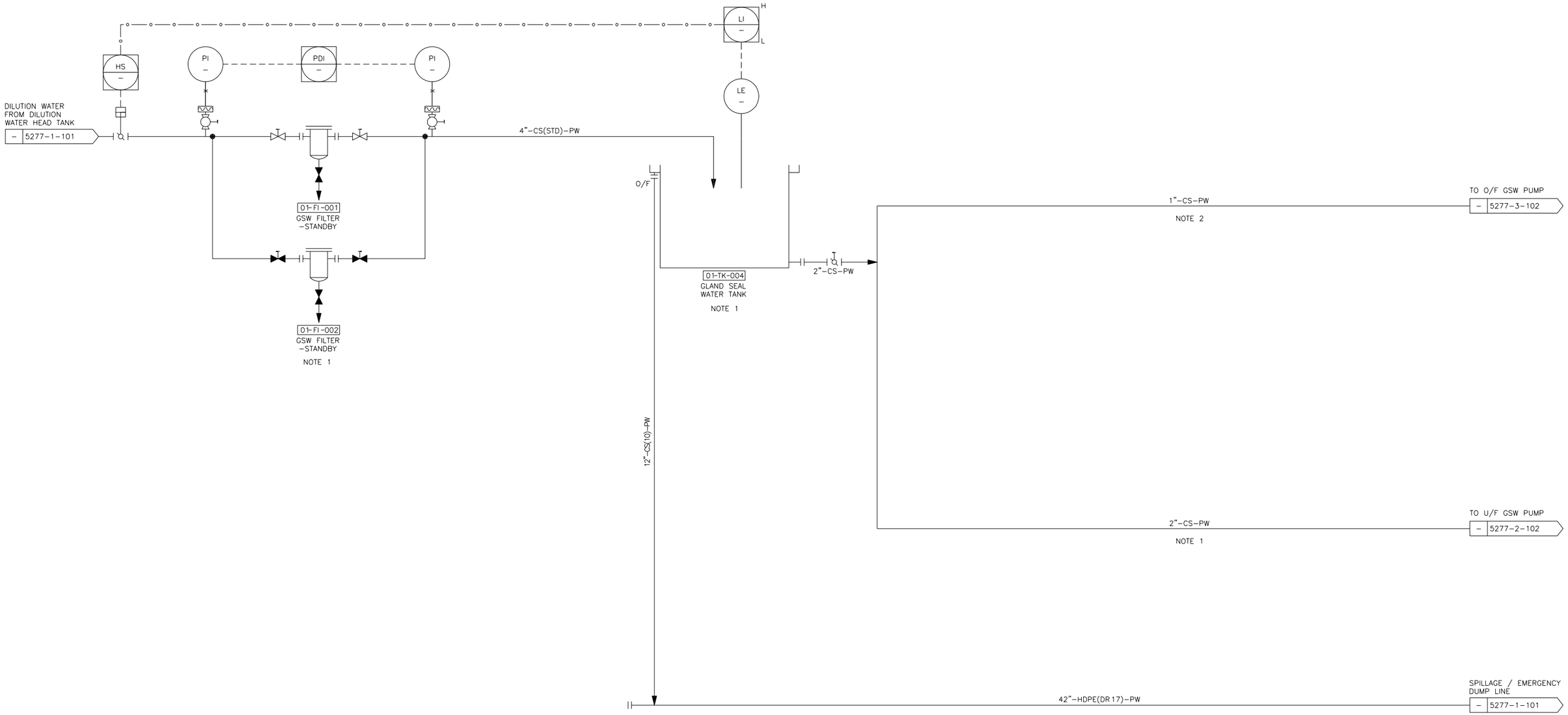
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE STATION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 2 OF 3

SHEET ###

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV–5277	D
DESIGNED	MJ	16–AUG–12	DRAWING NUMBER	REV
DRAWN	TF	16–AUG–12	5277–1–102	0

Tom Figas – P:\3 – Projects\KPV–5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277–1–102.dwg – 12/10/2012 3:09 PM



NOTES:
1. GSW FILTER & TANK TO BE INSTALLED IN YEAR 6 WHEN GSW PUMP FOR CYCLONE U/F WILL BE INSTALLED.

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-2-101	CYCLONE SAND DISTRIBUTION P&ID, CYCLONE U/F DISTRIBUTION
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-3-101	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F DIAGRAM
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###
CYCLONE STATION
PIPING AND INSTRUMENT DIAGRAM (P&ID)
SHEET 3 OF 3 (YEAR 6 TO 22)

SCALE		PROJECT NUMBER	SIZE
N.T.S.		KPV-5277	D
DESIGNED	CS	06 JUN 12	REV
DRAWN	TF	11 JUN 12	0

DRAWING NUMBER 5277-1-103

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COMPRESSED AIR
– 5277-1-102

1"-CS

NAG TAILINGS
CYCLONE U/F (SAND)
– 5277-1-101

32"-CS(10)6mmRL-PS

LI –

LIT –

HS –

I

20" N.C.

02-TK-003
CYCLONE
U/F TANK

12"

8" N.C.

02-PU-020
SAND SAMPLE
PUMP

2"-CS(STD)6mmRL-PS

DI –

DIC –

DE –

SAMPLE PORT

TO CYCLONE U/F
DILUTION WATER
CONTROLER
– 5277-1-101

18"-CS(10)6mmCL-PS

CYCLONE UNDERFLOW
JACKING STRUCTURE
– 5277-2-103

FLUSH WATER
– 5277-1-102

12"-CS(STD)-PW

24"-CS(10)-PW

12"-CS(STD)-PW

JACKING STRUCTURE
FLUSHING WATER
– 5277-2-102

SPILLAGE / EMERGENCY
DUMP LINE
– 5277-1-101

42"-HDPE(DR17)-PW

SPILLAGE / EMERGENCY
DUMP LINE
– 5277-3-101/102

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-1-101	CYCLONE SAND PLANT P&ID, CYCLONE STATION
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	2577-2-102	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE U/F JACKING HEADER
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-2-103	CYCLONE SAND DISTRIBUTION P&ID, GLAND SEAL WATER SYSTEM
						5277-3-101	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F DISTRIBUTION

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE SAND DISTRIBUTION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 1 OF 3 (YEAR 1 TO 5)

SHEET ###

SCALE		PROJECT NUMBER	SIZE
N.T.S.		KPV-5277	D
DESIGNED	CS	06 JUN 12	REV
DRAWN	TF	11 JUN 12	0

DRAWING NUMBER 5277-2-101

Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-2-101.dwg – 12/10/2012 3:13 PM

NAG TAILINGS
CYCLONE U/F (SAND)
– 5277-1-101

32"-CS(10)6mmRL-PS

FLUSH WATER
– 5277-1-102

12"-CS(STD)-PW

– 5277-1-103

12"

HS

LI
LIT

20" N.C.

02-TK-003
CYCLONE
U/F TANK

20"-CS(STD)6mmRL-PS

8" N.C.

8" N.C.

HS

6" N.C.
DRAIN

VFD

02-PU-001
CYCLONE
U/F PUMP
No.1

6" N.C.
DRAIN

FROM
GSW PUMP
02-PU-007

YEAR 6

VFD

02-PU-002
CYCLONE
U/F PUMP
No.2

FROM
GSW PUMP
02-PU-009

YEAR 12

VFD

02-PU-003
CYCLONE
U/F PUMP
No.3

FROM
GSW PUMP
02-PU-011

YEAR 19

PI
PIT

HS

FI
FIT

DIC
DI
DE

TO CYCLONE U/F
DILUTION WATER
CONTROLER
– 5277-1-101

CYCLONE UNDERFLOW
JACKING STRUCTURE
– 5277-2-103

M

18"-CS(80)-PS

FSAL

PI

HS

FS

TO PUMP
No.1

02-PU-007
CYCLONE U/F
GSW PUMP No.1

FSAL

PI

HS

FS

TO PUMP
No.4

02-PU-008
CYCLONE U/F
GSW PUMP No.1
–STANDBY

TYPICAL GSW PUMP ARRANGEMENT

02-PU-009 TYPICAL GSW PUMP ARRANGEMENT TO PUMP No.2

02-PU-010 TYPICAL GSW PUMP ARRANGEMENT TO PUMP No.5

02-PU-011 TYPICAL GSW PUMP ARRANGEMENT TO PUMP No.3

02-PU-012 TYPICAL GSW PUMP ARRANGEMENT TO PUMP No.6

24"-CS(10)-PW

HS

8" N.C.

8" N.C.

N.C.

20"-CS(STD)6mmRL-PS

6" N.C.
DRAIN

VFD

02-PU-004
CYCLONE
U/F PUMP
No.1-STANDBY

6" N.C.
DRAIN

FROM
GSW PUMP
02-PU-008

YEAR 6

VFD

02-PU-005
CYCLONE
U/F PUMP
No.2-STANDBY

FROM
GSW PUMP
02-PU-010

YEAR 12

VFD

02-PU-006
CYCLONE
U/F PUMP
No.3-STANDBY

FROM
GSW PUMP
02-PU-012

YEAR 19

PI
PIT

HS

N.C.

SEE NOTE 1

12"-CS(STD)-PW

JACKING STRUCTURE
FLUSHING WATER
– 5277-2-102

SPILLAGE / EMERGENCY
DUMP LINE
– 5277-1-101

42"-HDPE(DR17)-PW

SPILLAGE / EMERGENCY
DUMP LINE
– 5277-3-101/102

NOTE:
1. THIS DRAWING SHOWS GENERAL ARRANGEMENTS FOR YEAR 6 TO YEAR 19. PUMPS WILL BE INSTALLED IN STAGES @ YEAR 6, 12 AND 19

PRELIMINARY

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION
5277-1-101	CYCLONE SAND PLANT P&ID, CYCLONE STATION
2577-2-102	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE U/F JACKING HEADER
5277-2-103	CYCLONE SAND DISTRIBUTION P&ID, GLAND SEAL WATER SYSTEM
5277-3-101	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F DISTRIBUTION

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###
CYCLONE SAND DISTRIBUTION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 2 OF 3 (YEAR 6 TO 22)

SCALE		PROJECT NUMBER	SIZE
N.T.S.		KPV-5277	D
DESIGNED	CS 06 JUN 12	DRAWING NUMBER	REV
DRAWN	TF 11 JUN 12	5277-2-102	0

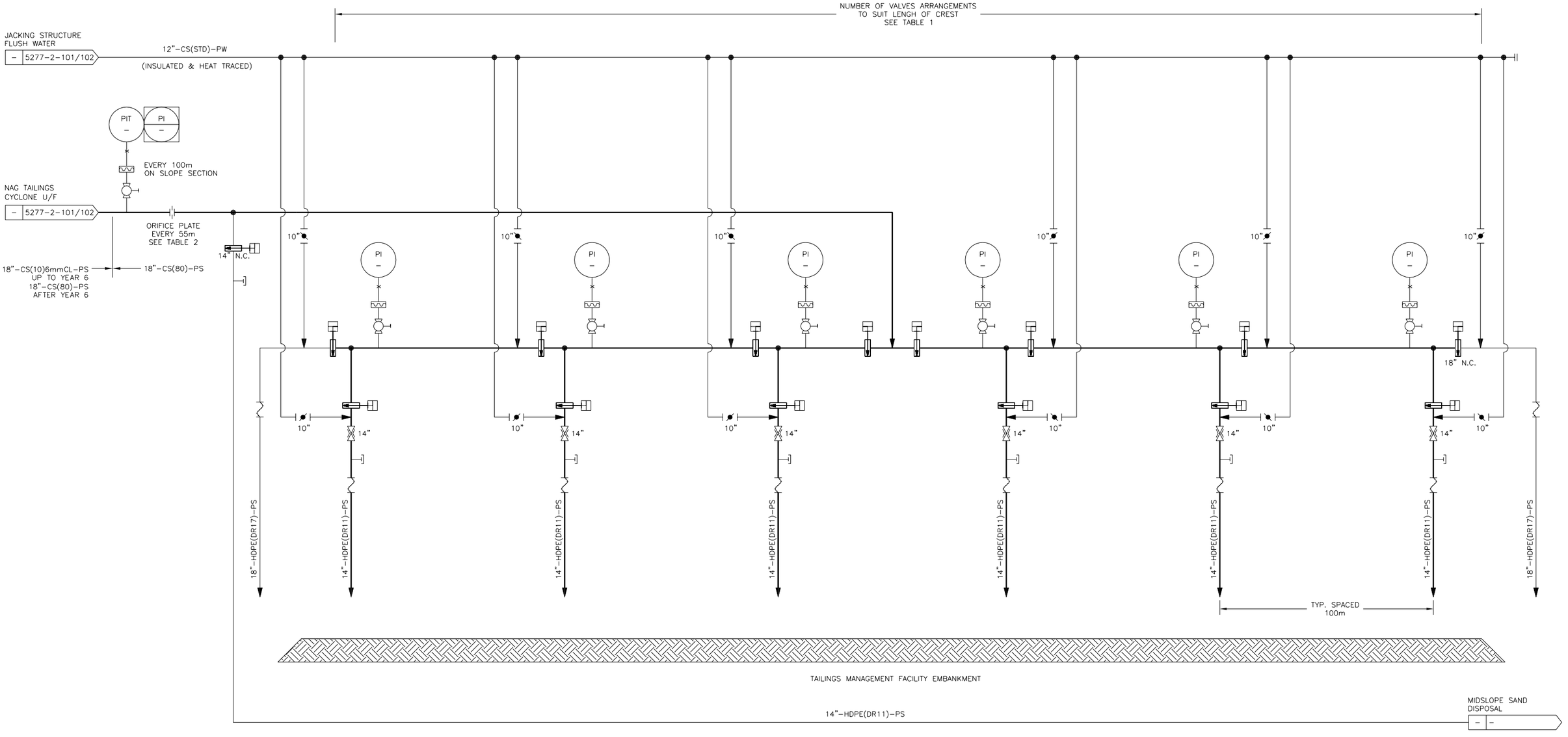
Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-2-102.dwg – 12/10/2012 3:15 PM

VALVE ARRANGEMENT		
YEARS	DAMM LENGTH (m)	NO. VALVES ARRANGEMENT
1	864	9
2	1308	14
4	1550	16
5	1610	17
6	1754	18
13	2109	22
20	2400	24
22	2460	25

TABLE 1

ORIFICE PLATES	
YEARS	No. OF ORIFICES
0	10
1	7
2	5
3	4
4	2
5	1
6	0

TABLE 2



NOTE:
1. ALL VALVES ON JACKING STRUCTURE TO BE INSULATED & HEAT TRACED

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-2-101	CYCLONE SAND DISTRIBUTION P&ID, CYCLONE U/F DISTRIBUTION
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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SHEET ###

CYCLONE SAND DISTRIBUTION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 3 OF 3

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	13 SEP 12	DRAWING NUMBER	REV
DRAWN	TF	13 SEP 12	5277-2-103	0

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NAG TAILINGS BYPASS
– 5277–1–101

32"–CS(STD)6mmRL–PS

NAG TAILINGS
CYCLONE O/F
– 5277–1–101

40"–CS(10)6mmRL–PS

LI H – L

LIT –

6"

12" N.C.

03–TK–005
CYCLONE
O/F TANK

FI –

FIT –

36"–HDPE(DR11)–PS

M

CYCLONE OVERFLOW
JACKING HEADER
– 5277–3–103

I

HS –

10" N.C.

FLUSH WATER
– 5277–1–102

12"–CS(STD)–PW

36"–CS(STD)–PW

SPILLAGE / EMERGENCY
DUMP LINE
– 5277–2–101/102

42"–HDPE(DR17)–PW

EMERGENCY DUMP LOCATION
AT TAILINGS MANAGEMENT FACILITY

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277–1–101	CYCLONE PLANT P&ID, CYCLONE STATION
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277–2–101	CYCLONE SAND DISTRIBUTION P&ID, CYCLONE U/F JACKING HEADER
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277–2–103	CYCLONE SAND DISTRIBUTION P&ID, GLAND SEAL WATER SYSTEM
						5277–3–102	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F JACKING HEADER

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CYCLONE OVERFLOW DISTRIBUTION
PIPING AND INSTRUMENT DIAGRAMS (P&ID)
SHEET 1 OF 3 (YEAR 1 TO 12)

SHEET ###

SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV–5277	D
DESIGNED	MJ	13 SEP 12	DRAWING NUMBER	REV
DRAWN	TF	13 SEP 12	5277–3–101	0

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NAG TAILINGS BYPASS
– | 5277-1-101
32"-CS(STD)6mmRL-PS

NAG TAILINGS CYCLONE O/F
– | 5277-1-101
40"-CS(10)6mmRL-PS

LI – H L
LIT –
6"
12" N.C.
03-TK-005
CYCLONE O/F TANK

HS –
10" N.C.
38"-CS(STD)6mmRL-PS
12" N.C.
DRAIN

VFD
03-PU-013
CYCLONE O/F PUMP
12" N.C.
DRAIN
FROM GSW PUMP 02-PU-017
YEAR 13

PI –
PIT –
FI –
FIT –
M
CYCLONE OVERFLOW JACKING HEADER
– | 5277-3-103
36"-HDPE(DR11)-PS

FLUSH WATER
– | 5277-1-102
12"-CS(STD)-PW

– | 5277-1-103

FSAL –
FS
TO PUMP No.13
02-PU-017
CYCLONE O/F GSW PUMP

TO PUMP No.15
02-PU-018
CYCLONE O/F GSW PUMP –STANDBY

36"-CS(STD)-PW

N.C.
38"-CS(STD)6mmRL-PS
12" N.C.
DRAIN
03-PU-015
CYCLONE O/F PUMP –STANDBY
12" N.C.
DRAIN
FROM GSW PUMP 02-PU-018
YEAR 13

SPILLAGE / EMERGENCY DUMP LINE
– | 5277-2-101/102
42"-HDPE(DR17)-PW
(900m TO TSF)

EMERGENCY DUMP LOCATION AT TAILINGS MANAGEMENT FACILITY

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-1-101	CYCLONE PLANT P&ID, CYCLONE STATION
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-2-101	CYCLONE SAND DISTRIBUTION P&ID, CYCLONE U/F JACKING HEADER
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK	5277-2-103	CYCLONE SAND DISTRIBUTION P&ID, GLAND SEAL WATER SYSTEM
						5277-3-102	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F JACKING HEADER

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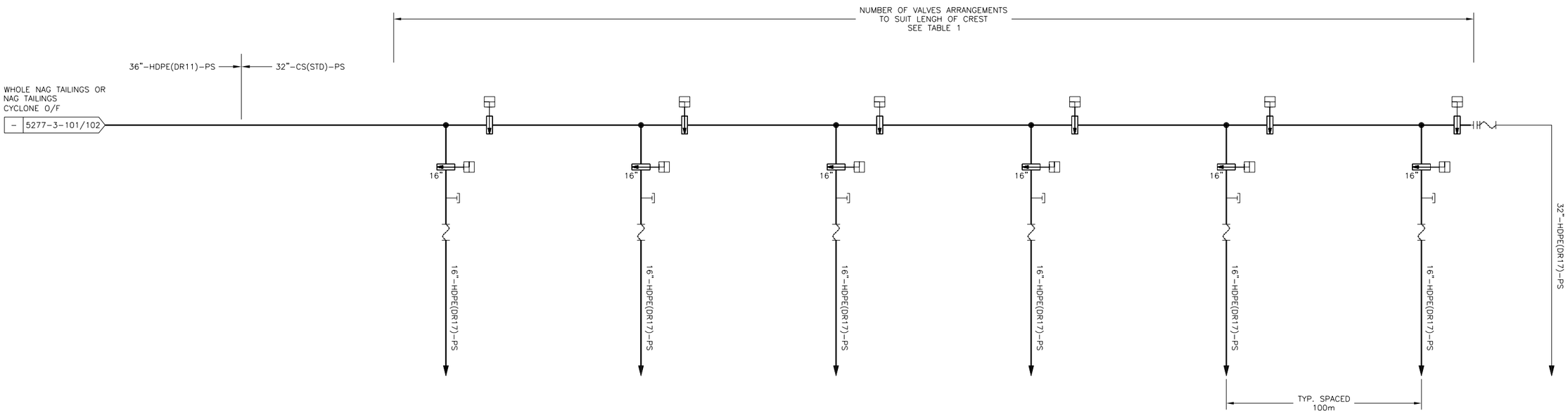
CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###
CYCLONE OVERFLOW DISTRIBUTION PIPING AND INSTRUMENT DIAGRAMS (P&ID) SHEET 2 OF 3 (YEAR 13 TO 22)

SCALE		PROJECT NUMBER	SIZE
N.T.S.		KPV-5277	D
DESIGNED	MJ	13 SEP 12	DRAWING NUMBER 5277-3-102 / REV 0
DRAWN	TF	13 SEP 12	

Tom Figas – P:\3 – Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-3-102.dwg – 12/10/2012 3:23 PM

VALVE ARRANGEMENT		
YEARS	DAMM LENGTH (m)	NO. VALVES ARRANGEMENT
0	864	9
2	1308	14
4	1550	16
5	1610	17
6	1754	18
13	2109	22
20	2400	24
22	2460	25

TABLE 1



NOTE:
1. ALL VALVES ON JACKING HEADER TO BE INSULATED & HEAT TRACED

PRELIMINARY

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK	5277-3-101	CYCLONE OVERFLOW DISTRIBUTION P&ID, CYCLONE O/F DIAGRAM
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK		

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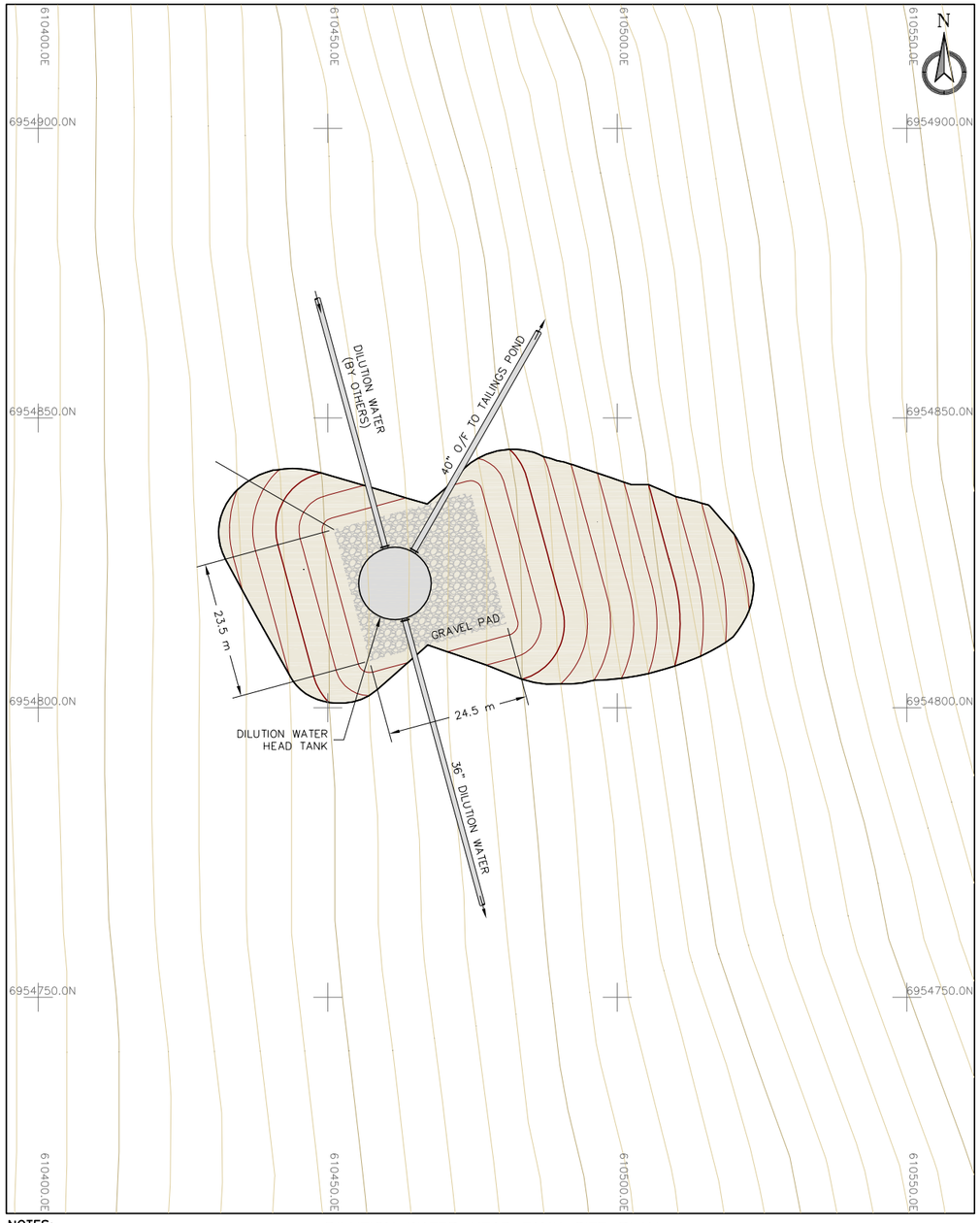
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###

CYCLONE OVERFLOW DISTRIBUTION
PIPING AND INSTRUMENT DIAGRAM (P&ID)
SHEET 3 OF 3

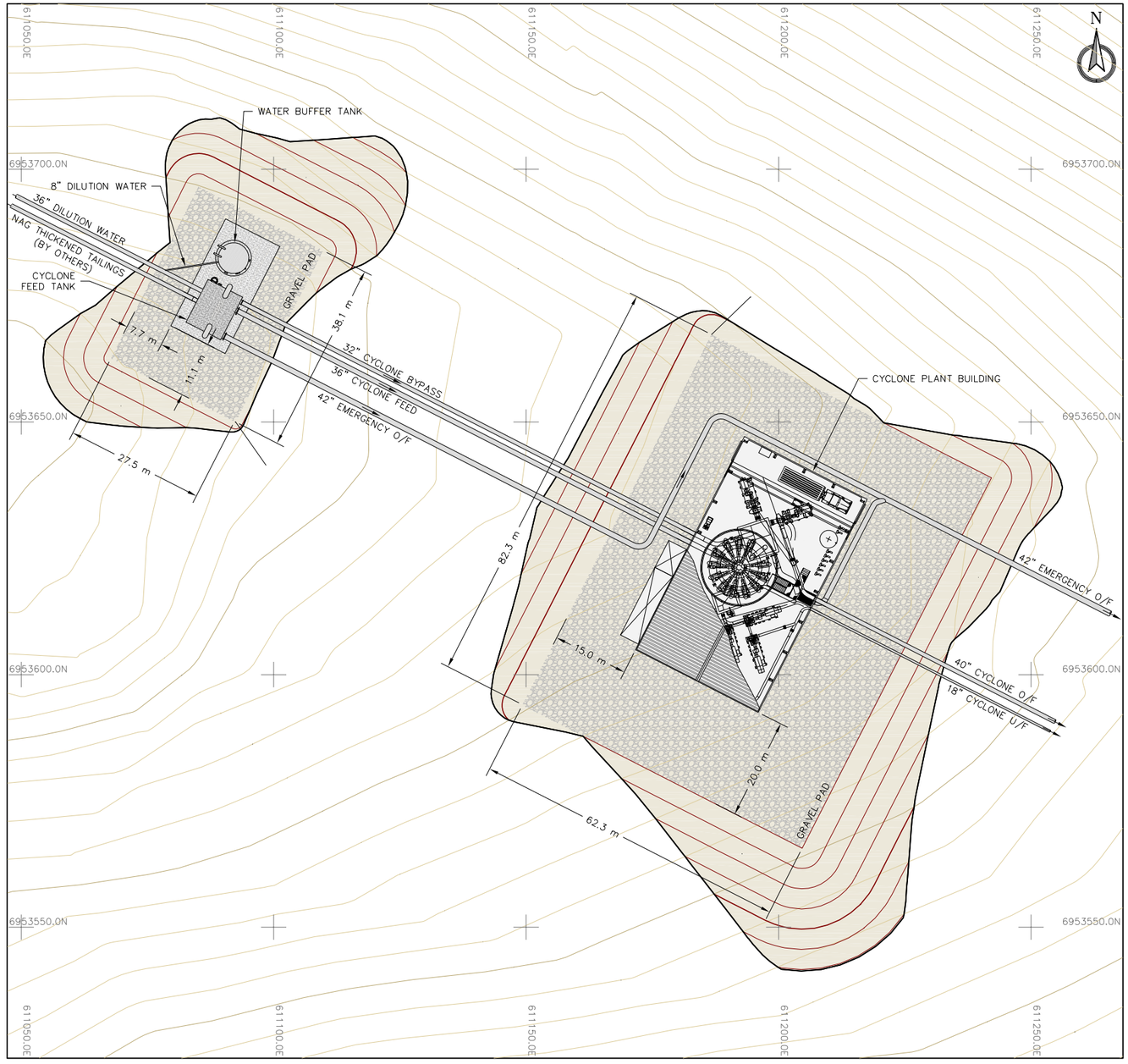
SCALE			PROJECT NUMBER	SIZE
N.T.S.			KPV-5277	D
DESIGNED	MJ	13 SEP 12	DRAWING NUMBER	REV
DRAWN	TF	13 SEP 12	5277-3-103	0

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DILUTION WATER HEAD TANK SITE PLAN

SCALE
5m 0 10m
SCALE IN METERS
CONTOUR INTERVAL 2



CYCLONE FEED & CYCLONE PLANT SITE PLAN

SCALE
5m 0 10m
SCALE IN METERS
CONTOUR INTERVAL 2

NOTES:
1. ACCESS ROADS – BY OTHERS.
2. ONLY MAIN PIPES SHOWN.

REVISIONS						REFERENCE DRAWINGS	
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD	DRG No.	DESCRIPTION
A	26–OCT–12	ISSUED FOR APPROVAL	M.J.	T.H.	Y.K.		
B	01–NOV–12	ISSUED FOR FEASIBILITY STUDY REPORT	M.J.	T.H.	Y.K.		
0	10–DEC–12	ISSUED FOR FEASIBILITY STUDY REPORT	M.J.	T.H.	Y.K.		

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET ###

CYCLONE FEED & PLANT SITE PLAN

SCALE			PROJECT NUMBER	SIZE
N/A			KPV–5277	D
DESIGNED	M.J.	26–OCT–12	DRAWING NUMBER	REV
DRAWN	T.H.	26–OCT–12	5277–0–301	0

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ULTIMATE BUILDING
46000

PHASE I BUILDING
5 BAYS @ 6800 = 34000

6000

6000

4"-CS(STD)-PW
FROM WATER HEAD TANK

32"-CS(STD)-PS O/F
TO JACKING HEADER

18"-CS(10)-PS U/F
TO JACKING STRUCTURE

DRAIN

63°

03-PU-017/018
CYCLONE O/F
GSW PUMPS

02-PU-007-012
CYCLONE U/F
GSW PUMPS

SPILLAGE SUMP

01-TK-004
GSW TANK ø3500

02-PU-003
CYCLONE U/F
PUMP#3

02-PU-002
CYCLONE U/F
PUMP#2

40"-CS(STD)-PW
03-TK-005 O/F

24"-CS(10)-PW
02-TK-003 O/F

2400 TYP.

02-PU-001
CYCLONE U/F
PUMP#1

1800 TYP.

5370 TYP.

03-PU-013
CYCLONE O/F PUMP

02-PU-019
SAND SAMPLER
PUMP

02-PU-005
CYCLONE U/F
PUMP#2
-STANDBY

42"-HDPE(DR17)-PW
SPILLAGE/EMERGENCY DUMP LINE

4 BAYS @ 6500 = 26000

5600 TYP.

HVAC

03-TK-005
CYCLONE O/F TANK
5500 x 6200 5000 DEPTH

01-CY-001
CYCLONE CLUSTER(S)

02-TK-003
CYCLONE U/F TANK
3200 x 4000 4000 DEPTH

A
1-302

2700 TYP.

03-PU-015
CYCLONE O/F PUMP
-STANDBY

01-PU-019
FLUSH WATER PUMP

01-CM-001
AIR COMPRESSOR PACKAGE

02-PU-004
CYCLONE U/F PUMP
#1-STANDBY

02-PU-006
CYCLONE U/F PUMP
#3-STANDBY

32"-CS(STD)-PS
TAILINGS BYPASS

38"-CS(STD)-PS
CYCLONE FEED

PHASE I
ELECTRICAL ROOM
6000 x 4000

ULTIMATE
ELECTRICAL ROOM
15000 x 4000

SCALE 1:75

1 0 1 3 5m

B
1-303

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION

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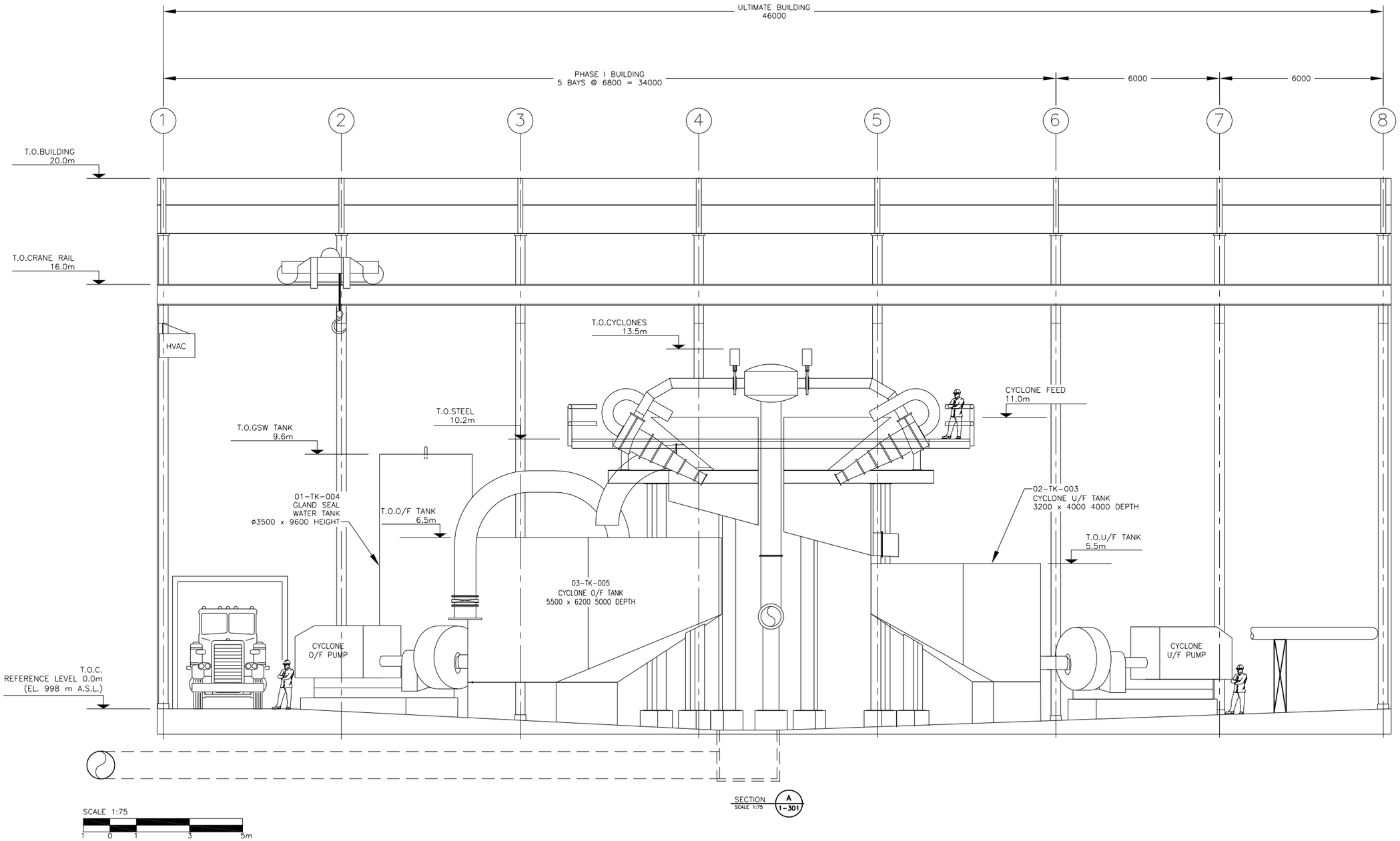
CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET 1 ###

CYCLONE PLANT
GENERAL ARRANGEMENT
CYCLONE PLANT BUILDING PLAN

SCALE			PROJECT NUMBER	SIZE
1:75			KPV-5277	D
DESIGNED	MJ	02 OCT 12	DRAWING NUMBER	REV
DRAWN	TF	02 OCT 12	5277-1-301	0

Tom Figas - P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\5277-1-301.dwg - 12/10/2012 3:29 PM



REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS	
DRG No.	DESCRIPTION

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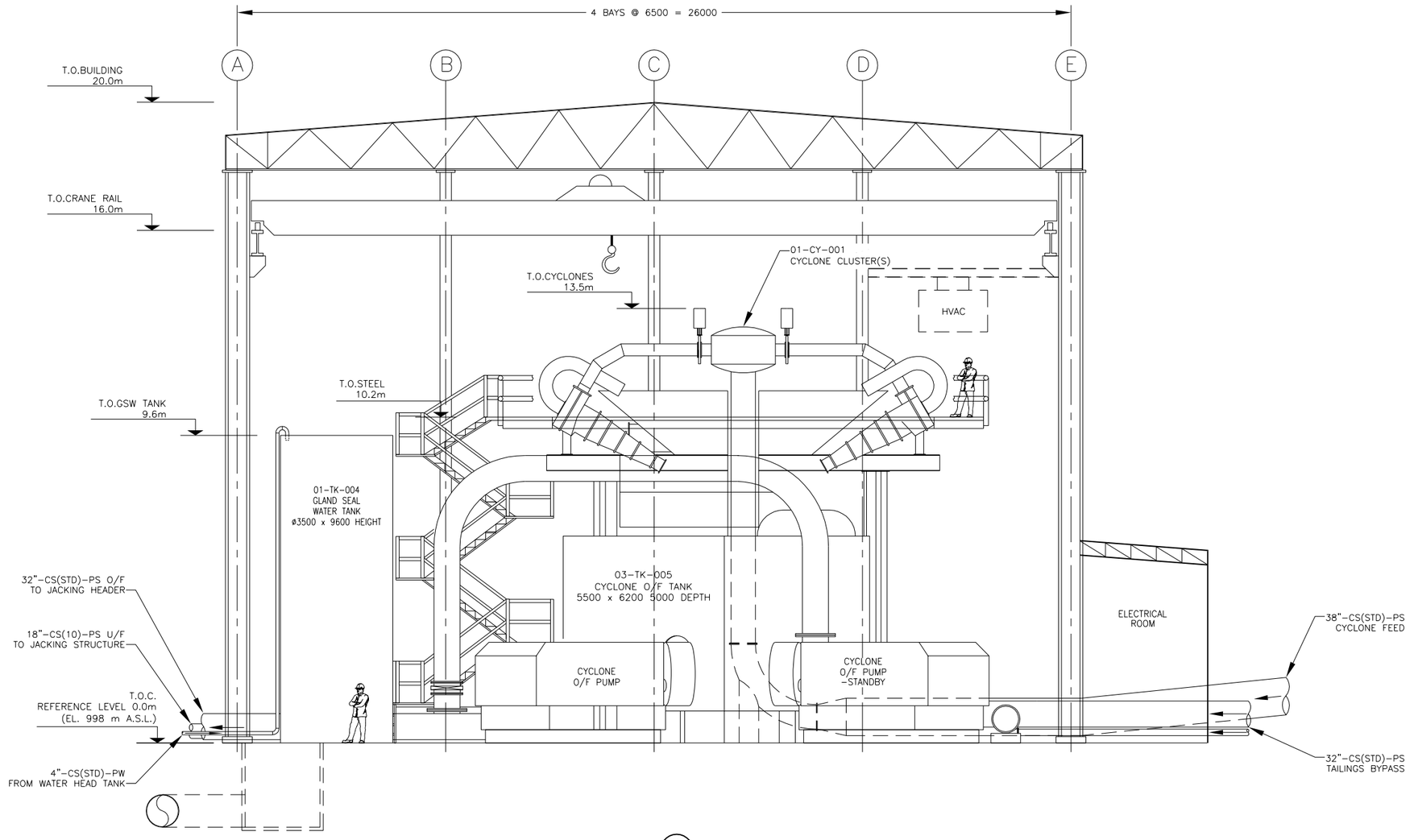
CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET 1 ###

CYCLONE PLANT
GENERAL ARRANGEMENT
CYCLONE PLANT BUILDING SECTION A

SCALE		PROJECT NUMBER	SIZE
1:75		KPV-5277	D
DESIGNED	MJ	02 OCT 12	DRAWING NUMBER 5277-1-302
DRAWN	TF	02 OCT 12	REV 0

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SECTION B
SCALE 1:75
1-301

SCALE 1:75

1 0 1 3 5m

NOTE:
- ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISIONS					
REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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DRG No.	DESCRIPTION

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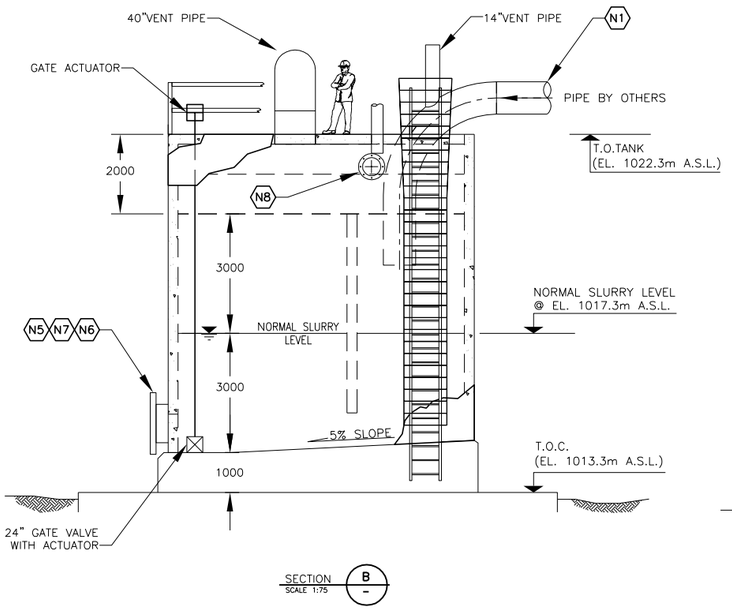
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET 1 ###

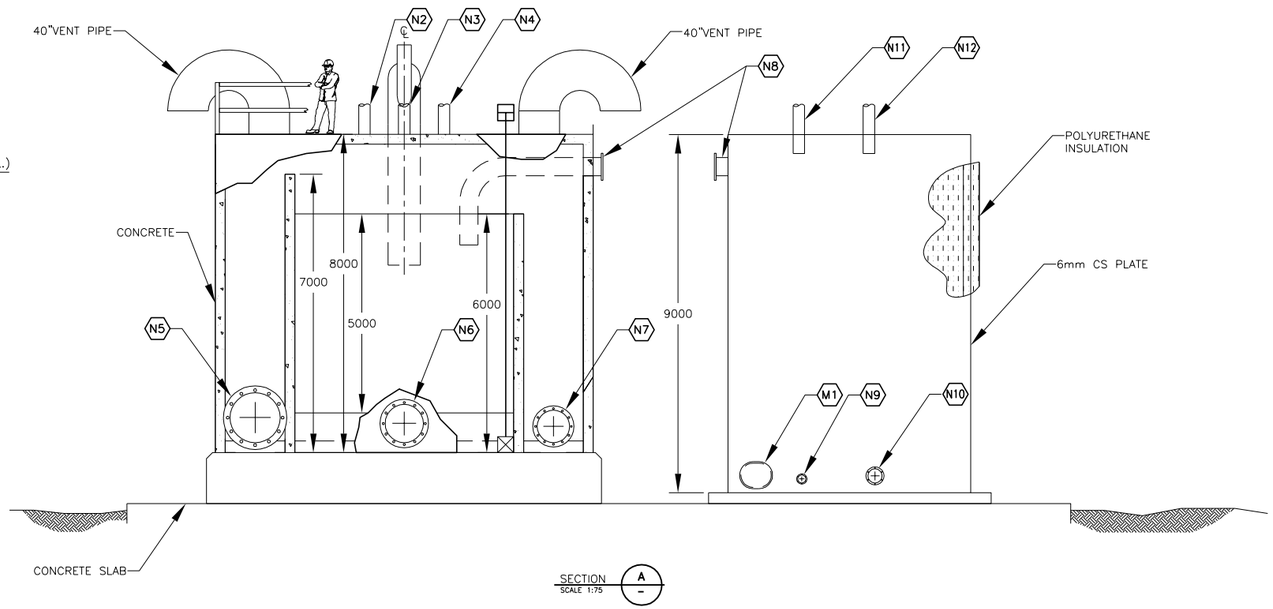
CYCLONE PLANT
GENERAL ARRANGEMENT
CYCLONE PLANT BUILDING SECTION B

SCALE			PROJECT NUMBER	SIZE
1:75			KPV-5277	D
DESIGNED	MJ	02 OCT 12	DRAWING NUMBER	REV
DRAWN	TF	02 OCT 12	5277-1-303	0

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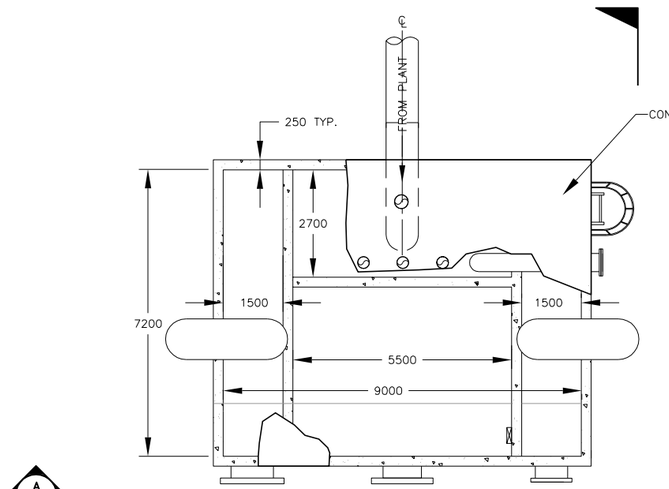


SECTION B
SCALE 1:75

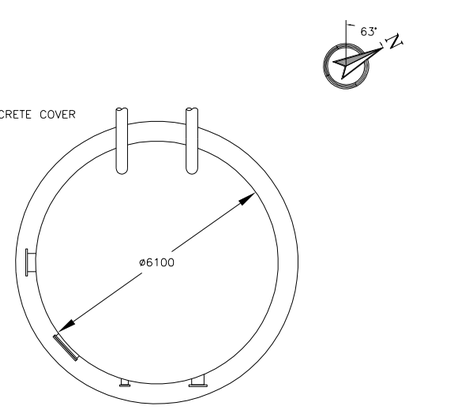


SECTION A
SCALE 1:75

Nozzle Number	Size	Description
N1	By Others	NAG Tailings (By Others)
N2	12"	Dilution Water
N3	12"	Dilution Water
N4	6"	Dilution Water
N5	42"	O/F from Feed Tank
N6	38"	Cyclone Feed
N7	32"	Cyclone By-pass
N8	18"	O/F from Water Buffer Tank
N9	8"	Water for Sand Dilution
N10	14"	Flush Water Pump Suction
N11	6"	Flush Water Return
N12	8"	Dilution Water Feed
M1	24"x30"	Manway for Flush Water Tank



01-TK-002
CYCLONE FEED TANK
PLAN VIEW



01-TK-006
WATER BUFFER TANK
PLAN VIEW

SCALE 1:75

1 0 1 3 5m

REVISIONS					
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A	25 OCT 12	ISSUED FOR APPROVAL	MJ	TF	YK
B	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
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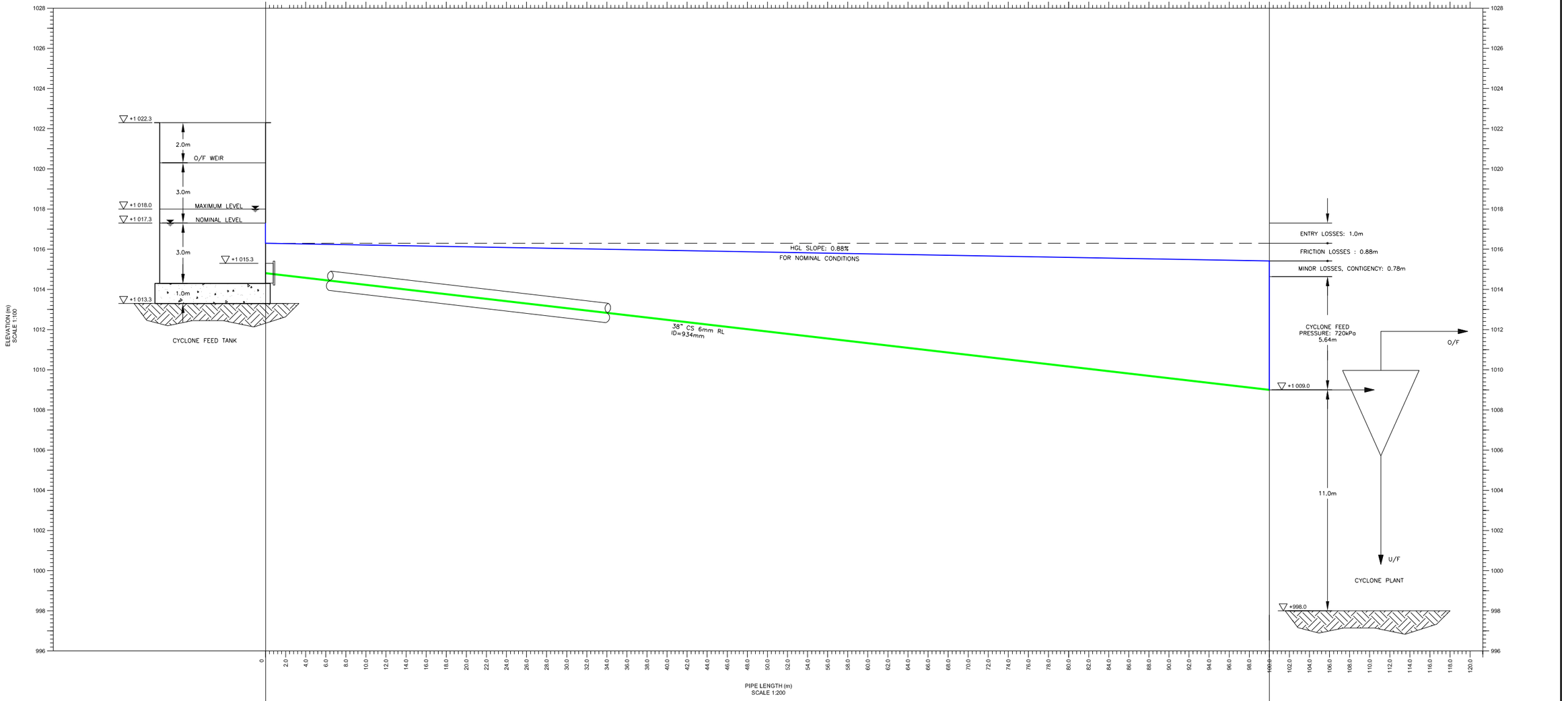
CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET 1 ###

CYCLONE PLANT
GENERAL ARRANGEMENT
CYCLONE FEED TANK

SCALE			PROJECT NUMBER	SIZE
1:75			KPV-5277	D
DESIGNED	MJ	02 OCT 12	DRAWING NUMBER	REV
DRAWN	TF	02 OCT 12	5277-1-304	0

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APPENDIX C – HYDRAULIC GRADE LINE PLOTS



NOTES	CYCLONE FEED TANK DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	115.3	1 009.0
PIPE NOMINAL DIAMETER / WALL THK	38"CS 6mm RL	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B, 6mm RL	
LINING TYPE / THICKNESS	RUBBER LINED	
PIPE INTERNAL DIAMETER	934mm	
PIPE PRESSURE RATING	13 990 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	36" / CLASS 150	
MAX ALLOWABLE WORKING PRESSURE	1 965 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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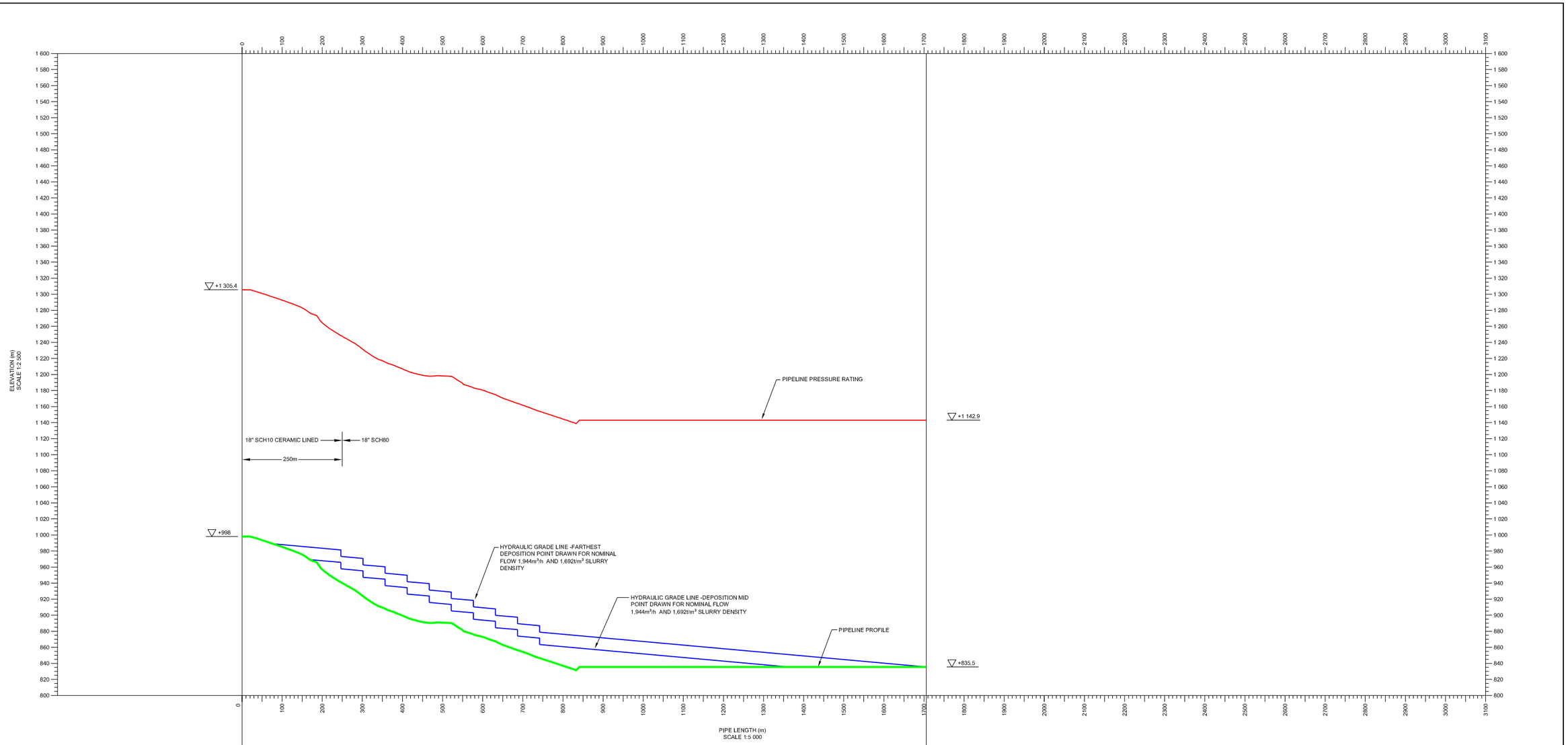
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
CYCLONE FEED

SCALE AS NOTED			PROJECT NUMBER KPV-5277	SIZE D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER 5277-1-201	REV 0
DRAWN	TF	12-OCT-12		

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NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	835.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 6.3mm CL 6mm FIRST 250m, 18" / 23.8mm REMAINING	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	433 mm / 409mm	
PIPE PRESSURE RATING	5 640 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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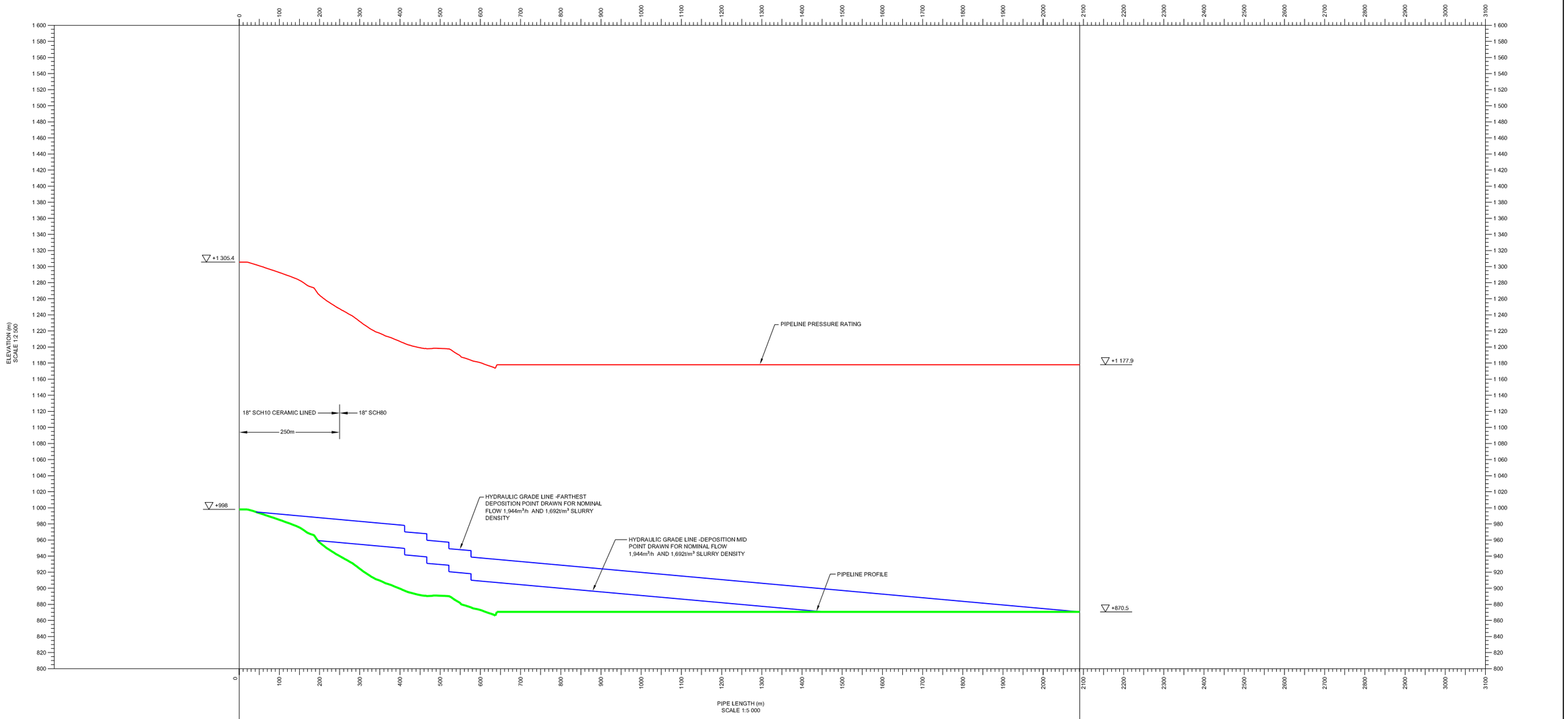
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR -1 AND 1

SCALE			PROJECT NUMBER	SIZE
AS NOTED			KPV-5277	D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER	REV
DRAWN	TF	12-OCT-12	5277-2-201	0

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NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	870.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 6.3mm CL 6mm FIRST 250m, 18" / 23.8mm REMAINING	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	433 mm / 409mm	
PIPE PRESSURE RATING	5 640 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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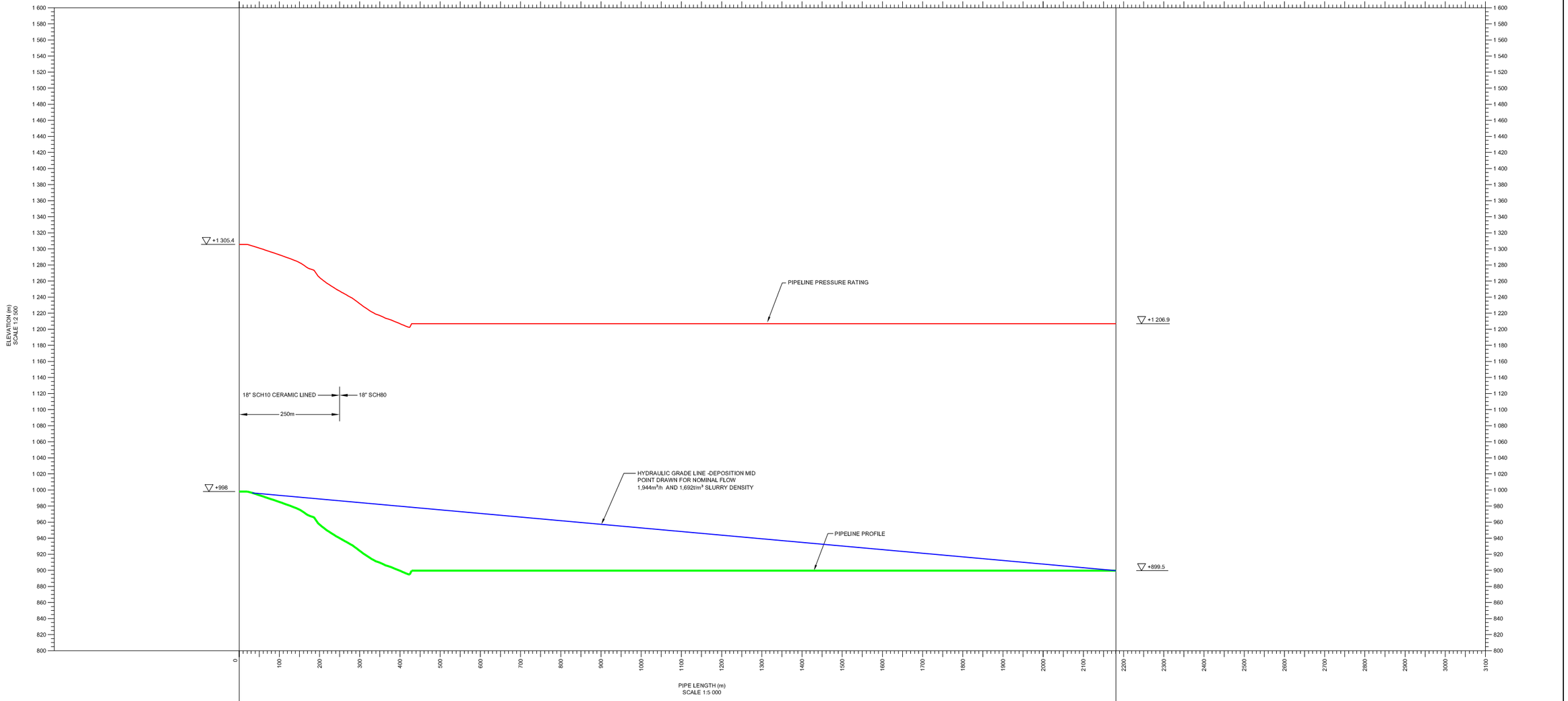
CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY

SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 3

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV–5277	D
DESIGNED MJ	12–OCT–12	DRAWING NUMBER	REV
DRAWN TF	12–OCT–12	5277–2–202	0

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NOTES	CYCLONE STATION DISCHARGE		DISCHARGE POINT
PIPELINE ELEVATION (m)	998		899.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 6.3mm CL 6mm FIRST 250m, 18" / 23.8mm REMAINING		
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B		
LINING TYPE / THICKNESS	N/A		
PIPE INTERNAL DIAMETER	433 mm / 409mm		
PIPE PRESSURE RATING	5 640 kPa		
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105		
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300		
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa		

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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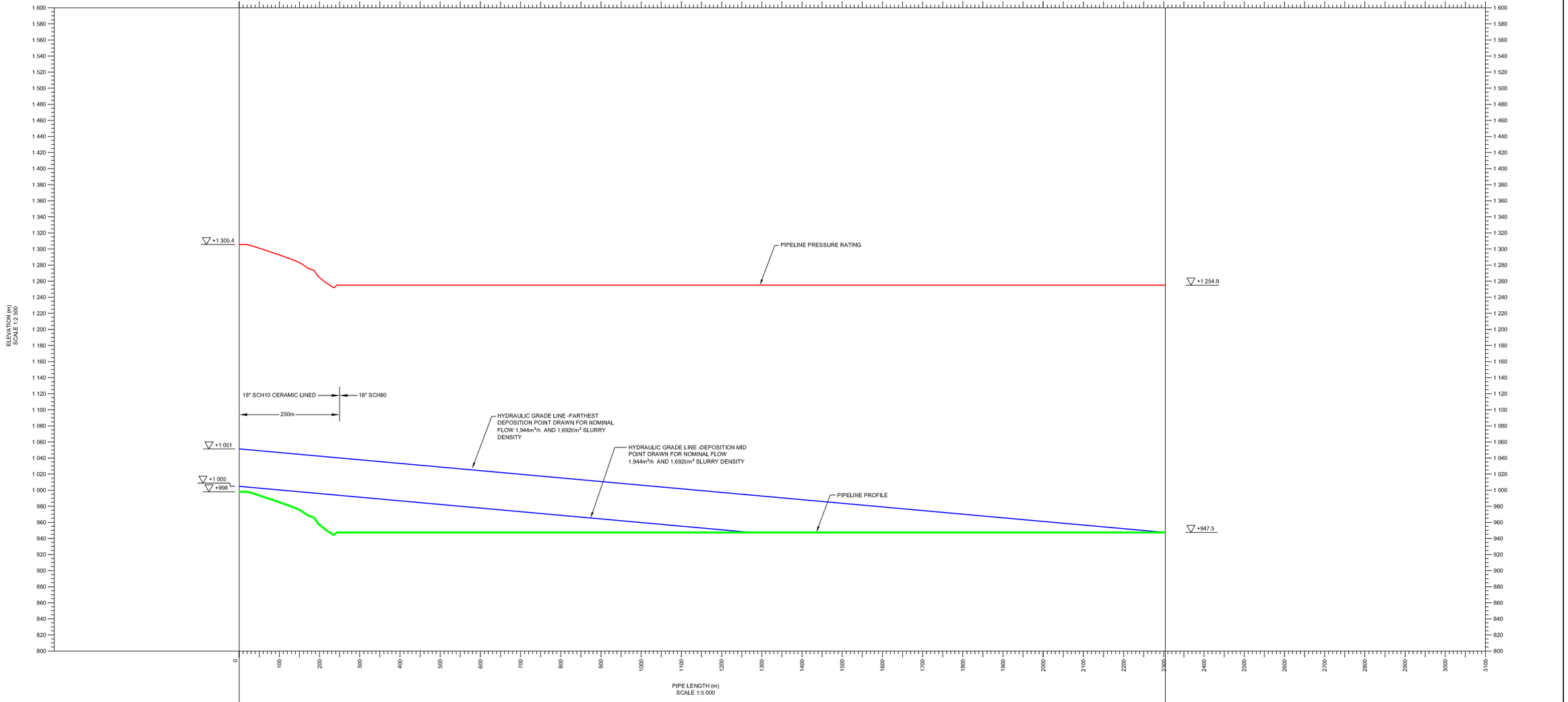
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TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 6

SCALE			PROJECT NUMBER	SIZE
AS NOTED			KPV–5277	D
DESIGNED	MJ	12–OCT–12	DRAWING NUMBER	REV
DRAWN	TF	12–OCT–12	5277–2–203	0

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	CYCLONE STATION DISCHARGE	DISCHARGE POINT
NOTES		
PIPELINE ELEVATION (m)	998	947.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 6.3mm CL 6mm FIRST 250m, 18" / 23.8mm REMAINING	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	433 mm / 409mm	
PIPE PRESSURE RATING	5 640 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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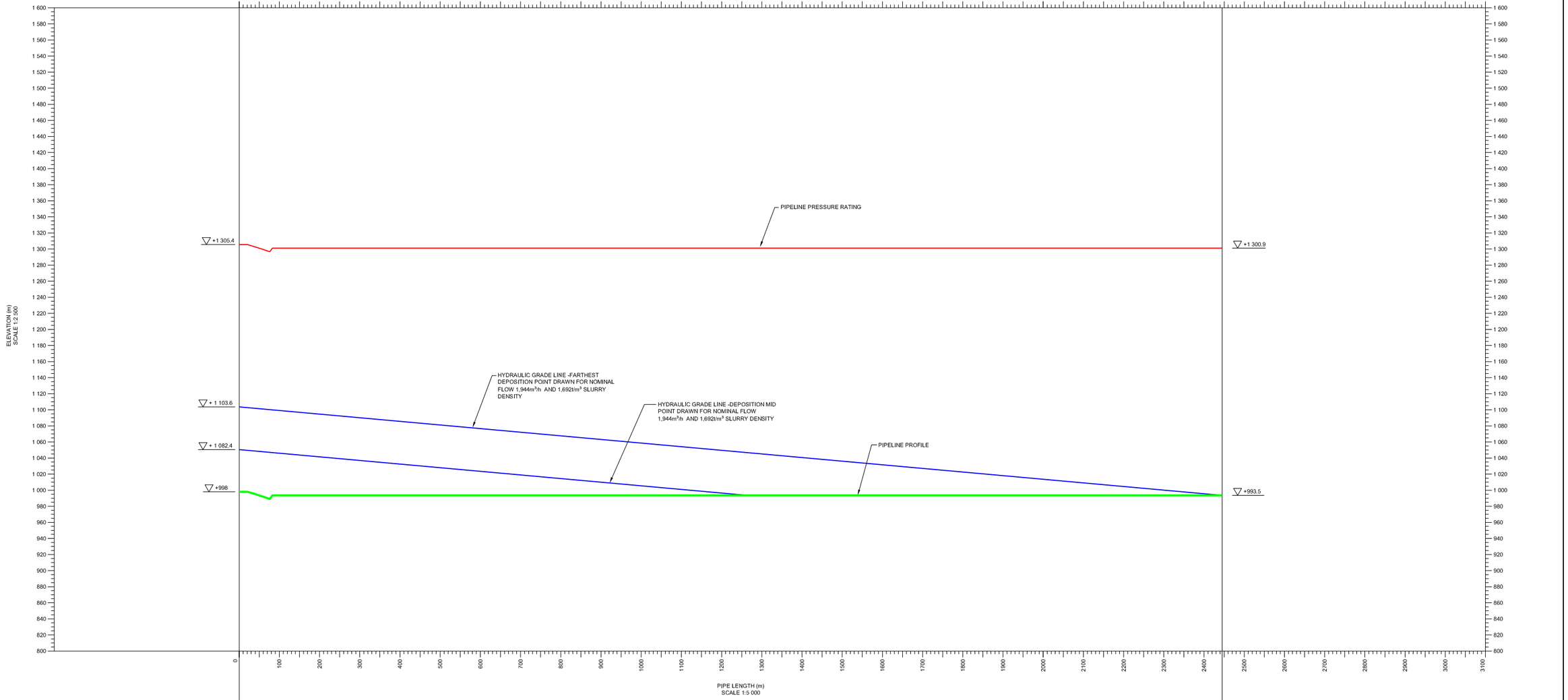
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CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 12

SHEET ###

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV-5277	D
DESIGNED MJ	12-OCT-12	DRAWING NUMBER	REV
DRAWN TF	12-OCT-12	5277-2-204	0

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NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	993.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 23.8mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	409mm	
PIPE PRESSURE RATING	24 000 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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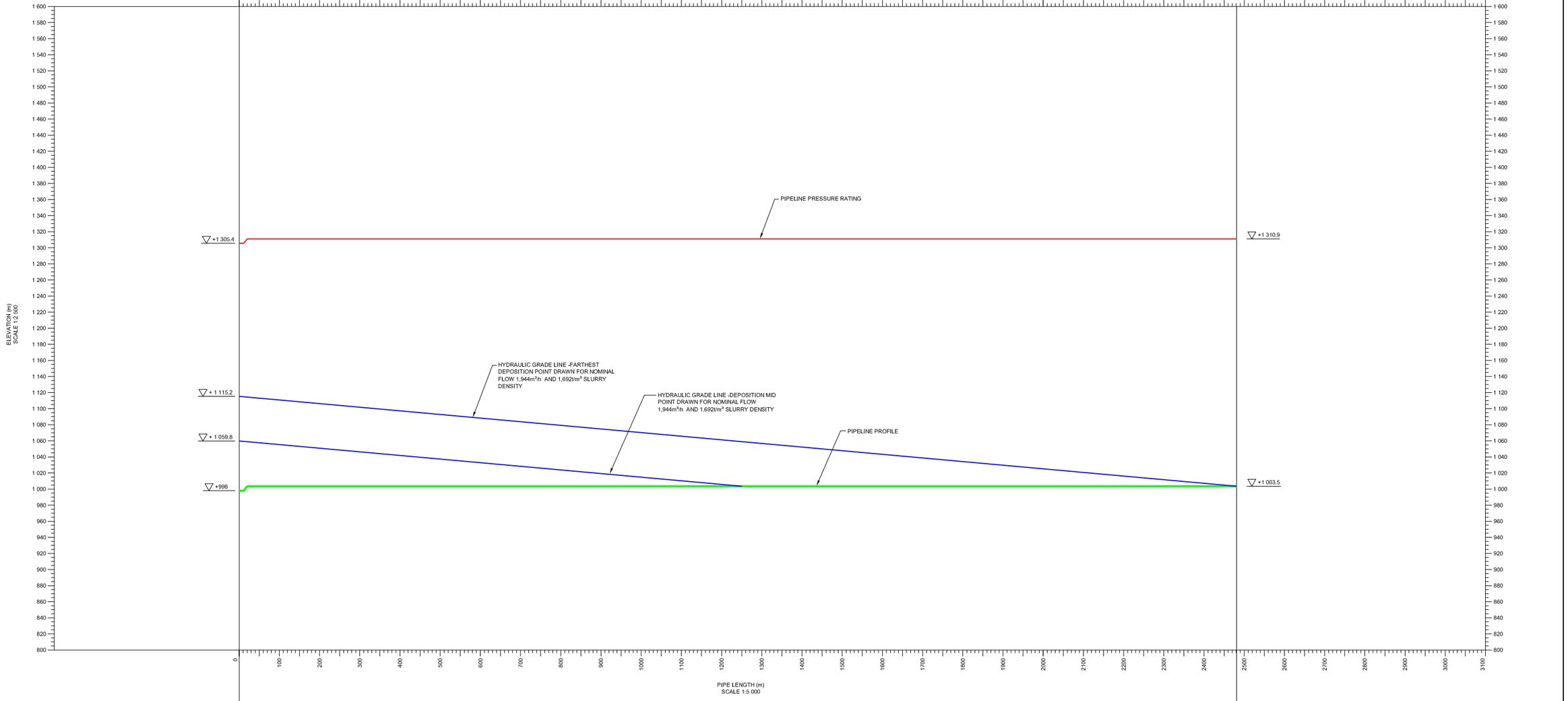
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 19

SCALE			PROJECT NUMBER	SIZE
AS NOTED			KPV-5277	D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER	REV
DRAWN	TF	12-OCT-12	5277-2-205	0

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NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	1 003.5
PIPE NOMINAL DIAMETER / WALL THK	18" / 23.8mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	409mm	
PIPE PRESSURE RATING	24 000 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	18" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 102 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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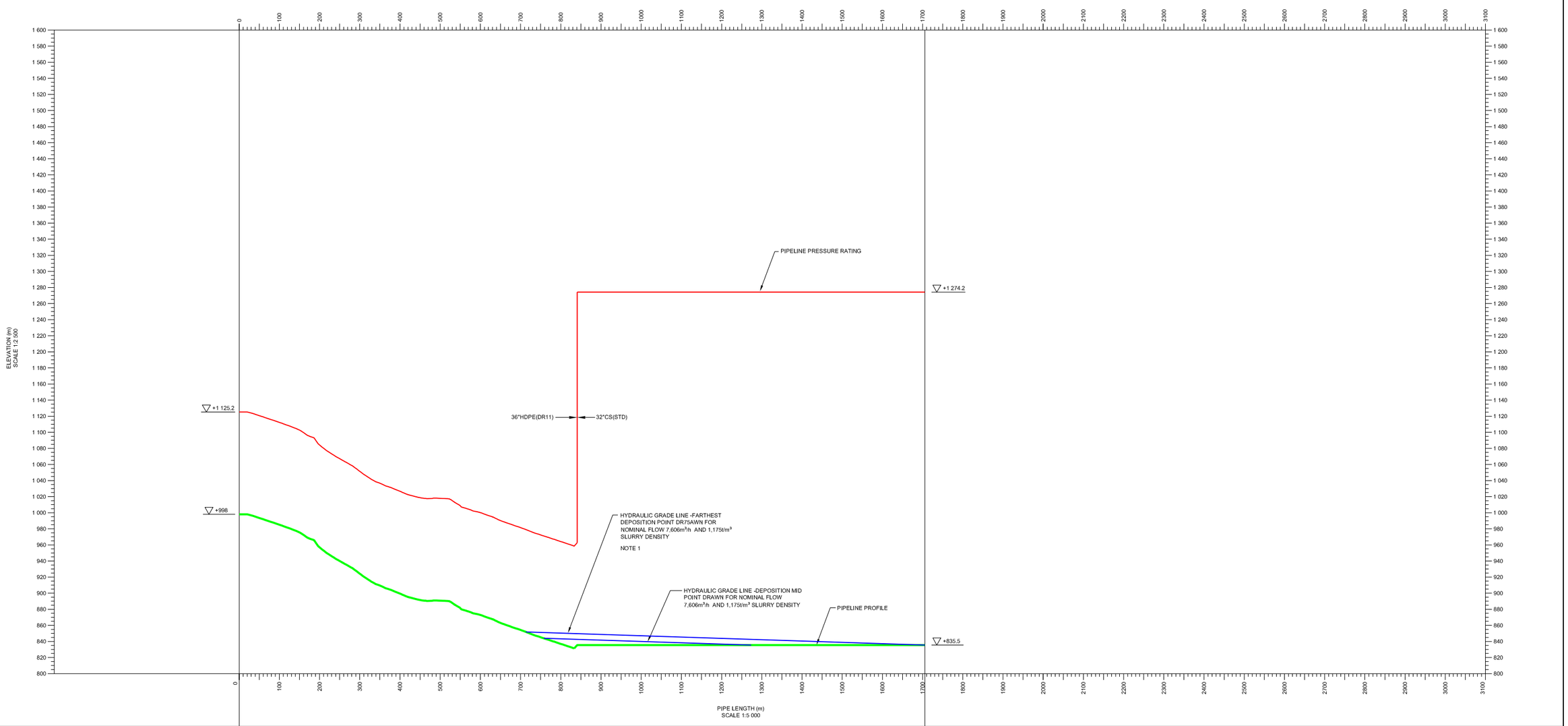
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SHEET ###

CYCLONE SAND DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 22

SCALE AS NOTED			PROJECT NUMBER KPV-5277		SIZE D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER 5277-2-206		REV 0
DRAWN	TF	12-OCT-12			

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NOTE
1. FOR SIMPLICITY HGL SLOPE FOR CS(STD) PIPE SHOWN. HDPE PIPE IS USED ONLY ON SLACK FLOW SECTION OF PIPE AND WILL BE REPLACED WITH CS PIPE AS THE LENGTH OF DAM PROGRESSES.

	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	835.5
PIPE NOMINAL DIAMETER / WALL THK	36"HDPE/83mm, 32"CS / 9.53mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	738mm, 794mm	
PIPE PRESSURE RATING	1 466 kPa, 5 057 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	36"/CLASS 150, 32" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	1 466 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

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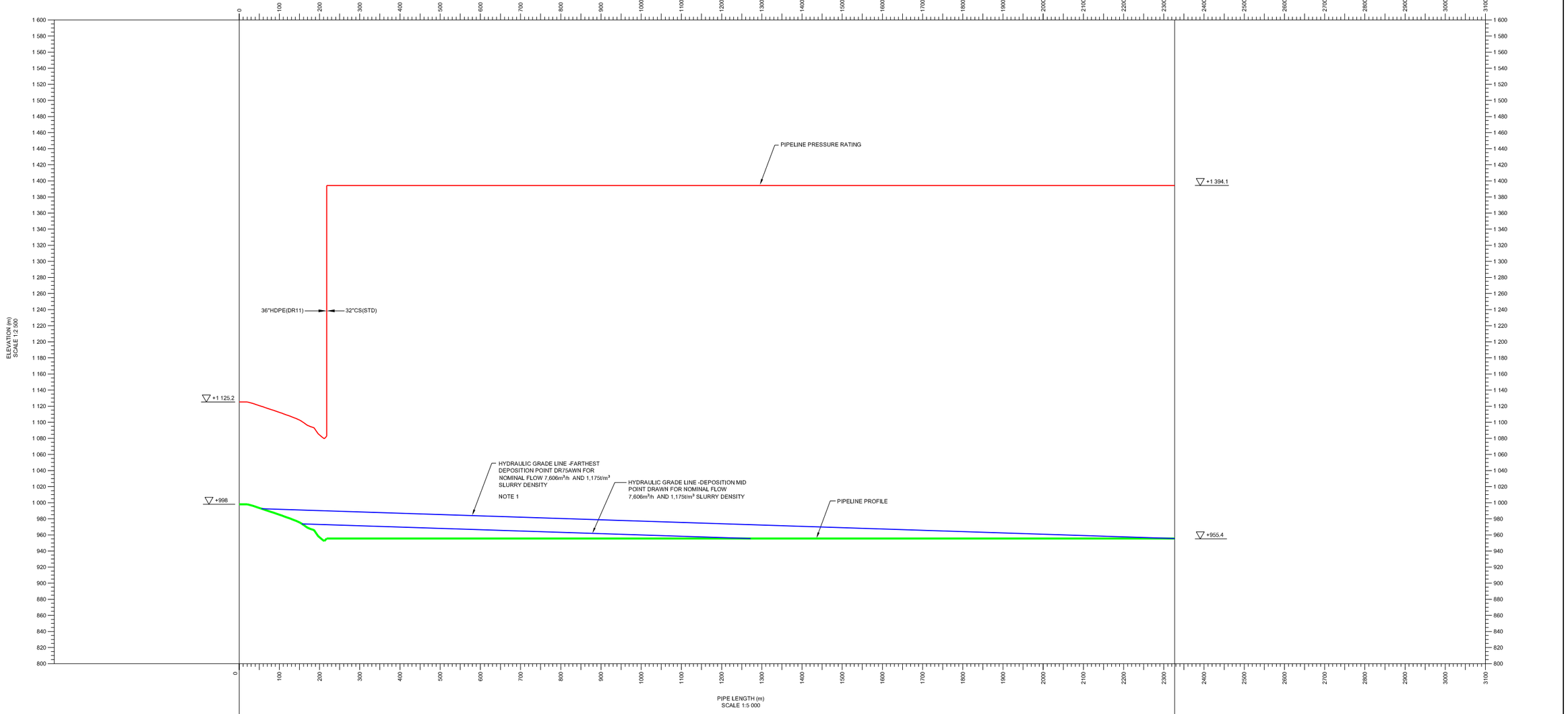
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CYCLONE OVERFLOW DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR -1 (O/F STREAM)

SHEET ###

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV-5277	D
DESIGNED MJ	12-OCT-12	DRAWING NUMBER	REV
DRAWN TF	12-OCT-12	5277-3-201	0

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NOTES
1. FOR SIMPLICITY HGL SLOPE FOR CS(STD) PIPE SHOWN. HDPE PIPE IS USED ONLY ON SLACK FLOW SECTION OF PIPE AND WILL BE REPLACED WITH CS PIPE AS THE LENGTH OF DAM PROGRESSES.

	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	955.4
PIPE NOMINAL DIAMETER / WALL THK	36"HDPE/83mm, 32"CS / 9.53mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	738mm, 794mm	
PIPE PRESSURE RATING	1 466 kPa, 5 057 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	36"/CLASS 150, 32" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	1 466 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS

DRG No.	DESCRIPTION

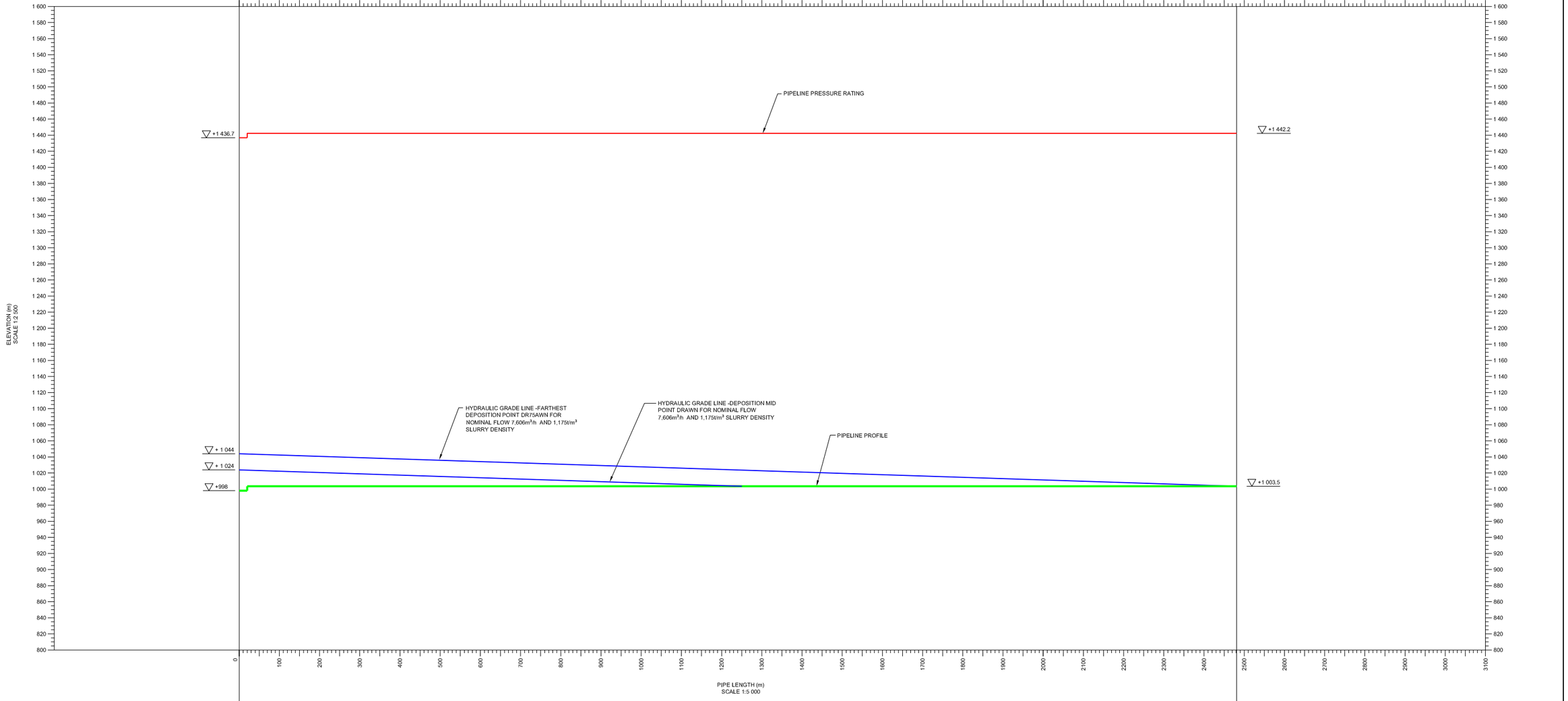
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE OVERFLOW DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 13 (O/F STREAM)

SHEET ###

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV-5277	D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER 5277-3-202 / REV 0
DRAWN	TF	12-OCT-12	

Tom Figos - P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\HGL\5277-3-202.dwg - 12/11/2012 7:55 AM



NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	1 003.5
PIPE NOMINAL DIAMETER / WALL THK	32" / 9.53mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	794mm	
PIPE PRESSURE RATING	5 057 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	32" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 057 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS

DRG No.	DESCRIPTION

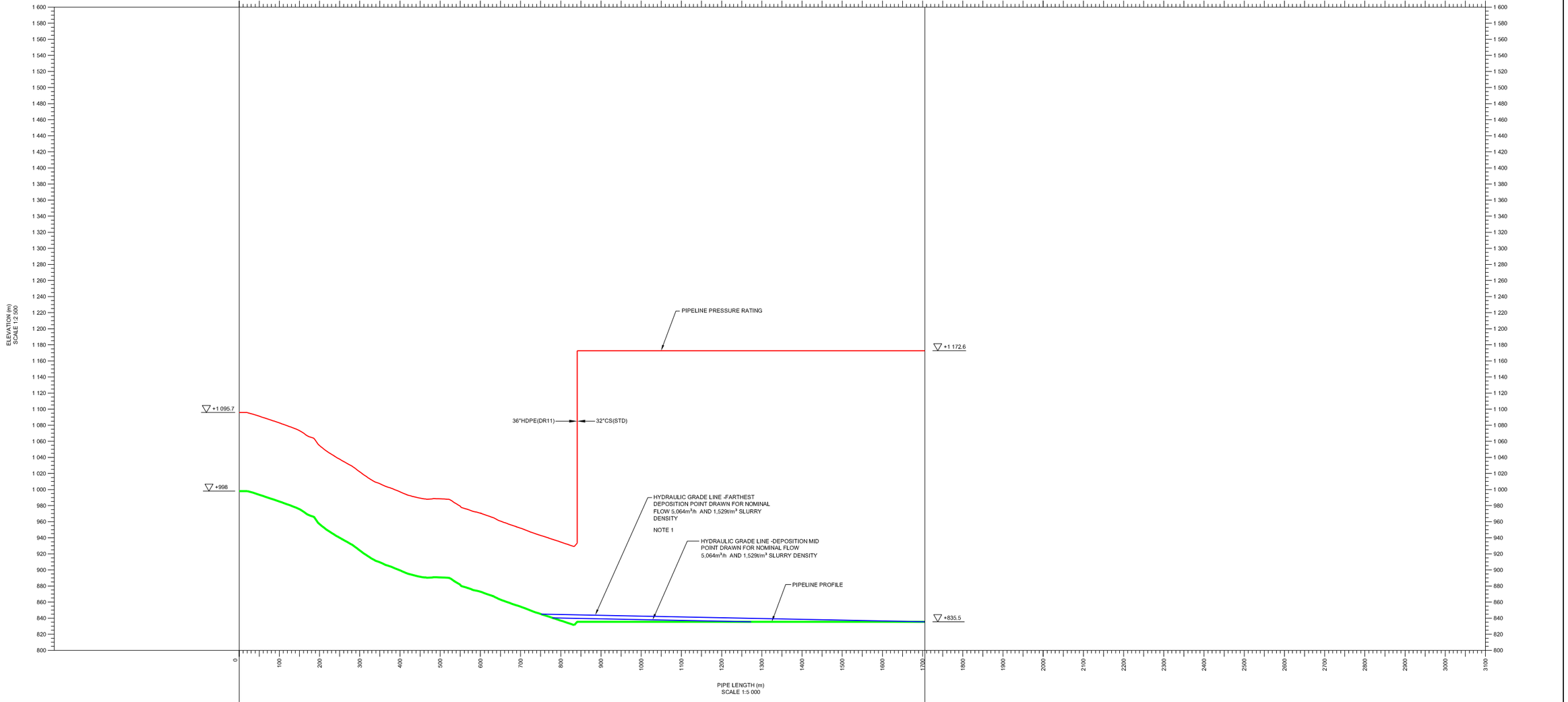
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE OVERFLOW DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 22 (O/F STREAM)

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV-5277	D
DESIGNED	MJ	12-OCT-12	REV
DRAWN	TF	12-OCT-12	0

SHEET ###
DRAWING NUMBER 5277-3-203

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NOTES
1. FOR SIMPLICITY HGL SLOPE FOR CS(STD) PIPE SHOWN. HDPE PIPE IS USED ONLY ON SLACK FLOW SECTION OF PIPE AND WILL BE REPLACED WITH CS PIPE AS THE LENGTH OF DAM PROGRESSES.

	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	835.5
PIPE NOMINAL DIAMETER / WALL THK	36"HDPE/83mm, 32"CS / 9.53mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	738mm, 794mm	
PIPE PRESSURE RATING	1 466 kPa, 5 057 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	36"/CLASS 150, 32" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	1 466 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS

DRG No.	DESCRIPTION

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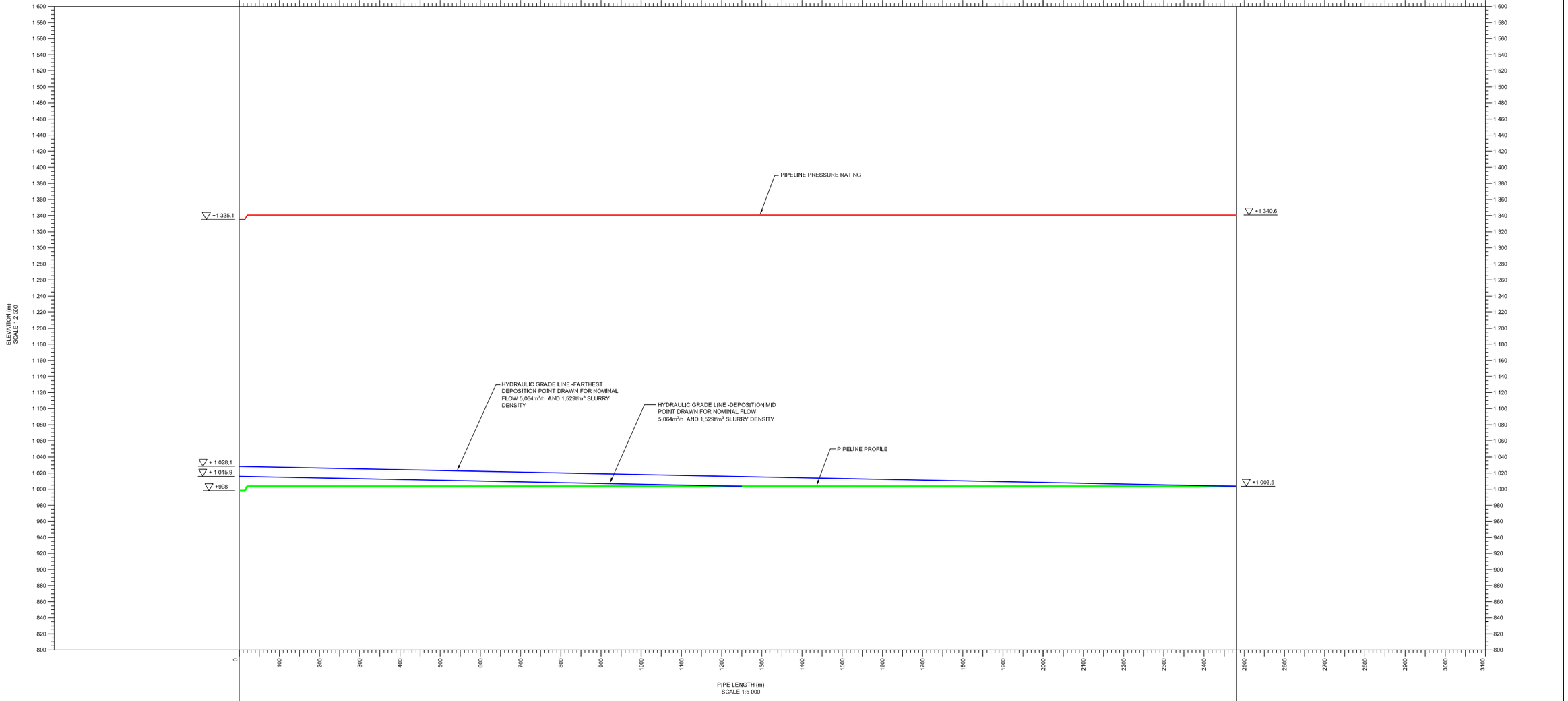
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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE OVERFLOW DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR -1 (NR TAILINGS STREAM)

SHEET ###

SCALE	AS NOTED		PROJECT NUMBER	SIZE
DESIGNED	MJ	12-OCT-12	KPV-5277	D
DRAWN	TF	12-OCT-12	DRAWING NUMBER 5277-3-204	REV 0

Tom Figos - P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\HGL\5277-3-204.dwg - 12/11/2012 7:58 AM



NOTES	CYCLONE STATION DISCHARGE	DISCHARGE POINT
PIPELINE ELEVATION (m)	998	1 003.5
PIPE NOMINAL DIAMETER / WALL THK	32" / 9.53mm	
PIPE SPECIFICATION / MATERIAL GRADE	ASME B36.10 / A106 Gr.B	
LINING TYPE / THICKNESS	N/A	
PIPE INTERNAL DIAMETER	794mm	
PIPE PRESSURE RATING	5 057 kPa	
FLANGE SPECIFICATION / MATERIAL	ASME B16.5 / ASTM A105	
FLANGE SIZE / PRESSURE RATING	32" / CLASS 300	
MAX ALLOWABLE WORKING PRESSURE	5 057 kPa	

PRELIMINARY

REVISIONS

REV	DATE	DESCRIPTION	DESG	DRWN	CHKD
A	01 NOV 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK
0	10 DEC 12	ISSUED FOR FEASIBILITY STUDY REPORT	MJ	TF	YK

REFERENCE DRAWINGS

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CASINO PROJECT
TAILINGS CYCLONE AND TRANSPORTATION STUDY
CYCLONE OVERFLOW DISTRIBUTION
HYDRAULIC GRADE LINE PLOT
YEAR 22 (NR TAILINGS STREAM)

SHEET ###

SCALE		PROJECT NUMBER	SIZE
AS NOTED		KPV-5277	D
DESIGNED	MJ	12-OCT-12	DRAWING NUMBER 5277-3-205 REV 0
DRAWN	TF	12-OCT-12	

P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Drawings\P&C Dwgs\Tailings Cyclone\HGL\5277-3-205.dwg - 12/11/2012 8:00 AM
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APPENDIX D – EQUIPMENT LIST

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET	DWG No.
01-TK-001	DILUTION WATER HEAD TANK	DxH, 12.5 m x 12.5 m			INSTALLED YEAR -1		5277-1-001
01-TK-002	CYCLONE FEED TANK	HxWxL, 8m x 7.7m x 8m			INSTALLED YEAR -1		
01-TK-004	GLAND SEAL WATER TANK	DxH, 3.5m x 9.6m			INSTALLED YEAR 6		
01-TK-006	WATER BUFFER TANK	DxH, 6.1m x 9m			INSTALLED YEAR -1		
01-CY-001	CYCLONE CLUSTER(S)	CLUSTER OF 12 x 800mm Dia., CAVEX CYCLONE			INSTALLED YEAR -1		
01-CR-001	OVERHEAD CRANE	15tonne	20kW		INSTALLED YEAR -1		
01-PU-019	FLUSH WATER PUMP	525 m^3/hr @ 40m	80 kW	8x10	INSTALLED YEAR -1		
01-CM-001	AIR COMPRESSOR PACKAGE	106 m^3/hr at 780 kPa	11kW	ATLAS COPCO GA11-8.5 W/DESICCANT AIR DRYER	INSTALLED YEAR -1		
01-FI-001	GSW FILTER - STANDBY	28.8 m^3/hr			INSTALLED YEAR -1		
01-FI-002	GSW FILTER - STANDBY	28.8 m^3/hr			INSTALLED YEAR -1		

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET	DWG No.
02-TK-003	CYCLONE U/F TANK	HxLxW, 4 m x 3.2 m x 4 m			INSTALLED YEAR -1		5277-2-001
02-PU-001	CYCLONE U/F PUMP No. 1	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 6		
02-PU-002	CYCLONE U/F PUMP No. 2	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 12		
02-PU-003	CYCLONE U/F PUMP No. 3	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 19		
02-PU-004	CYCLONE U/F PUMP No. 1 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 6		
02-PU-005	CYCLONE U/F PUMP No. 2 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 12		
02-PU-006	CYCLONE U/F PUMP No. 3 - STANDBY	2,236 m^3/hr @ 43 m	671kW VFD	WEIR 16/14 AHP	INSTALLED YEAR 19		
02-PU-007	CYCLONE U/F GSW PUMP No.1	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 6		
02-PU-008	CYCLONE U/F GSW PUMP No.1 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 6		
02-PU-009	CYCLONE U/F GSW PUMP No.2	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 12		
02-PU-010	CYCLONE U/F GSW PUMP No.2 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 12		
02-PU-011	CYCLONE U/F GSW PUMP No.3	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 19		
02-PU-012	CYCLONE U/F GSW PUMP No.3 - STANDBY	1.8 m^3/hr @ 213 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 19		
02-PU-019	SAND SAMPLER PUMP	34 m3/hr @ 12 m		GRACO HUSKY 2150 DOUBLE DIAPHRAGM PUMP	INSTALLED YEAR -1		
02-OR-001	CYCLONE U/F ORIFICE No. 1	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-002	CYCLONE U/F ORIFICE No. 2	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-003	CYCLONE U/F ORIFICE No. 3	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-004	CYCLONE U/F ORIFICE No. 4	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-005	CYCLONE U/F ORIFICE No. 5	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-006	CYCLONE U/F ORIFICE No. 6	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-007	CYCLONE U/F ORIFICE No. 7	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-008	CYCLONE U/F ORIFICE No. 8	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-009	CYCLONE U/F ORIFICE No. 9	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		
02-OR-010	CYCLONE U/F ORIFICE No. 10	ΔH=8 m Slurry, ID=0.254 m			INSTALLED YEAR -1		

TAG NO.	DESCRIPTION	CAPACITY/ DUTY	INSTALLED POWER	COMMENT	INSTALLATION YEAR	DATA SHEET	DWG No.
03-TK-005	CYCLONE O/F TANK	HxWxL, 5 m x 5.5 m x 6.2 m			INSTALLED YEAR -1		5277-3-001
03-PU-013	CYCLONE O/F PUMP	8,746 m^3/hr @ 60 m	2000kW VFD	WEIR 650L	INSTALLED YEAR 13		
03-PU-015	CYCLONE O/F PUMP - STANDBY	8,746 m^3/hr @ 60 m	2000kW VFD	WEIR 650L	INSTALLED YEAR 13		
03-PU-017	CYCLONE O/F GSW PUMP	1.8 m^3/hr @ 75 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 13		
03-PU-018	CYCLONE O/F GSW PUMP - STANDBY	1.8 m^3/hr @ 75 m	5kW	POSITIVE DISPLACEMENT	INSTALLED YEAR 13		

APPENDIX E – MATERIAL TAKE-OFF LISTS

TABLE 10.2
CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SCHEDULE OF QUANTITIES

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				INSTALLATION YEAR																					REV
Item Type	Item No.	Description	Unit	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Equipment	5	CYCLONE CLUSTER(S) CLUSTER OF 12 x 800mm Dia., CAVEX CYCLONE	No.	1																						B
		GLAND SEAL WATER TANK, STEEL TANK DxH, 3.5m x 9.6m	t steel							6																B
		OVERHEAD CRANE 15tonne Span 26m, Run 47m	No.	1																						B
		AIR COMPRESSOR PACKAGE, ATLAS COPCO GA11-8.5 W/DESICCANT AIR DRYER & RECEIVER	No.	1																						B
		CYCLONE U/F TANK, CONCRETE TANK HxLxW, 4 m x 3.2 m x 4 m	m3	26																						B
		CYCLONE O/F TANK, CONCRETE TANK HxWxL, 5 m x 5.5 m x 6.2 m	m3	55																						B
		CYCLONE FEED TANK, CONCRETE TANK HxWxL, 8m x 7.7m x 8m	m3	140																						B
		GLAND SEAL WATER PUMP, POSITIVE DISPLACEMENT PUMP 5kW	No.							2					2	2						2				B
		FLUSH WATER PUMP, 8x10 centrifugal pump 80 kW	No.	1																						B
		GLAND SEAL WATER FILTER 28.8 m3/hr	No.							2																B
		DILUTION WATER HEAD TANK, STEEL TANK INSULATED DxH, 12.5 m x 12.5 m	t steel	53																						B
		WATER BUFFER TANK, STEEL TANK INSULATED DxH, 6.1m x 9m	t steel	12																						B
		CERAMIC ORIFICE 18" PIPE ID=0.254 m @ $20,000/PIECE	No.	10																						B
		Cyclone U/F Pump, Warman 16/14 AHP Slurry Pump 671kW	No.							2					2							2				B
		Cyclone O/F Pump Warman 650L Slurry Pump 2000kW	No.													2										B
		SAND SAMPLER PUMP, GRACO HUSKY 2150 DOUBLE DIAPHRAGM PUMP 5kW	No.	1																						B
		O/F Jacking header hydraulic piston (19t)	No.	58		29	10	6	4	10	5	4	3	3	2	3	4	2	2	2	3	3	4	3	2	1	B
		U/F Jacking header hydraulic piston (27t)	No.	58		29	10	6	4	10	5	4	3	3	2	3	4	2	2	2	3	3	4	3	2	1	B
		Mobile Hydraulic Powerpacks (6000psi) for U/F and O/F jacking headers	No.	5																						B
PIPE	3	38"-CS(STD) 6mm RL OVERLAND PIPELINE	m	120																						B
		32"-CS(STD) 6mm RL OVERLAND PIPELINE	m	120																						B
		32"-CS(10) 6mm RL	m	8																						B
		40"-CS(10) 6mm RL	m	8																						B
		36"-HDPE(DR 11) OVERLAND PIPELINE	m	2200																						B
		8"-CS(STD)		147																						B
		12"-CS(STD)	m	64																						B
		18"-HDPE(DR 17) OVERLAND PIPELINE	m	120																						B
		40"-HDPE(DR 17) OVERLAND PIPELINE	m	500																						B
		12"-CS(10)	m	40																						B
		40"-CS(10)	m	20																						B
		24"-CS(10)	m	25																						B
		36"-CS(STD)	m	35																						B
		4"-CS(STD)	m	100																						B
		8"-HDPE(DR 17)	m	50																						B
		8"-HDPE(DR 11) OVERLAND PIPELINE	m	100																						B
		14"-HDPE(DR 11) OVERLAND PIPELINE	m	120																						B
		6"-HDPE(DR 11)	m	15																						B
		12"-CS(STD) OVERLAND PIPELINE	m	50																						B
		2"-CS(STD)	m	115																						B
		1"-CS(STD)	m	40																						B
		20"-CS(STD) 6mm RL	m							8																B
		14"-CS(STD) 6mm RL	m													4						4				B
		18"-CS(10) 6mm Ceramic Lined for Slack flow section CAN $2185 per meter OVERLAND PIPELINE	m	250																						B
		38"-CS(STD) 6mm RL	m														8									B
		42"-HDPE(DR 17) OVERLAND PIPELINE	m	900																						B
		1.5"-CS(STD) Allow. for small bore piping in Cyclone Plant	m	300																						B
		18"-CS(80) OVERLAND PIPELINE	m	900																						B
		6"-CS(STD)	m	40																						B
		6"-HDPE(DR 11) OVERLAND PIPELINE	m	100																						B
		32-HDPE(DR 17) OVERLAND PIPELINE	m	200																						B
		18-HDPE(DR 17) OVERLAND PIPELINE	m	100																						B
		14-HDPE(DR 11) OVERLAND PIPELINE	m	500																						B
		12"-CS(STD) PIPELINE ON JACKING HEADER INSULATED AND HEAT TRACED	m	900			250			250			250			250			250			250			250		B
		18"-CS(80) ON JACKING HEADER	m	1290			250			250			250			250			250			250			250		B
		32"-CS(STD) ON JACKING HEADER	m	860			250			250			250			250			250			250			250		B
		16"-HDPE(DR 17) OFF JACKING HEADER	m	1700		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	B
		14"-HDPE(DR 11) OFF JACKING HEADER	m	1700		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	B
Valve	4	18 - #150 - Knife Gate	No.	10																						B
		32" - #150 - Knife Gate	No.	10		5		2	1	1							5						2		1	B
		16" - #150 - Knife Gate	No.	11		5		2	1	1							3						2		1	B
		6" - #150 - Butterfly	No.	9																						B
		10" - #150 - Knife Gate	No.	1													3									B
		18" - #150 - Knife Gate	No.	3		5		2	1	3							4						2		1	B
		38" - #150 - Knife Gate	No.	1													2									B
		12" - #150 - Knife Gate	No.														4									B
		12" - #151 - Knife Gate	No.	1																						B
		4" - #150 - Butterfly	No.							1																B
		4" - #150 - Ball Valve	No.							4																B
		6" - #150 - Knife Gate	No.							4																B
		8" - #150 - Knife Gate	No.	1						4																B
		20" - #150 - Knife Gate	No.	1						2																B
		6" - #150 - Control Valve	No.	4																						B
		4" - #150 - Control Valve	No.	1																						B
		8" - #150 - Butterfly	No.	7																						B
		14" - #150 - Butterfly	No.	1																						B
		12" - #150 - Butterfly	No.	4																						B
		36" - #150 - Butterfly	No.	1																						B
		1.5" - #150 - Allowance for small bore valves	No.	100																						B
		10" - #150 - Butterfly	No.	18		10		4	2	2							8						4		2	B
		14" - #150 - Pinch Valve	No.	9		5		2	1	1							4						2		1	B

TABLE 10.2
CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SCHEDULE OF QUANTITIES

Print Nov/1/12 8:10:25

				INSTALLATION YEAR																					REV
Item Type	Item No.	Description	Unit	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Valve	4	14" - #150 - Knife Gate	No.	10		5		2	1	1							4							2		1	B
		24" - #150 - Square GateWATER WORKS TYPE	No.	1																							B
Instrument	6	26" Magnetic Flow Meter	No.	1																							B
		38" Magnetic Flow Meter	No.	1																							B
		Radar Level Meter	No.	7																							B
		18" Ultrasonic Flow Meter	No.	1																							B
		Ceramic Orifices (Included in Equipment Section)	No.	0																							B
		8" Magnetic Flow Meter	No.	1																							B
		700kW VFD FOR SAND PUMPS	No.							2						2							2				B
		2000kW VFD FOR CYCLONE O/F PUMPS	No.														2										B
		Capacitive Level Meter	No.	1																							B
		36" Magnetic Flow Meter	No.	1																							B
		38" Nuclear Density Meter	No.	2																							B
		2" Nuclear Density Meter	No.	1																							B
U/F Jacking Structure	10	Concrete Footings (59 Footings per Header) Reinforced Concrete Footing	m3	266																							B
		Pipe 300x12.7 Pipe	m	1770	2360	2080	1972	2060	2188	2268	2532						10216							11536		3586	B
		Holes in Pipe Piles Used for Raises 22 mm Diameter Holes Each Side	No.	23600	7980	2128	1064	1596	1064	3192	1064						4256							5320		2128	B
		Base Plate for Piles 500mm x 500mm x 30mm	No.	118																							B
		Anchor Bolts 25 mm diameter x 450 mm long	No.	472																							B
		Drift Pins 19 mm Headed Pin x 400 mm Long	No.	236	120	32	16	24	16	48	16						64							80		32	B
		Round Hollow Steel Section (HSS) HS355x9.5 x 450 mm long	m	106	54	14	7	11	7	22	7						29							36		14	B
		Patterned Holes 22 mm Diameter Hole in Spiral Pattern	No.	9440	4800	1280	640	960	640	1920	640						2560							3200		1280	B
		Flange 12.5 mm thick flange x 50 mm projection	No.	236	120	32	16	24	16	48	16						64							80		32	B
		3 Keeper Bolts 12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	No.	708	360	96	48	72	48	144	48						192							240		96	B
		Keeper Ring Plate 6mm thick plate x 100mm wide Ring Plate	No.	236	120	32	16	24	16	48	16						64							64		32	B
		Square Hollow Steel Section (HSS) HS355x355x9.5 - 300mm Long	m	71	36	10	5	7	5	14	5						19							24		10	B
		Flange 12.5 mm thick flange x 100 mm projection	No.	236	120	32	16	24	16	48	16						64							80		32	B
		Upper Jacking Beam W250x67	m	118	60	16		12	8	24	8						32							40		16	B
		Lower Jacking Beam W250x67	m	118	60	16	8	12	8	24	8						32							40		16	B
		Girder W610x101	m	1740																							B
		Beam W200x19	m	943																							B
		Diagonal L130x130x9	m	1109																							B
		Steel Connections Add 15% to Member Weights For Connections	kg	39877	20573	5486	2743	4115	2743	8229	2743						10972							13715		5486	B
		Grip Strut Grating 2" plank grip strut grating	m2	1547	800	213	107	160	107	320	107						427							533		213	B
		Guardrail Painted steel - 2 rail with kickplate	m	1926	996	266	133	199	133	398	133						531							664		266	B
		Steel Channels C200x 75	m	2857	1478	394	197	296	197	591	197						788							985		394	B
		Support Columns L75X75x6	m	696	360	96	48	72	48	144	48						192							240		96	B
		Pipe Supports for Piping - Angles/Saddles Add 10% of Pipe Weight for Supports	kg	67048	15000	4000	2000	3000	2000	6000	2000						8000							10000		4000	B
		Ladders at Platforms Ladder with Folding or Sliding Bottom	m	50	22	6	6	6	6	11	6						11							17		6	B
		Jacking Frame Epoxy Paint	m2	522	270	72	36	54	36	108	36						144							180		72	B
		Framing for Walkway and Platform Epoxy Paint	m2	7540	3900	1040	520	780	520	1560	520						2080							2600		1040	B
		Pipe Piles Epoxy Paint	m2	3328																							B
		Holes in Pipe Piles Used for Raises 22 mm Diameter Holes Each Side @150 mm on center	No.		31388	27634	26218	27394	29086	30158	33654						135864							153400		46944	B
		Pipe Piles Epoxy Paint (inside and outside of pile)	m2		1692	451	226	338	226	677	226						902							1128		451	B
		Weld 12.5 mm x 940 mm long	m	111																							B
		Weld 12.5 mm x 1115 mm long	m	262	133	36	18	27	18	53	18						71							89		36	B
		Weld 12.5 mm x1420 mm long	m	335	170	45	23	34	23	68	23						91							114		45	B
		Weld to Square Collar 6 mm x500 mm long	m	118	60	16	8	12	8	24	8						32							40		16	B
		Weld Full Penetration Groove Weld All Arnd Circumference of Pipe	m		222	224	197	197	201	8	254						955							1075		306	B
		Pipe - Material Cost 300x12.7 Pipe	m		900	240	120	180	120	360	120						480							600		240	B
		Pipe - Installation Cost Install 300mm Pipe By Driving It 5 Meters Below Grade	m		300	80	40	60	40	120	40						160							200		80	B
		Girder (2 Per Bay) W610x101	m		900	240	120	180	120	360	120						480							600		240	B
		Beam (5 Per Bay) W200x19	m		488	130	65	98	65	195	65						260							325		130	B
		Diagonal (4 Per Bay) L130x130x9	m		574	153	76	115	76	229	76						306							382		153	B
		Pipe Pile Raises Epoxy Paint (inside and outside of pile)	m2		4437	3346	3647	3798	4023	4174	4625						19101							21507		6755	B
		Makeup Piles Epoxy Paint (inside and outside of pile)	m2			565	60	75	90	90	136						106							181			B
Cyclone Building	7	Allowance for HVAC, Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Allowance for Electrical Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Allowance for Lighting Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Allowance for Concrete foundation Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Allowance for Plantforms Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Allowance for Structural Steel Building H=22m, L=47m, W=26m (By others)	No.	1																							B
		Cyclone Plant Building Phase I H=22m L=34m, W=26m (By Others)	No.	1																							B
		Cyclone Plant Building Ultimate Phase 12m Expansion (By Others)	No.						1																		B
Earth Work	8	Dilution Water Head Tank Pad (Cut)	m3 cut	1938																							B
		Dilution Water Head Tank Pad (Fill)	m3 fill	2227																							B
		Dilution Water Head Tank Pad (Net)	m3 fill	290																							B
		Cyclone Feed Tank Pad (Cut)	m3 cut	2369																							B
		Cyclone Feed Tank Pad (Fill)	m3 fill	1610																							B
		Cyclone Feed Tank Pad (Net)	m3 cut	760																							B
		Cyclone Plant Pad (Cut)	m3 cut	10755																							B
		Cyclone Plant Pad (Fill)	m3 fill	9989																							B
		Cyclone Plant Pad (Net)	m3 cut	766																							B
Gravel	8	Dilution Water Head Tank Pad Gravel	m3	68																							B
		Cyclone Feed Tank Pad Gravel	m3	116																							B
		Cyclone Plant Pad Gravel	m3	3837																							B
O/F Jacking Header	11	Anchor Bolts 25 mm diameter x 450 mm long	No.	472																							B
		Drift Pins 19 mm Headed Pin x 400 mm Long	No.	236	120	32	16	24	16	48	16						64							80		32	B
		Patterned Holes 22 mm Diameter Hole in Spiral Pattern	No.	9440	4800	1280	640	960	640	1920	640						2560							3200		1280	B

TABLE 10.2
CASINO MINING CORPORATION
CASINO COPPER-GOLD PROJECT

FEASIBILITY DESIGN OF THE TAILINGS MANAGEMENT FACILITY
SCHEDULE OF QUANTITIES

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				INSTALLATION YEAR																					REV
Item Type	Item No.	Description	Unit	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	B
O/F Jacking Header	11	Flange 12.5 mm thick flange x 50 mm projection	No.	236	120	32	16	24	16	48	16						64							80		32	B
		3 Keeper Bolts 12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	No.	708	360	96	48	72	48	144	48						192							240		96	B
		Keeper Ring Plate 6mm thick plate x 100mm wide Ring Plate	No.	236	120	32	16	24	16	48	16						64							80		32	B
		Flange 12.5 mm thick flange x 100 mm projection	No.	236	120	32	16	24	16	48	16						64							80		32	B
		Upper Jacking Beam W250x67	m	118	60		8	12	8	24	8						32							40		16	B
		Lower Jacking Beam W250x67	m	118	60	16	8	12	8	24	8						32							40		16	B
		Grip Strut Grating 2" plank grip strut grating	m2	13	6	1	1	1	1	3	1						3							4		1	B
		Guardrail Painted steel - 2 rail with kickplate	m	36	16	4	4	4	4	8	4						8							12		4	B
		Ladders at Platforms Ladder with Folding or Sliding Bottom	m	50	22	6	6	6	6	11	6						11							17		6	B
		Pipe 250x12.7 Pipe	m	1770	2360	2080	1972	2060	2188	2268	2532						10216							11536		3586	B
		Holes in Pipe Piles Used for Raises 22 mm Diameter Holes Each Side @150 mm on center	No.	23600	39368	29762	27282	28990	30150	33350	34718						140120							158720		49072	B
		Base Plate for Piles 450mmx450mmx30mm	No.	118																							B
		Pipe 300x9.3 Pipe x 450 mm long	m	106	54	14	7	11	7	22	7						29							36		14	B
		Square Hollow Steel Section (HSS) HS305x305x9.5 - 300mm Long	m	71	36	10	5	7	5	14	5						19							24		10	B
		Sliding Bearing Pad - 150 mmx 150 mm Pad has Teflon Sheet, Neoprene and 2 Stl Plates	No.	59	30	8	4	6	4	12	4						16							20		8	B
		Pipe Supports for Pipe Add 10% of Pipe Weight for Supports	kg	29000	15000	4000	2000	3000	2000	6000	2000						8000							10000		4000	B
		Steel Framing L75X75x6	m	81	36	9	9	9	9	18	9						18							27		9	B
		Jacking Frames Epoxy Paint	m2	476	255	68	34	51	34	102	34													170		68	B
		Pipe Piles Epoxy Paint (inside and outside of pile)	m2	2785	1416	378	189	283	189	566	189						755							944		378	B
		Weld to Square Collar 6 mm x500 mm long	m	118	60	16	8	12	8	24	8						32							40		16	B
		Weld Full Penetration Groove Weld All Arnd Circumference of Pipe	m				13		9	6	19						6							25			B
		Pipe Pile Raises Epoxy Paint (inside and outside of pile)	m2		3705	2795	3046	3171	3360	3485	3862						15951							17961		5630	
		Makeup Piles Epoxy Paint (inside and outside of pile)	m2			471	50	63	75	75	113						88							151			
		Weld 12.5 mm x 785 mm long	m	93																							
		Weld 12.5 mm x 960 mm long	m	227	115	31	15	23	15	46	15						61							77		31	
		Weld 12.5 mm x1200 mm long	m	283	144	38	19	29	19	58	19						77							96		38	
		Weld Full Penetration Groove Weld All Around Circumference of Pipe	m		185	140	152	159	168	174	193						798							898			
		Pipe - Material Cost 250x12.7 Pipe	m		900	240	120	180	120	360	120						480							600		240	
		Pipe - Installation Cost Install 250mm Pipe By Driving It 5 Meters Below Grade	m		300	80	40	60	40	120	40						160							200		80	

NOTE:
1. NO CONTINGENCY ADDED TO QUANTITIES

P:\3 - Projects\KPV-5277 (Casino Project Tailing Cyclone and Transport)\Costing & Enquiries\MTOs\[Casino MTOs by P&C Rev B Oct 31.xlsx]KP format

APPENDIX F – POWER CONSUMPTION

Casino Project, Tailings Cyclone and Transport Study

Power Consumption for Cylone Plant and Tailings Transport System

Sum of Annual Electrical Power (MW.h)	
Year	Total
-1	922.9 MWh
1	922.9 MWh
2	944.8 MWh
3	966.7 MWh
4	988.6 MWh
5	1,010.5 MWh
6	2,024.6 MWh
7	2,927.7 MWh
8	3,653.5 MWh
9	4,541.1 MWh
10	5,323.9 MWh
11	5,851.5 MWh
12	6,492.6 MWh
13	7,218.4 MWh
14	8,119.6 MWh
15	10,018.1 MWh
16	11,891.1 MWh
17	13,787.1 MWh
18	18,256.2 MWh
19	21,781.7 MWh
20	23,786.8 MWh
21	25,311.8 MWh
22	26,827.4 MWh

APPENDIX G – JACKING HEADER STRUCTURAL DESIGN REPORT

Casino Project
Jacking Header
Feasibility Design Study





Prepared for
Paterson Cooke
October 2012

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1. Summary Pages 1-2
2. Preliminary Load List Pages 3-5
3. Material Take Off (MTO) Pages 6-10
4. Drawings Pages 11-16
5. Sketches Pages 17-20

Casino Jacking Header
Summary

1. General

The proposed project will consist of two jacking headers that will support slurry piping for discharge onto a tailings embankment. The fines tailings header consists of a 32" (813 mm) pipe that will span between jacking frames. The sand tailings header consists of 3 pipes with a walkway platform. Each header will be approximately 870 meters long and be supported by steel piling. The project is located in the Dawson Mountains of the province of Yukon in Canada. The feasibility study analyzed start up conditions only and did not consider subsequent yearly operations.

The following present the findings of our study.

2. General Arrangement

The electrical cable tray for both headers was placed above the piping instead of below it. This will avoid possible water leakage from the piping coming in contact with the electrical conduits.

Platforms were provided to operate piping valves and egress ladders down to the embankment were provided at the sand tailings header at 100 meters on center.

3. Steel Framing

At the sand tailings header, heavy steel wide flange members were used to support the piping at the walkway platform instead of prefabricated steel trusses. While the weight of the wide flange beam will be comparable to that of a prefabricated truss, using a wide flange beam will simplify the framing and connection details.

A Teflon bearing pad is recommended to accommodate thermal movement at the fines tailing header. Because of the long length of both headers, significant thermal growth will be encountered and appropriate engineering details will need to be provided to accommodate loads and movement from thermal changes.

4. Foundation

The jacking structures will be founded initially on concrete footings located at the crest of an embankment dam. It has been reported that footings near the edge of the dam can rotate causing maintenance problems with future pipe pile raises. Providing additional compaction and careful construction observation during the installation of the footings and embankment should prevent rotation of the footings in the future.

At the startup of the header operations the pipe piles will be founded on concrete footings. As tailings are deposited the mechanism for resisting structural loads will change. Lateral loads will change from being resisted by the concrete footings to being resisted by compacted tailings.

Stronger piles may be needed initially during this transition phase until the sufficient tailings are built up around the piles. It is possible that the size of the piles can be reduced for future raises, but further analysis is required.

Preliminary Structural Load List
Casino Jacking Header

1. General

The proposed jacking structures will be required to withstand the loads listed below including anticipated jacking loads.

2. Design Loads

The following describes the structural loads considered in the preliminary design of the jacking header. These loads include the following types of loads.

1. Dead Loads
2. Live Loads
3. Snow Loads
4. Wind Loads
5. Seismic Loads
6. Jacking Loads
7. Geotechnical Information

2.1 Dead loads

Dead loads acting on the structure or a portion thereof shall consist of the weight of all permanent construction, including platforms, ladders, piping, lights and all fixed equipment.

2.2 Live Loads

Live loads shall consist of uniform surface loads or equivalent point loads developed to represent loading effects due to the movement of materials, equipment or personnel on a temporary basis. Loads will be identified as live loads when the item imposing the load is not permanent or rigidly fixed to the structure. The platform of the jacking header shall be designed for a minimum live load of 4.8 kPa (100 psf). A weight of 0.22 kN/m (15 plf) along the length of the header shall be used for electrical conduits. The weights of lights will be covered by a weight of 0.07 kN/m (5 plf) along the edge of the walkway platform at the sand tailings header.

2.3 Snow Loads

A snow load of 2.26 kPa (47 psf) will be used on the horizontal surfaces of the header for snow loads. It is our understanding that the slurry header will not be operational during the winter months. Therefore, possible ice loads from the buildup of frozen slurry were not considered.

2.4 Wind Loads

Wind loads shall be 1.78 kPa (37.2 psf) on flat areas such as steel framing members and 1.23 kPa (25.6 psf) on round areas such as the steel piling and the elevated pipes.

2.5 Seismic Loads

The following parameters shall be used in the design.

Sa (0.2 sec) = 0.544g
Sa (0.5 sec) = 0.336g
Sa (1.0 sec) = 0.168g
Sa (2.0 sec) = 0.094g
PGA = 0.250g

Soil Conditions – A stiff soil was assumed for use in the seismic design.

2.6 Jacking Loads

The slurry header will need to be raised periodically as slurry is deposited. Raises will be performed by hydraulic jacks. Jacking loads will be calculated to size jacks and structural steel members.

The jacking loads for the two headers were analyzed. During jacking it was assumed that the slurry piping was full and that there was a live load on any access platforms or walkways of 15psf. The following jacking loads were determined. The loads do not include a safety factor.

Fines Tailings Jacking Structure – 169 kN (19 tons).

Sand Tailings Jacking Structure – 269 kN (27 tons)

2.7 Geotechnical Information

The following geotechnical information was used in the feasibility study.

1. Soil will consist of hydraulic fill sand with 12% fines.
2. Net allowable bearing pressure = 143.6 kN/m^2 (3000 psf)
3. Modulus of subgrade reaction = 27.13 MN/m^3 (100 pci)

3. Materials

3.1 Structural Concrete

The minimum ultimate compressive strength of structural concrete shall be 31.0 MPa (4500 psi) at 28 days.

3.2 Reinforcement

Reinforcing steel bars shall be grade 60. All bars shall conform to the specifications for deformed billet bars for concrete reinforcement (ASTM A615).

3.3 Structural Steel

All structural steel shall be ASTM A992, Grade 50 unless otherwise specified. Structural steel pipe shall be ASTM A53, grade B.

4. Unit Weights

The following unit weights will be used.

1. Unit weight of concrete shall be assumed equal to 2403 kg/m^3 (150 lbs/ft^3) for design purposes.
2. Unit weight of water shall be assumed equal to 1000 kg/m^3 (62.4 lbs/ft^3).
3. The weight of the slurry shall be assumed to equal 1602 kg/m^3 (100 lbs/ft^3).

MATERIAL TAKE OFF (MTO)

Casino Project
Tailings Jacking Structure
Summary of Modifications Per Year

Increase in Header Length Per Year (1)

Years	Length of Header	Length of Header	Increase in Header Length			
	Calculated	Adjusted for 15 Meter Bays	Number of Added Bays	Added Length	Running Total	
			Each Bay has a Length of 15 Meters	Added Bays x 15 Meters		
Year -1	865	870			870	
Year 1	1,316	1,320	30	450	1320	
Year 2	1,434	1,440	8	120	1440	
Year 3	1,492	1,500	4	60	1500	
Year 4	1,592	1,590	6	90	1590	
Year 5	1,640	1,650	4	60	1650	
Year 6	1,816	1,830	12	180	1830	
Year 7	1,865	1,890	4	60	1890	
Year 13	2,120	2,130	16	240	2130	
Year 20	2,428	2,430	20	300	2430	
Year 22	2,542	2,550	8	120	2550	

Vertical Tailing Raises Per Year

Years	Elevation of Tailings	Raise Height
	(Meters)	(Meters)
Year -1	830	
Year 1	850	20
Year 2	863	13
Year 3	870	7
Year 4	881	11
Year 5	889	8
Year 6	902	13
Year 7	908	6
Year 13	952	44
Year 20	995	43
Year 22	1006	11

Vertical Piles Raises Per Year (2)

Years	Pile Extension on Constructed Header Structure			Makeup Pile Extension on New Added Section of Header (3)		
	Number of Bays Needing Pile Extension	Number of Piles Needing Extension	Length of Added Pile	Number of Bays Affected	Number of Piles Affected	Length of Added Pile
			(Meters Per Pile)			(Meters Per Pile)
Year -1						
Year 1	58	118	20			
Year 2	88	178	10	30	60	5
Year 3	96	194	10	8	16	2
Year 4	100	202	10	4	8	5
Year 5	106	214	10	6	12	4
Year 6	110	222	10	4	8	6
Year 7	122	246	10	12	24	3
Year 13	126	254	40	4	8	7
Year 20	142	286	40	16	32	3
Year 22	162	326	11			

Footnotes:
1. The Length of the Jacking Structures will Increase During Depostion of Tailings
2. Depostion of Tailings Will Require That Piles Be Added to The Top of the Constructed Piles to Allow For Vertical Raises of The Jacking Structure
3. As tailings are deposited, the length of the jacking structure will increase.
   The elevation of the piles in the new expanded sections will be on a different elevation than the rest of the jacking structure.
   A makeup length of pile will be required so that the top of all of the piles are on the same elevation.
   This will allow future raises for all piles to be the same.

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year -1)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 3 - Concrete					
Concrete Footings (59 Footings per Header)	Reinforced Concrete Footing	59	Cubic Meters	4.50	265.5
Division 5					
Pipe Piles (118 Piles Per Jacking Structure)					
Pipe	300x12.7 Pipe	118	Length - Meters	15.00	1770.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	118	Number of Holes	200.00	23600.0
Base Plate for Piles	500mm x 500mm x 30mm	118	Number of Base Plates	1.00	118.0
Anchor Bolts	25 mm diameter x 450 mm long	118	Number of Anchor Bolts	4.00	472.0
Weld	12.5 mm x 940 mm long	118	Length of Weld - Meters	0.94	110.9
	(1/2" weld around perimeter of pile)				
Jacking Frame (Sheet 1) 236 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	236	Number of Pins	1.00	236.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	236	Length - Meters	0.45	106.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	236	Number of Holes	40.00	9440.0
Flange	12.5 mm thick flange x 50 mm projection	236	Number of Flanges	1.00	236.0
Weld	12.5 mm x 1115 mm long	236	Length of Weld - Meters	1.11	262.0
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	236	Number of Bolts	3.00	708.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	236	Number of Plates	1.00	236.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	236	Length - Meters	0.30	70.8
Flange	12.5 mm thick flange x 100 mm projection	236	Number of Flanges	1.00	236.0
Weld	12.5 mm x1420 mm long	236	Length of Weld - Meters	1.42	335.1
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	59	Length - Meters	2.00	118.0
Weld to Square Collar	6 mm x500 mm long	118	Length - Meters	0.50	59.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	59	Length - Meters	2.00	118.0
Weld to Square Collar	6 mm x500 mm long	118	Length - Meters	0.50	59.0
	(1/4" weld around perimeter of beam web)				

Jacking Header Consists of 58 bays. Each bay is 15 meters long

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year -1)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder	W610x101	116	Length - Meters	15.00	1740.0
Beam	W200x19	290	Length - Meters	3.25	942.5
Diagonal	L130x130x9	232	Length - Meters	4.78	1109.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		31765.0
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	58	Square meters	26.67	1546.9
Guardrail	Painted steel - 2 rail with kickplate	58	Length - Meters	33.20	1925.6
Steel Channels	C200x 75	58	Length - Meters	49.25	2856.5
Support Columns	L75X75x6	58	Length - Meters	12.00	696.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		8112.0
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	58	10% Total Pipe Weight - kg	1156.00	67048.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	9	Length - Meters	5.50	49.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	58	Square meters	9.00	522.0
Framing for Walkway and Platform	Epoxy Paint	58	Square meters	130.00	7540.0
Pipe Piles	Epoxy Paint	118	Square meters	28.20	3327.6

Jacking Header Consists of 58 bays. Each bay is 15 meters long

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year -1)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 3 - Concrete					
Concrete Footings (59 Footings per Header)	Reinforced Concrete Footing	59	Cubic Meters	3.04	179.4
Division 5 - Metals					
Pipe Piles (118 Piles Per Jacking Structure)					
Pipe	250x12.7 Pipe	118	Length - Meters	15.00	1770.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	118	Number of Holes	200.00	23600.0
Base Plate for Piles	450mmx450mmx30mm	118	Number of Base Plates	1.00	118.0
Anchor Bolts	25 mm diameter x 450 mm long	118	Number of Anchor Bolts	4.00	472.0
Weld	12.5 mm x 785 mm long	118	Length of Weld - Meters	0.79	92.6
	(1/2" weld around perimeter of pile)				
Jacking Frame (Sheet 1) 236 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	236	Number of Pins	1.00	236.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	236	Length - Meters	0.45	106.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	236	Number of Holes	40.00	9440.0
Flange	12.5 mm thick flange x 50 mm projection	236	Number of Flanges	1.00	236.0
Weld	12.5 mm x 960 mm long	236	Length of Weld - Meters	0.96	226.6
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	236	Number of Bolts	3.00	708.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	236	Number of Plates	1.00	236.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	236	Length - Meters	0.30	70.8
Flange	12.5 mm thick flange x 100 mm projection	236	Number of Flanges	1.00	236.0
Weld	12.5 mm x1200 mm long	236	Length of Weld - Meters	1.20	283.2
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	59	Length - Meters	2.00	118.0
Weld to Square Collar	6 mm x500 mm long	118	Length - Meters	0.50	59.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	59	Length - Meters	2.00	118.0
Weld to Square Collar	6 mm x500 mm long	118	Length - Meters	0.50	59.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	59	Number of Pads	1.00	59.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	58	10% Total Pipe Weight - kg	500.00	29000.0
Platform for Valves (9 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	9	Square meters	1.44	13.0
Guardrail	Painted steel - 2 rail with kickplate	9	Length - Meters	4.00	36.0
Steel Framing	L75X75x6	9	Length - Meters	9.00	81.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	9	Length - Meters	5.50	49.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	56	Square meters	8.50	476.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	118	Square meters	23.60	2784.8

Jacking Header Consists of 58 bays. Each bay is 15 meters long

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 1)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 1					
Length Increase of Header	**Addition of 30 Bays @ 15 Meters Per Bay = 450 Meters**				
Vertical Pile Raise	**118 Piles Raised Up by Welding New Pipes to End of Constructed Piles (2 Pile Raises of 10 Meters Each)**				
	(236 New Piles x 10 Meters Long)				
Access to Grade	**4 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	236	Length - Meters	10.00	2360.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	236	Number of Holes	133.00	31388.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	236	Length of Weld - Meters	0.94	221.8
Length Increase in Header					
Pipe Piles (60 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	60	Length - Meters	15.00	900.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	60	Number of Holes	133.00	7980.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	60	Length - Meters	5.00	300.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 120 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	120	Number of Pins	1.00	120.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	120	Length - Meters	0.45	54.0
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	120	Number of Holes	40.00	4800.0
Flange	12.5 mm thick flange x 50 mm projection	120	Number of Flanges	1.00	120.0
Weld	12.5 mm x 1115 mm long	120	Length of Weld - Meters	1.11	133.2
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	120	Number of Bolts	3.00	360.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	120	Number of Plates	1.00	120.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	120	Length - Meters	0.30	36.0
Flange	12.5 mm thick flange x 100 mm projection	120	Number of Flanges	1.00	120.0
Weld	12.5 mm x1420 mm long	120	Length of Weld - Meters	1.42	170.4
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	30	Length - Meters	2.00	60.0
Weld to Square Collar	6 mm x500 mm long	60	Length - Meters	0.50	30.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	30	Length - Meters	2.00	60.0
Weld to Square Collar	6 mm x500 mm long	60	Length - Meters	0.50	30.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 1)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	60	Length - Meters	15.00	900.0
Beam (5 Per Bay)	W200x19	150	Length - Meters	3.25	487.5
Diagonal (4 Per Bay)	L130x130x9	120	Length - Meters	4.78	573.6
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		16389.7
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	30	Square meters	26.67	800.1
Guardrail	Painted steel - 2 rail with kickplate	30	Length - Meters	33.20	996.0
Steel Channels	C200x 75	30	Length - Meters	49.25	1477.5
Support Columns	L75X75x6	30	Length - Meters	12.00	360.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		4183.4
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	30	10% Total Pipe Weight - kg	500.00	15000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	4	Length - Meters	5.50	22.0
Division 9					
Painting					
Jacking Frame	Epoxy Paint	30	Square meters	9.00	270.0
Framing for Walkway and Platform	Epoxy Paint	30	Square meters	130.00	3900.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	60	Square meters	28.20	1692.0
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	236	Square meters	18.80	4436.8

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 1)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 1					
Length Increase of Header	**Addition of 30 Bays @ 15 Meters Per Bay = 450 Meters**				
Vertical Pile Raise	**118 Piles Raised Up by Welding New Pipes to End of Constructed Piles (2 Pile Raises of 10 Meters Each)**				
	(236 New Piles x 10 Meters Long)				
Platforms	**4 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	236	Length - Meters	10.00	2360.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	236	Number of Holes	133.00	31388.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	236	Length of Weld - Meters	0.79	185.3
Length Increase in Header					
Pipe Piles (60 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	60	Length - Meters	15.00	900.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	60	Number of Holes	133.00	7980.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	60	Length - Meters	5.00	300.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 120 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	120	Number of Pins	1.00	120.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	120	Length - Meters	0.45	54.0
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	120	Number of Holes	40.00	4800.0
Flange	12.5 mm thick flange x 50 mm projection	120	Number of Flanges	1.00	120.0
Weld	12.5 mm x 960 mm long	120	Length of Weld - Meters	0.96	115.2
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	120	Number of Bolts	3.00	360.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	120	Number of Plates	1.00	120.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	120	Length - Meters	0.30	36.0
Flange	12.5 mm thick flange x 100 mm projection	120	Number of Flanges	1.00	120.0
Weld	12.5 mm x1200 mm long	120	Length of Weld - Meters	1.20	144.0
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	30	Length - Meters	2.00	60.0
Weld to Square Collar	6 mm x500 mm long	60	Length - Meters	0.50	30.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	30	Length - Meters	2.00	60.0
Weld to Square Collar	6 mm x500 mm long	60	Length - Meters	0.50	30.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	30	Number of Pads	1.00	30.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	30	10% Total Pipe Weight - kg	500.00	15000.0
Platform for Valves (4 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	4	Square meters	1.44	5.8
Guardrail	Painted steel - 2 rail with kickplate	4	Length - Meters	4.00	16.0
Steel Framing	L75X75x6	4	Length - Meters	9.00	36.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	4	Length - Meters	5.50	22.0
Division 9					
Painting					
Jacking Frames	Epoxy Paint	30	Square meters	8.50	255.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	60	Square meters	23.60	1416.0
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	236	Square meters	15.70	3705.2

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 2)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 2					
Length Increase of Header	**Addition of 8 Bays @ 15 Meters Per Bay = 120 Meters**				
Vertical Pile Raise	**178 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(178 New Piles x 10 Meters Long)				
	60 Piles x 5 Meters Makeup Piles Added				
Access to Grade	**1 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	178	Length - Meters	10.00	1780.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	178	Number of Holes	133.00	23674.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	178	Length of Weld - Meters	0.94	167.3
Makeup Piles					
Pipe	300x12.7 Pipe	60	Length - Meters	5.00	300.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	60	Number of Holes	66.00	3960.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	60	Length of Weld - Meters	0.94	56.4
Length Increase in Header					
Pipe Piles (16 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	16	Length - Meters	15.00	240.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	16	Number of Holes	133.00	2128.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	16	Length - Meters	5.00	80.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 32 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	32	Number of Pins	1.00	32.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	32	Length - Meters	0.45	14.4
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	32	Number of Holes	40.00	1280.0
Flange	12.5 mm thick flange x 50 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x 1115 mm long	32	Length of Weld - Meters	1.11	35.5
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	32	Number of Bolts	3.00	96.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	32	Number of Plates	1.00	32.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	32	Length - Meters	0.30	9.6
Flange	12.5 mm thick flange x 100 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x1420 mm long	32	Length of Weld - Meters	1.42	45.4
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 2)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	16	Length - Meters	15.00	240.0
Beam (5 Per Bay)	W200x19	40	Length - Meters	3.25	130.0
Diagonal (4 Per Bay)	L130x130x9	32	Length - Meters	4.78	153.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		4370.6
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	8	Square meters	26.67	213.4
Guardrail	Painted steel - 2 rail with kickplate	8	Length - Meters	33.20	265.6
Steel Channels	C200x 75	8	Length - Meters	49.25	394.0
Support Columns	L75X75x6	8	Length - Meters	12.00	96.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		1115.6
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	8	10% Total Pipe Weight - kg	500.00	4000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	8	Square meters	9.00	72.0
Framing for Walkway and Platform	Epoxy Paint	8	Square meters	130.00	1040.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	28.20	451.2
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	178	Square meters	18.80	3346.4
Makeup Piles	Epoxy Paint (inside and outside of pile)	60	Square meters	9.42	565.2

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 2					
Length Increase of Header	**Addition of 8 Bays @ 15 Meters Per Bay = 120 Meters**				
Vertical Pile Raise	**178 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters Each)**				
	(178 New Piles x 10 Meters Long)				
	60 Piles x 5 Meters Makeup Piles Added				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	178	Length - Meters	10.00	1780.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	178	Number of Holes	133.00	23674.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	178	Length of Weld - Meters	0.79	139.7
Makeup Piles					
Pipe	250x12.7 Pipe	60	Length - Meters	5.00	300.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	60	Number of Holes	66.00	3960.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	60	Length of Weld - Meters	0.79	47.4
Length Increase in Header					
Pipe Piles (16 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	16	Length - Meters	15.00	240.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	16	Number of Holes	133.00	2128.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	16	Length - Meters	5.00	80.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 32 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	32	Number of Pins	1.00	32.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	32	Length - Meters	0.45	14.4
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	32	Number of Holes	40.00	1280.0
Flange	12.5 mm thick flange x 50 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x 960 mm long	32	Length of Weld - Meters	0.96	30.7
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	32	Number of Bolts	3.00	96.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	32	Number of Plates	1.00	32.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	32	Length - Meters	0.30	9.6
Flange	12.5 mm thick flange x 100 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x1200 mm long	32	Length of Weld - Meters	1.20	38.4
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	8	Number of Pads	1.00	8.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	8	10% Total Pipe Weight - kg	500.00	4000.0
Platform for Valves (1 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	8	Square meters	8.50	68.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	23.60	377.6
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	178	Square meters	15.70	2794.6
Makeup Piles	Epoxy Paint (inside and outside of pile)	60	Square meters	7.85	471.0

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 3)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 3					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**194 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(194 New Piles x 10 Meters Long)				
	16 Piles x 2 Meters Makeup Piles Added				
Access to Grade	**1 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	194	Length - Meters	10.00	1940.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	194	Number of Holes	133.00	25802.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	194	Length of Weld - Meters	0.94	182.4
Makeup Piles					
Pipe	300x12.7 Pipe	16	Length - Meters	2.00	32.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	16	Number of Holes	26.00	416.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	16	Length of Weld - Meters	0.94	15.0
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 1115 mm long	16	Length of Weld - Meters	1.11	17.8
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1420 mm long	16	Length of Weld - Meters	1.42	22.7
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 3)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	8	Length - Meters	15.00	120.0
Beam (5 Per Bay)	W200x19	20	Length - Meters	3.25	65.0
Diagonal (4 Per Bay)	L130x130x9	16	Length - Meters	4.78	76.5
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		2185.3
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	4	Square meters	26.67	106.7
Guardrail	Painted steel - 2 rail with kickplate	4	Length - Meters	33.20	132.8
Steel Channels	C200x 75	4	Length - Meters	49.25	197.0
Support Columns	L75X75x6	4	Length - Meters	12.00	48.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		557.8
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	4	Square meters	9.00	36.0
Framing for Walkway and Platform	Epoxy Paint	4	Square meters	130.00	520.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	28.20	225.6
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	194	Square meters	18.80	3647.2
Makeup Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	3.77	60.3

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 3)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 3					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**194 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(194 New Piles x 10 Meters Long)				
	16 Piles x 2 Meters Makeup Piles Added				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	194	Length - Meters	10.00	1940.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	194	Number of Holes	133.00	25802.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	194	Length of Weld - Meters	0.79	152.3
Makeup Piles					
Pipe	250x12.7 Pipe	16	Length - Meters	2.00	32.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	16	Number of Holes	26.00	416.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	16	Length of Weld - Meters	0.79	12.6
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 960 mm long	16	Length of Weld - Meters	0.96	15.4
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1200 mm long	16	Length of Weld - Meters	1.20	19.2
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	4	Number of Pads	1.00	4.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Platform for Valves (1 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	4	Square meters	8.50	34.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	23.60	188.8
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	194	Square meters	15.70	3045.8
Makeup Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	3.14	50.2

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 4)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 4					
Length Increase of Header	**Addition of 6 Bays @ 15 Meters Per Bay = 90 Meters**				
Vertical Pile Raise	**202 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(202 New Piles x 10 Meters Long)				
	8 Piles x 5 Meters Makeup Piles Added				
Access to Grade	**1 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	202	Length - Meters	10.00	2020.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	202	Number of Holes	133.00	26866.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	202	Length of Weld - Meters	0.94	189.9
Makeup Piles					
Pipe	300x12.7 Pipe	8	Length - Meters	5.00	40.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	66.00	528.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.94	7.5
Length Increase in Header					
Pipe Piles (12 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	12	Length - Meters	15.00	180.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	12	Number of Holes	133.00	1596.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	12	Length - Meters	5.00	60.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 24 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	24	Number of Pins	1.00	24.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	24	Length - Meters	0.45	10.8
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	24	Number of Holes	40.00	960.0
Flange	12.5 mm thick flange x 50 mm projection	24	Number of Flanges	1.00	24.0
Weld	12.5 mm x 1115 mm long	24	Length of Weld - Meters	1.11	26.6
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	24	Number of Bolts	3.00	72.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	24	Number of Plates	1.00	24.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	24	Length - Meters	0.30	7.2
Flange	12.5 mm thick flange x 100 mm projection	24	Number of Flanges	1.00	24.0
Weld	12.5 mm x1420 mm long	24	Length of Weld - Meters	1.42	34.1
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	6	Length - Meters	2.00	12.0
Weld to Square Collar	6 mm x500 mm long	12	Length - Meters	0.50	6.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	6	Length - Meters	2.00	12.0
Weld to Square Collar	6 mm x500 mm long	12	Length - Meters	0.50	6.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 4)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	12	Length - Meters	15.00	180.0
Beam (5 Per Bay)	W200x19	30	Length - Meters	3.25	97.5
Diagonal (4 Per Bay)	L130x130x9	24	Length - Meters	4.78	114.7
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		3277.9
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	6	Square meters	26.67	160.0
Guardrail	Painted steel - 2 rail with kickplate	6	Length - Meters	33.20	199.2
Steel Channels	C200x 75	6	Length - Meters	49.25	295.5
Support Columns	L75X75x6	6	Length - Meters	12.00	72.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		836.7
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	6	10% Total Pipe Weight - kg	500.00	3000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	6	Square meters	9.00	54.0
Framing for Walkway and Platform	Epoxy Paint	6	Square meters	130.00	780.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	12	Square meters	28.20	338.4
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	202	Square meters	18.80	3797.6
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	9.42	75.4

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 4)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 4					
Length Increase of Header	**Addition of 6 Bays @ 15 Meters Per Bay = 90 Meters**				
Vertical Pile Raise	**202 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(202 New Piles x 10 Meters Long)				
	8 Piles x 5 Meters Makeup Piles Added				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	202	Length - Meters	10.00	2020.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	202	Number of Holes	133.00	26866.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	202	Length of Weld - Meters	0.79	158.6
Makeup Piles					
Pipe	250x12.7 Pipe	8	Length - Meters	5.00	40.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	66.00	528.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.79	6.3
Length Increase in Header					
Pipe Piles (12 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	12	Length - Meters	15.00	180.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	12	Number of Holes	133.00	1596.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	12	Length - Meters	5.00	60.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 24 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	24	Number of Pins	1.00	24.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	24	Length - Meters	0.45	10.8
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	24	Number of Holes	40.00	960.0
Flange	12.5 mm thick flange x 50 mm projection	24	Number of Flanges	1.00	24.0
Weld	12.5 mm x 960 mm long	24	Length of Weld - Meters	0.96	23.0
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	24	Number of Bolts	3.00	72.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	24	Number of Plates	1.00	24.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	24	Length - Meters	0.30	7.2
Flange	12.5 mm thick flange x 100 mm projection	24	Number of Flanges	1.00	24.0
Weld	12.5 mm x1200 mm long	24	Length of Weld - Meters	1.20	28.8
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	6	Length - Meters	2.00	12.0
Weld to Square Collar	6 mm x500 mm long	12	Length - Meters	0.50	6.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	6	Length - Meters	2.00	12.0
Weld to Square Collar	6 mm x500 mm long	12	Length - Meters	0.50	6.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	6	Number of Pads	1.00	6.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	6	10% Total Pipe Weight - kg	500.00	3000.0
Platform for Valves (1 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	6	Square meters	8.50	51.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	12	Square meters	23.60	283.2
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	202	Square meters	15.70	3171.4
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	7.85	62.8

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 5)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 5					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**214 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(214 New Piles x 10 Meters Long)				
	12 Piles x 4 Meters Makeup Piles Added				
Access to Grade	**1 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	214	Length - Meters	10.00	2140.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	214	Number of Holes	133.00	28462.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	214	Length of Weld - Meters	0.94	201.2
Makeup Piles					
Pipe	300x12.7 Pipe	12	Length - Meters	4.00	48.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	12	Number of Holes	52.00	624.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	12	Length of Weld - Meters	0.94	11.3
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 1115 mm long	16	Length of Weld - Meters	1.11	17.8
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1420 mm long	16	Length of Weld - Meters	1.42	22.7
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 5)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	8	Length - Meters	15.00	120.0
Beam (5 Per Bay)	W200x19	20	Length - Meters	3.25	65.0
Diagonal (4 Per Bay)	L130x130x9	16	Length - Meters	4.78	76.5
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		2185.3
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	4	Square meters	26.67	106.7
Guardrail	Painted steel - 2 rail with kickplate	4	Length - Meters	33.20	132.8
Steel Channels	C200x 75	4	Length - Meters	49.25	197.0
Support Columns	L75X75x6	4	Length - Meters	12.00	48.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		557.8
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	4	Square meters	9.00	36.0
Framing for Walkway and Platform	Epoxy Paint	4	Square meters	130.00	520.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	28.20	225.6
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	214	Square meters	18.80	4023.2
Makeup Piles	Epoxy Paint (inside and outside of pile)	12	Square meters	7.54	90.5

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 5)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 5					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**214 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(214 New Piles x 10 Meters Long)				
	12 Piles x 4 Meters Makeup Piles Added				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	214	Length - Meters	10.00	2140.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	214	Number of Holes	133.00	28462.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	214	Length of Weld - Meters	0.79	168.0
Makeup Piles					
Pipe	250x12.7 Pipe	12	Length - Meters	4.00	48.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	12	Number of Holes	52.00	624.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	12	Length of Weld - Meters	0.79	9.5
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1)16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 960 mm long	16	Length of Weld - Meters	0.96	15.4
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1200 mm long	16	Length of Weld - Meters	1.20	19.2
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	4	Number of Pads	1.00	4.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Platform for Valves (1 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	4	Square meters	8.50	34.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	23.60	188.8
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	214	Square meters	15.70	3359.8
Makeup Piles	Epoxy Paint (inside and outside of pile)	12	Square meters	6.28	75.4

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 6)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 6					
Length Increase of Header	**Addition of 12 Bays @ 15 Meters Per Bay = 180 Meters**				
Vertical Pile Raise	**222 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(222 New Piles x 10 Meters Long)				
	8 Piles x 6 Meters Makeup Piles Added				
Access to Grade	**2 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	222	Length - Meters	10.00	2220.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	222	Number of Holes	133.00	29526.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	222	Length of Weld - Meters	0.94	208.7
Makeup Piles					
Pipe	300x12.7 Pipe	8	Length - Meters	6.00	48.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	79.00	632.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.94	7.5
Length Increase in Header					
Pipe Piles (24 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	24	Length - Meters	15.00	360.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	24	Number of Holes	133.00	3192.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	24	Length - Meters	5.00	120.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 48 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	48	Number of Pins	1.00	48.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	48	Length - Meters	0.45	21.6
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	48	Number of Holes	40.00	1920.0
Flange	12.5 mm thick flange x 50 mm projection	48	Number of Flanges	1.00	48.0
Weld	12.5 mm x 1115 mm long	48	Length of Weld - Meters	1.11	53.3
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	48	Number of Bolts	3.00	144.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	48	Number of Plates	1.00	48.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	48	Length - Meters	0.30	14.4
Flange	12.5 mm thick flange x 100 mm projection	48	Number of Flanges	1.00	48.0
Weld	12.5 mm x1420 mm long	48	Length of Weld - Meters	1.42	68.2
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	12	Length - Meters	2.00	24.0
Weld to Square Collar	6 mm x500 mm long	24	Length - Meters	0.50	12.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	12	Length - Meters	2.00	24.0
Weld to Square Collar	6 mm x500 mm long	24	Length - Meters	0.50	12.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 6)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	24	Length - Meters	15.00	360.0
Beam (5 Per Bay)	W200x19	60	Length - Meters	3.25	195.0
Diagonal (4 Per Bay)	L130x130x9	48	Length - Meters	4.78	229.4
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		6555.9
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	12	Square meters	26.67	320.0
Guardrail	Painted steel - 2 rail with kickplate	12	Length - Meters	33.20	398.4
Steel Channels	C200x 75	12	Length - Meters	49.25	591.0
Support Columns	L75X75x6	12	Length - Meters	12.00	144.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		1673.4
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	12	10% Total Pipe Weight - kg	500.00	6000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	2	Length - Meters	5.50	11.0
Division 9					
Painting					
Jacking Frame	Epoxy Paint	12	Square meters	9.00	108.0
Framing for Walkway and Platform	Epoxy Paint	12	Square meters	130.00	1560.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	24	Square meters	28.20	676.8
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	222	Square meters	18.80	4173.6
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	11.30	90.4

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 6)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 6					
Length Increase of Header	**Addition of 12 Bays @ 15 Meters Per Bay = 180 Meters**				
Vertical Pile Raise	**222 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(222 New Piles x 10 Meters Long)				
	8 Piles x 6 Meters Makeup Piles Added				
Platforms	**2 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	222	Length - Meters	10.00	2220.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	222	Number of Holes	133.00	29526.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	222	Length of Weld - Meters	0.79	174.3
Makeup Piles					
Pipe	250x12.7 Pipe	8	Length - Meters	6.00	48.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	79.00	632.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.79	6.3
Length Increase in Header					
Pipe Piles (24 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	24	Length - Meters	15.00	360.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	24	Number of Holes	133.00	3192.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	24	Length - Meters	5.00	120.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 48 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	48	Number of Pins	1.00	48.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	48	Length - Meters	0.45	21.6
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	48	Number of Holes	40.00	1920.0
Flange	12.5 mm thick flange x 50 mm projection	48	Number of Flanges	1.00	48.0
Weld	12.5 mm x 960 mm long	48	Length of Weld - Meters	0.96	46.1
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	48	Number of Bolts	3.00	144.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	48	Number of Plates	1.00	48.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	48	Length - Meters	0.30	14.4
Flange	12.5 mm thick flange x 100 mm projection	48	Number of Flanges	1.00	48.0
Weld	12.5 mm x1200 mm long	48	Length of Weld - Meters	1.20	57.6
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	12	Length - Meters	2.00	24.0
Weld to Square Collar	6 mm x500 mm long	24	Length - Meters	0.50	12.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	12	Length - Meters	2.00	24.0
Weld to Square Collar	6 mm x500 mm long	24	Length - Meters	0.50	12.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	12	Number of Pads	1.00	12.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	12	10% Total Pipe Weight - kg	500.00	6000.0
Platform for Valves (2 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	2	Square meters	1.44	2.9
Guardrail	Painted steel - 2 rail with kickplate	2	Length - Meters	4.00	8.0
Steel Framing	L75X75x6	2	Length - Meters	9.00	18.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	2	Length - Meters	5.50	11.0
Division 9					
Painting					
Jacking Frames	Epoxy Paint	12	Square meters	8.50	102.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	24	Square meters	23.60	566.4
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	222	Square meters	15.70	3485.4
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	9.42	75.4

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 7)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 7					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**246 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(246 New Piles x 10 Meters Long)				
	24 Piles x 3 Meters Makeup Piles Added				
Access to Grade	**1 Ladder**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	246	Length - Meters	10.00	2460.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	246	Number of Holes	133.00	32718.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	246	Length of Weld - Meters	0.94	231.2
Makeup Piles					
Pipe	300x12.7 Pipe	24	Length - Meters	3.00	72.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	24	Number of Holes	39.00	936.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	24	Length of Weld - Meters	0.94	22.6
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 1115 mm long	16	Length of Weld - Meters	1.11	17.8
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1420 mm long	16	Length of Weld - Meters	1.42	22.7
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 7)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	8	Length - Meters	15.00	120.0
Beam (5 Per Bay)	W200x19	20	Length - Meters	3.25	65.0
Diagonal (4 Per Bay)	L130x130x9	16	Length - Meters	4.78	76.5
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		2185.3
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	4	Square meters	26.67	106.7
Guardrail	Painted steel - 2 rail with kickplate	4	Length - Meters	33.20	132.8
Steel Channels	C200x 75	4	Length - Meters	49.25	197.0
Support Columns	L75X75x6	4	Length - Meters	12.00	48.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		557.8
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	4	Square meters	9.00	36.0
Framing for Walkway and Platform	Epoxy Paint	4	Square meters	130.00	520.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	28.20	225.6
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	246	Square meters	18.80	4624.8
Makeup Piles	Epoxy Paint (inside and outside of pile)	24	Square meters	5.65	135.6

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 7)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 7					
Length Increase of Header	**Addition of 4 Bays @ 15 Meters Per Bay = 60 Meters**				
Vertical Pile Raise	**246 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raise of 10 Meters)**				
	(246 New Piles x 10 Meters Long)				
	24 Piles x 3 Meters Makeup Piles Added				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	246	Length - Meters	10.00	2460.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	246	Number of Holes	133.00	32718.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	246	Length of Weld - Meters	0.79	193.1
Makeup Piles					
Pipe	250x12.7 Pipe	24	Length - Meters	3.00	72.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	24	Number of Holes	39.00	936.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	24	Length of Weld - Meters	0.79	19.0
Length Increase in Header					
Pipe Piles (8 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	8	Length - Meters	15.00	120.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	133.00	1064.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	8	Length - Meters	5.00	40.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 16 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	16	Number of Pins	1.00	16.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	16	Length - Meters	0.45	7.2
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	16	Number of Holes	40.00	640.0
Flange	12.5 mm thick flange x 50 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x 960 mm long	16	Length of Weld - Meters	0.96	15.4
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	16	Number of Bolts	3.00	48.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	16	Number of Plates	1.00	16.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	16	Length - Meters	0.30	4.8
Flange	12.5 mm thick flange x 100 mm projection	16	Number of Flanges	1.00	16.0
Weld	12.5 mm x1200 mm long	16	Length of Weld - Meters	1.20	19.2
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	4	Length - Meters	2.00	8.0
Weld to Square Collar	6 mm x500 mm long	8	Length - Meters	0.50	4.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	4	Number of Pads	1.00	4.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	4	10% Total Pipe Weight - kg	500.00	2000.0
Platform for Valves (2 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	4	Square meters	8.50	34.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	23.60	188.8
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	246	Square meters	15.70	3862.2
Makeup Piles	Epoxy Paint (inside and outside of pile)	24	Square meters	4.71	113.0

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 13)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 13					
Length Increase of Header	**Addition of 16 Bays @ 15 Meters Per Bay = 240 Meters**				
Vertical Pile Raise	**254 Piles Raised Up by Welding New Pipes to End of Constructed Piles (4 Pile Raises of 10 Meters Each)**				
	(1016 New Piles x 10 Meters Long)				
	8 Piles x 7 Meters Makeup Piles Added				
Access to Grade	**2 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	1016	Length - Meters	10.00	10160.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	1016	Number of Holes	133.00	135128.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	1016	Length of Weld - Meters	0.94	955.0
Makeup Piles					
Pipe	300x12.7 Pipe	8	Length - Meters	7.00	56.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	92.00	736.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.94	7.5
Length Increase in Header					
Pipe Piles (32 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	32	Length - Meters	15.00	480.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	32	Number of Holes	133.00	4256.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	32	Length - Meters	5.00	160.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 64 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	64	Number of Pins	1.00	64.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	64	Length - Meters	0.45	28.8
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	64	Number of Holes	40.00	2560.0
Flange	12.5 mm thick flange x 50 mm projection	64	Number of Flanges	1.00	64.0
Weld	12.5 mm x 1115 mm long	64	Length of Weld - Meters	1.11	71.0
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	64	Number of Bolts	3.00	192.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	64	Number of Plates	1.00	64.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	64	Length - Meters	0.30	19.2
Flange	12.5 mm thick flange x 100 mm projection	64	Number of Flanges	1.00	64.0
Weld	12.5 mm x1420 mm long	64	Length of Weld - Meters	1.42	90.9
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	16	Length - Meters	2.00	32.0
Weld to Square Collar	6 mm x500 mm long	32	Length - Meters	0.50	16.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	16	Length - Meters	2.00	32.0
Weld to Square Collar	6 mm x500 mm long	32	Length - Meters	0.50	16.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 13)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	32	Length - Meters	15.00	480.0
Beam (5 Per Bay)	W200x19	80	Length - Meters	3.25	260.0
Diagonal (4 Per Bay)	L130x130x9	64	Length - Meters	4.78	305.9
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		8741.2
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	16	Square meters	26.67	426.7
Guardrail	Painted steel - 2 rail with kickplate	16	Length - Meters	33.20	531.2
Steel Channels	C200x 75	16	Length - Meters	49.25	788.0
Support Columns	L75X75x6	16	Length - Meters	12.00	192.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		2231.2
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	16	10% Total Pipe Weight - kg	500.00	8000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	2	Length - Meters	5.50	11.0
Division 9					
Painting					
Jacking Frame	Epoxy Paint	16	Square meters	9.00	144.0
Framing for Walkway and Platform	Epoxy Paint	16	Square meters	130.00	2080.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	32	Square meters	28.20	902.4
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	1016	Square meters	18.80	19100.8
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	13.19	105.5

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 13)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 13					
Length Increase of Header	**Addition of 16 Bays @ 15 Meters Per Bay = 240 Meters**				
Vertical Pile Raise	**254 Piles Raised Up by Welding New Pipes to End of Constructed Piles (4 Pile Raises of 10 Meters Each)**				
	(1016 New Piles x 10 Meters Long)				
	8 Piles x 7 Meters Makeup Piles Added				
Platforms	**2 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	1016	Length - Meters	10.00	10160.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	1016	Number of Holes	133.00	135128.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	1016	Length of Weld - Meters	0.79	797.6
Makeup Piles					
Pipe	250x12.7 Pipe	8	Length - Meters	7.00	56.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	8	Number of Holes	92.00	736.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	8	Length of Weld - Meters	0.79	6.3
Length Increase in Header					
Pipe Piles (32 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	32	Length - Meters	15.00	480.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	32	Number of Holes	133.00	4256.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	32	Length - Meters	5.00	160.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 64 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	64	Number of Pins	1.00	64.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	64	Length - Meters	0.45	28.8
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	64	Number of Holes	40.00	2560.0
Flange	12.5 mm thick flange x 50 mm projection	64	Number of Flanges	1.00	64.0
Weld	12.5 mm x 960 mm long	64	Length of Weld - Meters	0.96	61.4
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	64	Number of Bolts	3.00	192.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	64	Number of Plates	1.00	64.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	64	Length - Meters	0.30	19.2
Flange	12.5 mm thick flange x 100 mm projection	64	Number of Flanges	1.00	64.0
Weld	12.5 mm x1200 mm long	64	Length of Weld - Meters	1.20	76.8
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	16	Length - Meters	2.00	32.0
Weld to Square Collar	6 mm x500 mm long	32	Length - Meters	0.50	16.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	16	Length - Meters	2.00	32.0
Weld to Square Collar	6 mm x500 mm long	32	Length - Meters	0.50	16.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	16	Number of Pads	1.00	16.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	16	10% Total Pipe Weight - kg	500.00	8000.0
Platform for Valves (2 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	2	Square meters	1.44	2.9
Guardrail	Painted steel - 2 rail with kickplate	2	Length - Meters	4.00	8.0
Steel Framing	L75X75x6	2	Length - Meters	9.00	18.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	2	Length - Meters	5.50	11.0
Division 9					
Painting					
Jacking Frames	Epoxy Paint	16	Square meters	8.50	136.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	32	Square meters	23.60	755.2
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	1016	Square meters	15.70	15951.2
Makeup Piles	Epoxy Paint (inside and outside of pile)	8	Square meters	10.99	87.9

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 20)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 20					
Length Increase of Header	**Addition of 20 Bays @ 15 Meters Per Bay = 300 Meters**				
Vertical Pile Raise	**286 Piles Raised Up by Welding New Pipes to End of Constructed Piles (4 Pile Raises of 10 Meters Each)**				
	(1144 New Piles x 10 Meters Long)				
	32 Piles x 3 Meters Makeup Piles Added				
Access to Grade	**3 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	1144	Length - Meters	10.00	11440.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	1144	Number of Holes	133.00	152152.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	1144	Length of Weld - Meters	0.94	1075.4
Makeup Piles					
Pipe	300x12.7 Pipe	32	Length - Meters	3.00	96.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	32	Number of Holes	39.00	1248.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	32	Length of Weld - Meters	0.94	30.1
Length Increase in Header					
Pipe Piles (40 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	40	Length - Meters	15.00	600.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	40	Number of Holes	133.00	5320.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	40	Length - Meters	5.00	200.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 80 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	80	Number of Pins	1.00	80.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	80	Length - Meters	0.45	36.0
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	80	Number of Holes	40.00	3200.0
Flange	12.5 mm thick flange x 50 mm projection	80	Number of Flanges	1.00	80.0
Weld	12.5 mm x 1115 mm long	80	Length of Weld - Meters	1.11	88.8
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	80	Number of Bolts	3.00	240.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	64	Number of Plates	1.00	64.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	80	Length - Meters	0.30	24.0
Flange	12.5 mm thick flange x 100 mm projection	80	Number of Flanges	1.00	80.0
Weld	12.5 mm x1420 mm long	80	Length of Weld - Meters	1.42	113.6
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	20	Length - Meters	2.00	40.0
Weld to Square Collar	6 mm x500 mm long	40	Length - Meters	0.50	20.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	20	Length - Meters	2.00	40.0
Weld to Square Collar	6 mm x500 mm long	40	Length - Meters	0.50	20.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 20)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	40	Length - Meters	15.00	600.0
Beam (5 Per Bay)	W200x19	100	Length - Meters	3.25	325.0
Diagonal (4 Per Bay)	L130x130x9	80	Length - Meters	4.78	382.4
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		10926.5
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	20	Square meters	26.67	533.4
Guardrail	Painted steel - 2 rail with kickplate	20	Length - Meters	33.20	664.0
Steel Channels	C200x 75	20	Length - Meters	49.25	985.0
Support Columns	L75X75x6	20	Length - Meters	12.00	240.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		2789.0
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	20	10% Total Pipe Weight - kg	500.00	10000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	3	Length - Meters	5.50	16.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	20	Square meters	9.00	180.0
Framing for Walkway and Platform	Epoxy Paint	20	Square meters	130.00	2600.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	40	Square meters	28.20	1128.0
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	1144	Square meters	18.80	21507.2
Makeup Piles	Epoxy Paint (inside and outside of pile)	32	Square meters	5.65	180.8

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 20)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 20					
Length Increase of Header	**Addition of 20 Bays @ 15 Meters Per Bay = 300 Meters**				
Vertical Pile Raise	**286 Piles Raised Up by Welding New Pipes to End of Constructed Piles (4 Pile Raises of 10 Meters Each)**				
	(1144 New Piles x 10 Meters Long)				
	32 Piles x 3 Meters Makeup Piles Added				
Platforms	**3 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	1144	Length - Meters	10.00	11440.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	1144	Number of Holes	133.00	152152.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	1144	Length of Weld - Meters	0.79	898.0
Makeup Piles					
Pipe	250x12.7 Pipe	32	Length - Meters	3.00	96.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	32	Number of Holes	39.00	1248.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	32	Length of Weld - Meters	0.79	25.3
Length Increase in Header					
Pipe Piles (40 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	40	Length - Meters	15.00	600.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	40	Number of Holes	133.00	5320.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	40	Length - Meters	5.00	200.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 80 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	80	Number of Pins	1.00	80.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	80	Length - Meters	0.45	36.0
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	80	Number of Holes	40.00	3200.0
Flange	12.5 mm thick flange x 50 mm projection	80	Number of Flanges	1.00	80.0
Weld	12.5 mm x 960 mm long	80	Length of Weld - Meters	0.96	76.8
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	80	Number of Bolts	3.00	240.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	80	Number of Plates	1.00	80.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	80	Length - Meters	0.30	24.0
Flange	12.5 mm thick flange x 100 mm projection	80	Number of Flanges	1.00	80.0
Weld	12.5 mm x1200 mm long	80	Length of Weld - Meters	1.20	96.0
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	20	Length - Meters	2.00	40.0
Weld to Square Collar	6 mm x500 mm long	40	Length - Meters	0.50	20.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	20	Length - Meters	2.00	40.0
Weld to Square Collar	6 mm x500 mm long	40	Length - Meters	0.50	20.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	20	Number of Pads	1.00	20.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	20	10% Total Pipe Weight - kg	500.00	10000.0
Platform for Valves (2 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	3	Square meters	1.44	4.3
Guardrail	Painted steel - 2 rail with kickplate	3	Length - Meters	4.00	12.0
Steel Framing	L75X75x6	3	Length - Meters	9.00	27.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	3	Length - Meters	5.50	16.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	20	Square meters	8.50	170.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	40	Square meters	23.60	944.0
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	1144	Square meters	15.70	17960.8
Makeup Piles	Epoxy Paint (inside and outside of pile)	32	Square meters	4.71	150.7

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 22)
(Sheet 1 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 23					
Length Increase of Header	**Addition of 8 Bays @ 15 Meters Per Bay = 120 Meters**				
Vertical Pile Raise	**326 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raises of 11 Meters)**				
	(326 New Piles x 11 Meters Long)				
Access to Grade	**1 Ladders**				
Division 5					
Vertical Pile Raises					
Pipe	300x12.7 Pipe	326	Length - Meters	11.00	3586.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	326	Number of Holes	144.00	46944.0
Weld	Full Penetration Groove Weld All Arnd Circumference of Pipe	326	Length of Weld - Meters	0.94	306.4
Length Increase in Header					
Pipe Piles (16 Piles Per Jacking Structure)					
Pipe - Material Cost	300x12.7 Pipe	16	Length - Meters	15.00	240.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side	16	Number of Holes	133.00	2128.0
Pipe - Installation Cost	Install 300mm Pipe By Driving It 5 Meters Below Grade	16	Length - Meters	5.00	80.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 32 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	32	Number of Pins	1.00	32.0
Circular Collar					
Round Hollow Steel Section (HSS)	HS355x9.5 x 450 mm long	32	Length - Meters	0.45	14.4
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	32	Number of Holes	40.00	1280.0
Flange	12.5 mm thick flange x 50 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x 1115 mm long	32	Length of Weld - Meters	1.11	35.5
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	32	Number of Bolts	3.00	96.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	32	Number of Plates	1.00	32.0
Square Collar					
Square Hollow Steel Section (HSS)	HS355x355x9.5 - 300mm Long	32	Length - Meters	0.30	9.6
Flange	12.5 mm thick flange x 100 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x1420 mm long	32	Length of Weld - Meters	1.42	45.4
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				

Casino Project
Sand Tailings Jacking Structure
Material Take Off - MTO (Year 22)
(Sheet 2 of 2)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Division 5 Cont'd					
Platform Framing (Sheet 2)					
Girder (2 Per Bay)	W610x101	16	Length - Meters	15.00	240.0
Beam (5 Per Bay)	W200x19	40	Length - Meters	3.25	130.0
Diagonal (4 Per Bay)	L130x130x9	32	Length - Meters	4.78	153.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		4370.6
Walkway Platform (Sheet 3)					
Grip Strut Grating	2" plank grip strut grating	8	Square meters	26.67	213.4
Guardrail	Painted steel - 2 rail with kickplate	8	Length - Meters	33.20	265.6
Steel Channels	C200x 75	8	Length - Meters	49.25	394.0
Support Columns	L75X75x6	8	Length - Meters	12.00	96.0
Steel Connections	Add 15% to Member Weights For Connections		15% Total Weight - kg		1115.6
Misc					
Pipe Supports for Piping - Angles/Saddles	Add 10% of Pipe Weight for Supports	8	10% Total Pipe Weight - kg	500.00	4000.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frame	Epoxy Paint	8	Square meters	9.00	72.0
Framing for Walkway and Platform	Epoxy Paint	8	Square meters	130.00	1040.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	28.20	451.2
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	326	Square meters	20.72	6754.7

Casino Project
Fines Tailings Jacking Structure
Material Take Off - MTO (Year 22)

Item	Description	Number of Items	Unit Measure	Unit Measure Per Item	Total
Modification Summary for Year 23					
Length Increase of Header	**Addition of 8 Bays @ 15 Meters Per Bay = 120 Meters**				
Vertical Pile Raise	**326 Piles Raised Up by Welding New Pipes to End of Constructed Piles (1 Pile Raises of 11 Meters)**				
	(326 New Piles x 11 Meters Long)				
Platforms	**1 Valve Platforms**				
Division 5 - Metals					
Vertical Pile Raises					
Pipe	250x12.7 Pipe	326	Length - Meters	11.00	3586.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	326	Number of Holes	144.00	46944.0
Weld	Full Penetration Groove Weld All Around Circumference of Pipe	326	Length of Weld - Meters	0.79	255.9
Length Increase in Header					
Pipe Piles (16 Piles Per Jacking Structure)					
Pipe - Material Cost	250x12.7 Pipe	16	Length - Meters	15.00	240.0
Holes in Pipe Piles Used for Raises	22 mm Diameter Holes Each Side @150 mm on center	16	Number of Holes	133.00	2128.0
Pipe - Installation Cost	Install 250mm Pipe By Driving It 5 Meters Below Grade	16	Length - Meters	5.00	80.0
	(Pipe 5 Meters Below Grade, 10 Meters Above Grade)				
Jacking Frame (Sheet 1) 32 Collars Per Header					
Drift Pins	19 mm Headed Pin x 400 mm Long	32	Number of Pins	1.00	32.0
Circular Collar					
Pipe	300x9.3 Pipe x 450 mm long	32	Length - Meters	0.45	14.4
Patterned Holes	22 mm Diameter Hole in Spiral Pattern	32	Number of Holes	40.00	1280.0
Flange	12.5 mm thick flange x 50 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x 960 mm long	32	Length of Weld - Meters	0.96	30.7
	(1/2" weld around perimeter of pile)				
Keeper					
3 Keeper Bolts	12.5mm Dia Bolt X 75 mm Long With Nut & 2 Washers	32	Number of Bolts	3.00	96.0
Keeper Ring Plate	6mm thick plate x 100mm wide Ring Plate	32	Number of Plates	1.00	32.0
Square Collar					
Square Hollow Steel Section (HSS)	HS305x305x9.5 - 300mm Long	32	Length - Meters	0.30	9.6
Flange	12.5 mm thick flange x 100 mm projection	32	Number of Flanges	1.00	32.0
Weld	12.5 mm x1200 mm long	32	Length of Weld - Meters	1.20	38.4
	(1/2" weld around perimeter of collar)				
Upper Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Lower Jacking Beam	W250x67	8	Length - Meters	2.00	16.0
Weld to Square Collar	6 mm x500 mm long	16	Length - Meters	0.50	8.0
	(1/4" weld around perimeter of beam web)				
Misc					
Sliding Bearing Pad - 150 mmx 150 mm	Pad has Teflon Sheet, Neoprene and 2 Stl Plates	8	Number of Pads	1.00	8.0
Pipe Supports for Pipe	Add 10% of Pipe Weight for Supports	8	10% Total Pipe Weight - kg	500.00	4000.0
Platform for Valves (4 Total per Header)					
Grip Strut Grating	2" plank grip strut grating	1	Square meters	1.44	1.4
Guardrail	Painted steel - 2 rail with kickplate	1	Length - Meters	4.00	4.0
Steel Framing	L75X75x6	1	Length - Meters	9.00	9.0
Ladders at Platforms	Ladder with Folding or Sliding Bottom	1	Length - Meters	5.50	5.5
Division 9					
Painting					
Jacking Frames	Epoxy Paint	8	Square meters	8.50	68.0
Pipe Piles	Epoxy Paint (inside and outside of pile)	16	Square meters	23.60	377.6
Pipe Pile Raises	Epoxy Paint (inside and outside of pile)	326	Square meters	17.27	5630.0

Steel Section Table

Steel Section	Metric Designation	Imperial Designation	Notes
Wide Flange	W200x19	W8x13	
	W250x67	W10x45	
	W610x101	W24x68	
Channel	C200x75	C8x11.5	
Angle	L75x75x6	L3x3x1/4	
	L130x130x9	L5x5x5/16	
Pipe	250x12.7	10" x strong	
	300x9.3	12" std	
	300x12.7	12" x strong	
	360x9.3	14" std	
HSS -Square	HS305x305x9.5	HSS12x12x0.375	CSA G40.2/21
	HS355x355x9.5	HSS14x14x0.375	
HSS - Round	HS355x9.5	14.0 Round HSS x 0.25	
Bolts	12.5 mm	1/2"	
	19 mm	3/4"	
	22 mm	7/8"	
	25 mm	1"	

HSS - Hollow Structural Section

Wide flange, channel shapes and other rolled members shall meet ASTM A992. These members shall have a minimum yield strength, Fy = 50 ksi (350 MPa).

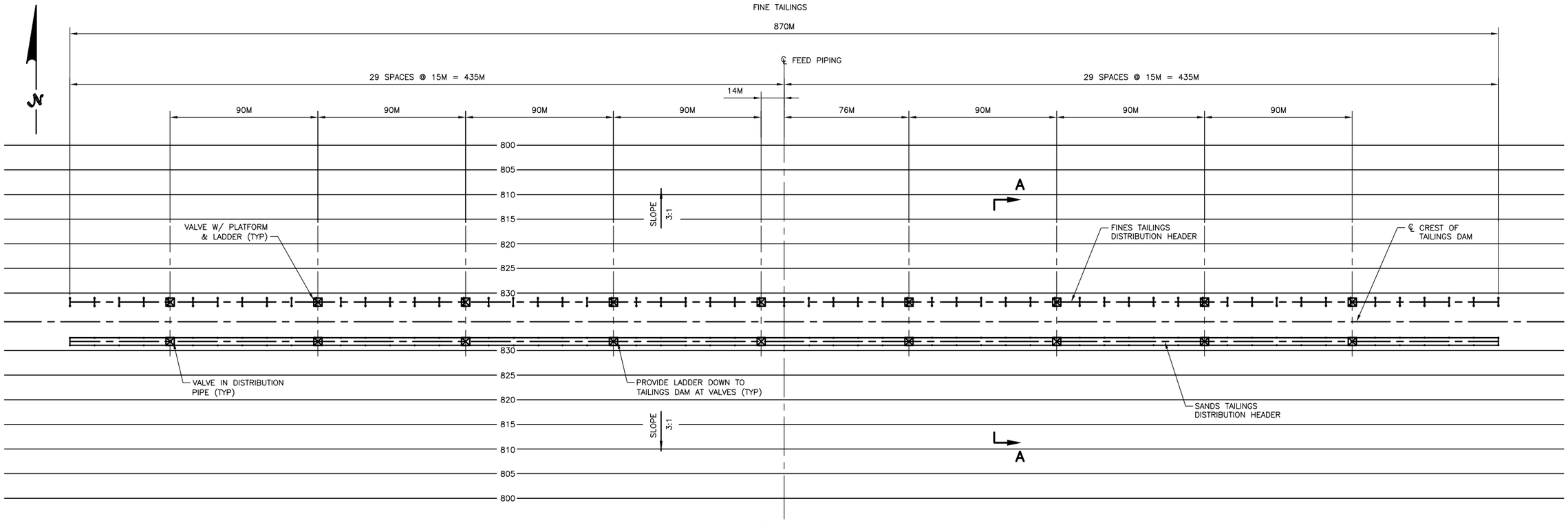
Angles and plate members shall meet ASTM A 36. These members shall have a minimum yield strength, Fy = 36 ksi (250 MPa).

Hollow Steel Sections shall meet the ASTM A500, grade B. These members shall have a minimum yield strength, Fy = 42 ksi (290 MPa).

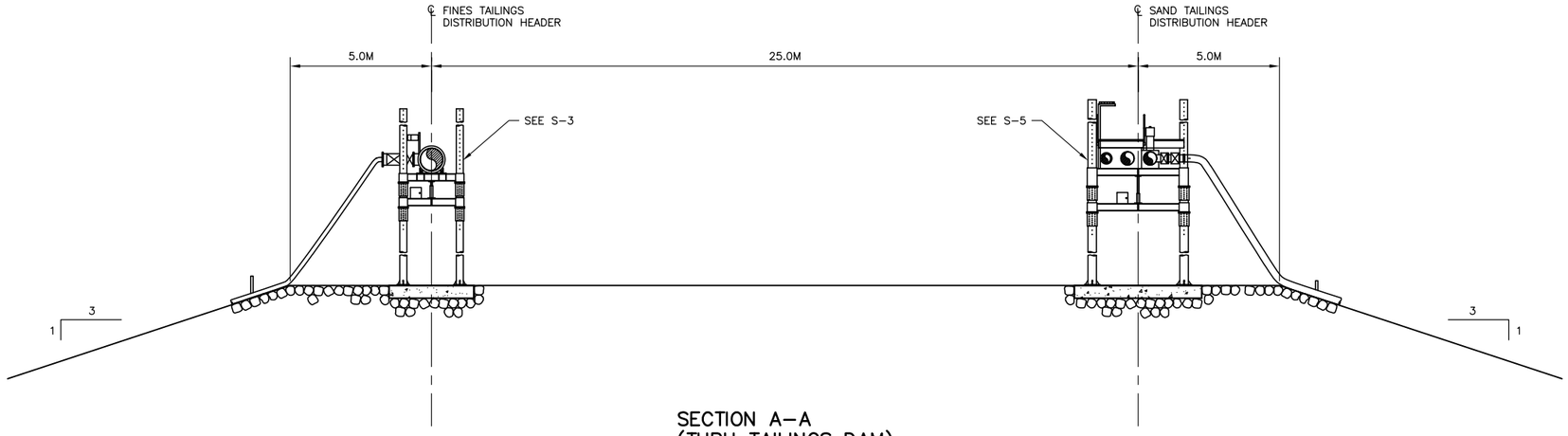
Pipe Sections shall have a minimum yield strength, Fy = 35 ksi (240 Mpa)

The steel shall meet the supplemental requirements of a Charpy V-Notch Impact Test.
The minimum energy used in the Impact test shall be 25 ft lb @ 10 degrees F or 34 joules @ -12degrees C.

DRAWINGS



SAND TAILINGS PLAN
SCALE: 1:1250



SECTION A–A (THRU TAILINGS DAM)
SCALE: 1:100

0 50M 100M

SCALES ARE FULL SIZE, SCALE ACCORDINGLY

0 1M 2M 3M 4M 5M

SCALES ARE FULL SIZE, SCALE ACCORDINGLY

FEASIBILTY STUDY
NOT FOR CONSTRUCTION

REVISIONS			
REV.	DATE	DESCRIPTION	APPRVD BY

CONSULTANTS:

PATERSON & COOKE
221 Corporate Circle, Suite D
Golden, CO 80401-5637
ph 303.800-6280
www.PatersonCooke.com

SM&RC Structural Engineers Inc.
215 S. Wadsworth Blvd.,
Suite 320 ph 303.274.8656
Lakewood, CO 80226 fx 303.274.3777
www.smrcstructures.com

CLIENT:

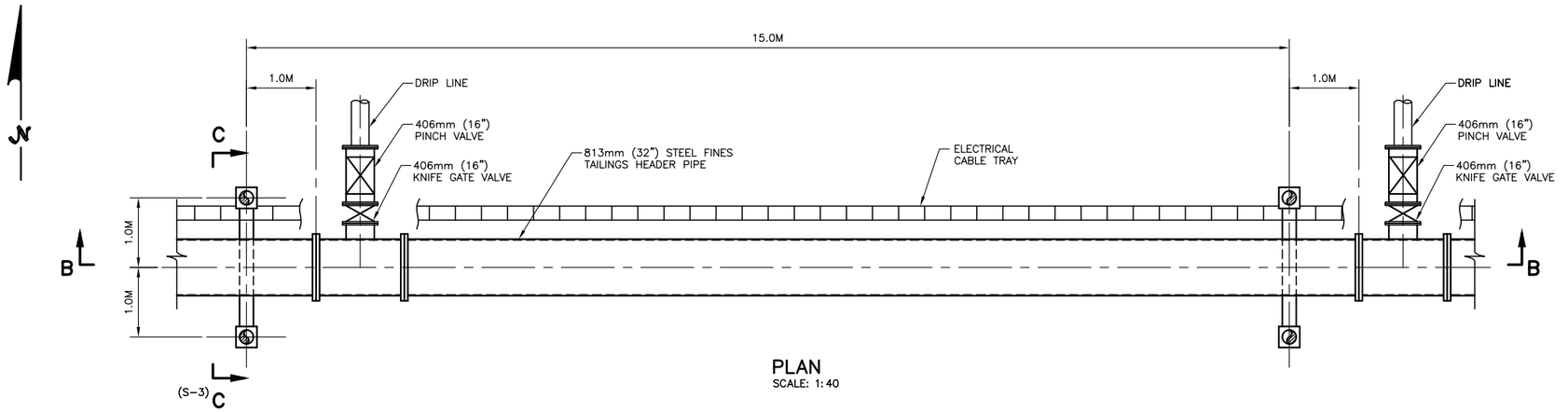
CASINO PROJECT

CASINO JACKING HEADER FEASIBILTY STUDY

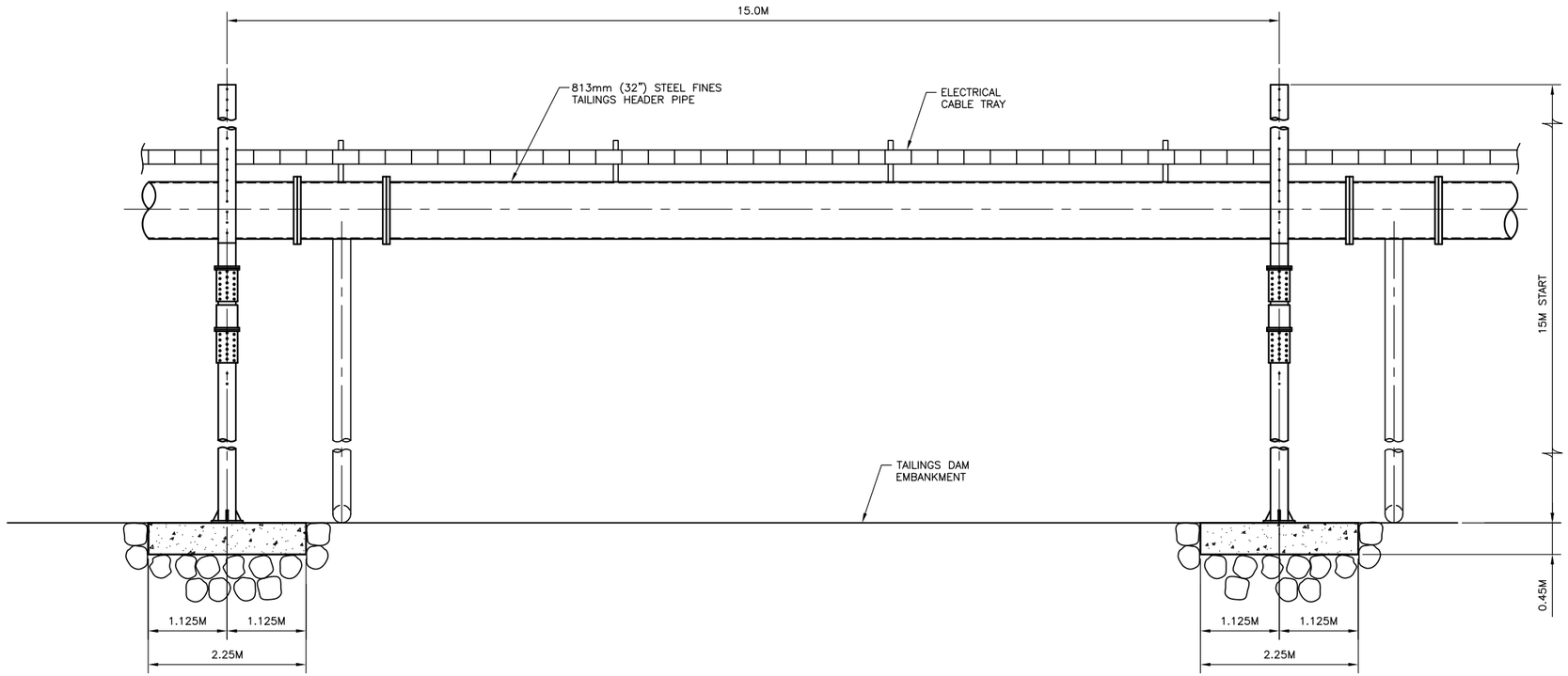
TAILINGS STRUCTURES
GENERAL ARRANGEMENT

SMRC PROJECT NO.	DRAWING NO.
PC-2012-01	S-1
DESIGN BY: JI	
DRAWN BY: RC	
CHECKED BY:	SHEET: 1 OF 5

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PLAN
SCALE: 1:40



SECTION B–B
SCALE: 1:40

0 1M 2M

SCALES ARE FULL SIZE,
SCALE ACCORDINGLY

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221 Corporate Circle, Suite D
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SMRC Structural Engineers Inc.
215 S. Wadsworth Blvd.,
Suite 320 ph 303.274.8656
Lakewood, CO 80226 fax 303.953.3777
www.smrcstructures.com

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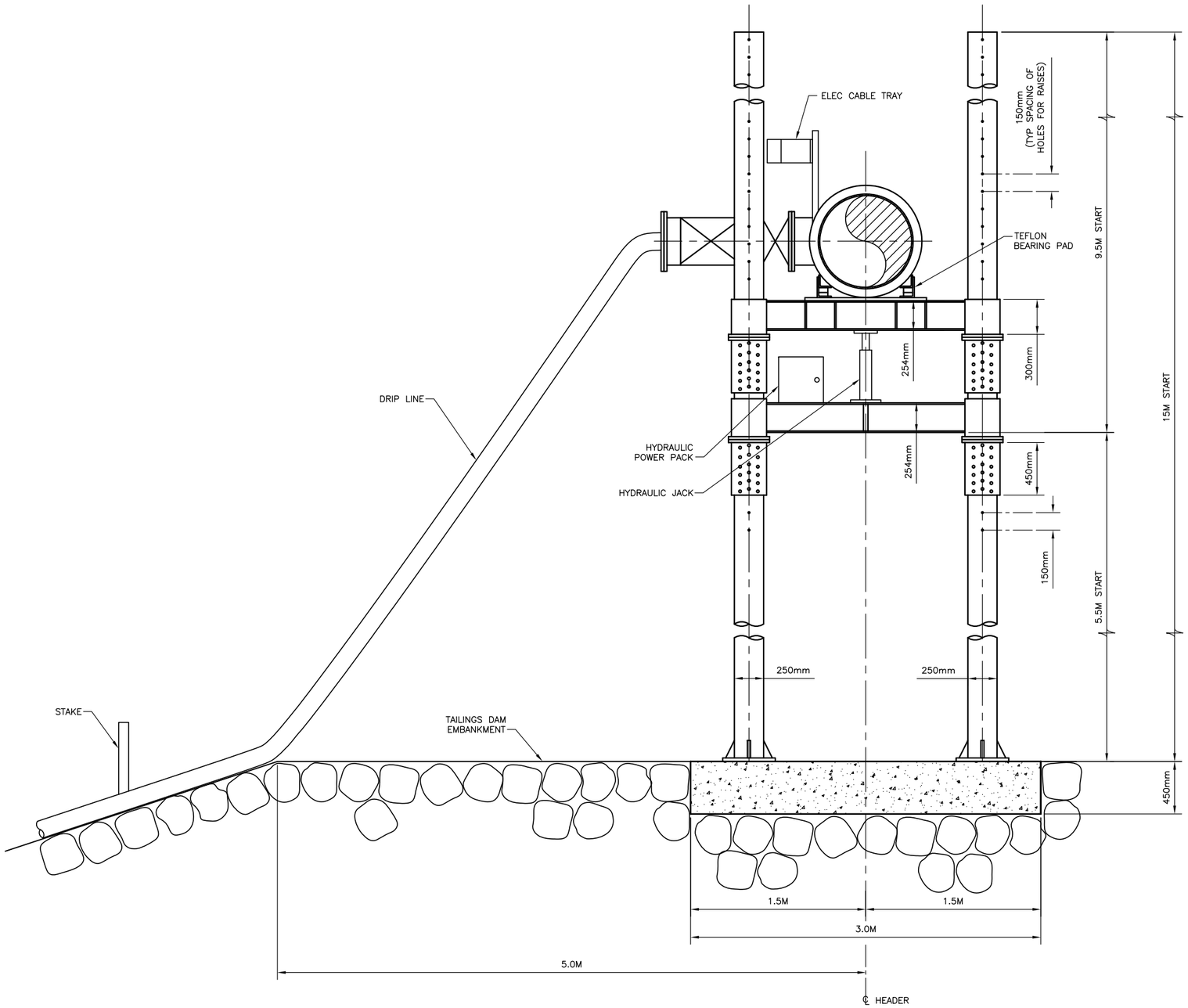
CASINO PROJECT

CASINO JACKING HEADER FEASIBILTY STUDY

FINES TAILINGS DISTRIBUTION HEADER
PLAN AND SECTION

SMRC PROJECT NO.	DRAWING NO.
PC-2012-01	S-2
DESIGN BY: JI	
DRAWN BY: RC	
CHECKED BY:	SHEET: 2 of 5

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SECTION C–C (S–2)
SCALE: 1:20

0 1M 2M

SCALES ARE FULL SIZE,
SCALE ACCORDINGLY

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CLIENT:

CASINO PROJECT

CASINO JACKING HEADER FEASIBILTY STUDY

FINES TAILINGS DISTRIBUTION HEADER SECTION

SMRC PROJECT NO.	PC-2012-01
DESIGN BY:	JI
DRAWN BY:	RC
CHECKED BY:	
DRAWING NO.	S-3
SHEET:	3 of 5

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EXHIBIT 2 page 42 of 193