Appendix 13.7-D Best Management Practices (BMPs) for Treatment (Bioremediation) of Small Volumes of Hydrocarbon Contaminated Material

TELKWA COAL
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Hydrocarbon Contaminated Soil Treatment Facility Management Plan

Tenas Project, British Columbia, Canada

Telkwa Coal

SRK Consulting (Canada) Inc. ▪ 1CT027.006 ▪ March 2021

FINAL

Hydrocarbon Contaminated Soil Treatment Facility Management Plan

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Useful Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

ENV	Ministry of Environment and Climate Change Strategy
EMLI	Ministry of Energy, Mines, and Low Carbon Innovation
HEPHs	Heavy Extractable Petroleum Hydrocarbons
LEHPs	Light Extractable Petroleum Hydrocarbons
PAH	Polycyclic Aromatic Hydrocarbons
PHC	Petroleum Hydrocarbon
STF	Soil Treatment Facility

1 Introduction

1.1 Overview

This Soil Treatment Facility (STF) Management Plan (the Plan) provides information on how petroleum hydrocarbon (PHC) contaminated soil will be handled in a safe and environmentally sound manner at the Tenas Project, British Columbia (the Site). The purpose of this Plan is to provide a consolidated summary on the operations and closure of the soil treatment facility to be used to treat PHC contaminated soil generated by ongoing operators.

The objectives of this Plan are to:

- Ensure employees and contractors are aware of their responsibilities regarding operations and maintenance of the soil treatment facility;
- Outline appropriate operation and maintenance requirements of the facility from initiation to closure; and
- Support safe and compliant waste facility operations and maintenance.

Details of the STF design are provided in SRK design memorandum (SRK 2021).

1.2 Roles and Responsibility

Telkwa Coal Ltd. is responsible for activities associated with Tenas Project, including implementation and management of this Plan.

The Project's Mine Superintendent will be responsible for the execution of this plan, their responsibilities include:

- Maintain records regarding inspections, personnel training, equipment testing and maintenance
- Provide assistance in responding to environmental hazards
- Oversee or delegate supervision to oversee soil handling, transport, sampling, and management in accordance with this Plan
- Coordination with other managers and supervisors to ensure safe and appropriate allocation of resources on site

2 Soil Treatment Facility Operating Procedures

2.1 Baseline Sampling

Prior to construction of the STF, soil samples must be taken from the foundation to establish baseline soil conditions. A minimum of 5 samples must be taken in a grid pattern across the facility footprint by a Qualified Professional and analyzed for PHC fractions F1 to F4, benzene, ethylbenzene, toluene, xylenes (BETX), styrene and polycyclic aromatic hydrocarbons (PAH). Samples will then be taken post closure to assess and confirm contaminants have not leached from the soil storage cells during operations.

Prior to commencing operation of the STF, groundwater samples from the STF groundwater monitoring wells are to be collected and tested for BETX, styrene, F1, F2, PAH, dissolved metals, pH, alkalinity, chloride, sulphate, turbidity, conductivity, total suspended solids, ammonia, nitrite and nitrate. Groundwater monitoring well locations are presented in Section 3.

2.2 Material Selection and Soil Sampling

The facility operators must sample and characterize materials prior to treatment within the STF. Material characterization aids in optimizing treatment prescriptions and confirms that materials are not considered hazardous waste. Soil characterized as hazardous waste and/or which contains untreatable contaminants (e.g. metals, glycols, etc.) must not be treated within the STF. Ideally, potentially contaminated materials are sampled and characterized in their original location prior to being transported to the STF. In situations where material sampling and characterization prior to transport to the STF is not possible or feasible, these materials should be placed, flagged and labeled in an isolated portion of the STF, and subsequently sampled and characterized. Once samples confirm treatment acceptability criteria have been met, the materials could then undergo prescribed treatments (e.g., spread, and augmented).

During the treatment process, soils should be sampled quarterly, where possible. Sampling at this frequency is useful to inform the adjustment of cell conditions to promote maximum biological activity. Soil samples should be analyzed for appropriate indicator parameters including, but not limited to pH, temperature, moisture, microbial counts, contaminant concentrations, and nutrient levels (BCME 2013).

Material being place, remediated and removed from the facility will be sampled at a frequency of 1 discrete sample per 50 m^3 of soil per sampling collection.

2.3 Material Placement

The facility comprises of a lined cell 1 (35 m x 30 m). An indicator layer will be placed above the liner cover material to assist in preventing the operators from damaging the liner when the soil is being off loaded; efforts should be made to minimize damage to the indicator layer. As outlined in the design memorandum, the indicator layer can be a variety of available non-hazardous materials, such as a layer of recycled woodchips, geotextile, straw, gravel, etc. The PHC contaminated soil will be placed in the cells an average of 0.3 m thick for treatment above the indicator layer.

When transferring soil from a dump truck to a soil treatment facility, excess liquid within the soil should be collected, as far as reasonably possible, and disposed of to minimize leachate generation (BCME 2013).

In the event where the material volumes exceed the estimated quantity and additional storage is required, the material will be stockpiled to a maximum height of 3 m. Nutrients may be added to the stockpile and actively aerated of the material will be required. Material piles must be reduced to 0.3 m as soon as possible.

Subject to Protocol 3, “Blending, Mixing or Dilution as a Remediation Approach” (BCME 1999), a soil treatment facility may be used to treat soil with different origins and different compositions or contaminant concentrations. These soils must be kept and treated in separate stockpiles within the soil treatment facility. Each treatment stockpile must be managed to provide the most efficient and environmentally sound remediation for the type of contaminant being treated. (BCME 2013).

2.4 Aeration

In the event of excess PHC contaminated material generation, stockpiles exceed 0.3 m, aeration will be required to maintain continued soil remediation.

Gas transfer in the contaminated soil is important for two reasons: (a) the bioremediation process requires oxygen to occur and (b) gas transfer promotes volatilization of the PHC from the soil. To achieve the gas transfer, the contaminated soil is turned and aerated weekly during the field season, as equipment availability and weather conditions allow. Under the same climatic conditions, a wet soil will volatilize less mass of hydrocarbons than a dryer soil and therefore soil aeration is primarily performed on fair days (days with sun) under dry conditions.

Aeration can be conducted using a backhoe or more specialised equipment such as an aerating scalper bucket attachment on an excavator. The frequency of aeration is based on the treatment performance, it can range from once a week to once every few weeks during the summer months.

2.5 Management of Moisture Content

Water is required for microbial respiration and therefore PHC remediation. Hydrocarbon-degrading microbes (hydrocarbonoclastes) need to come into contact with solubilized nutrients in order for PHC bioremediation to occur; this contact is largely governed by the soil moisture content. According to the Technical Guidance 14 for Contaminated Sites: Operation of Soil Treatment Facilities for Bioremediation of Hydrocarbon Contaminated Soil the moisture content should range between 10 % to 30 % by weight for optimal remediation.

Water that collects in the STF sump can be applied to the treatment area to increase moisture content. Should additional water be required to increase and maintain the soil moisture content, water is to be withdrawn in accordance with the limits of the water licence (refer to the Tenas Project – Water Management Plan for further details).

Should the moisture content exceed 30%, the following activities may be done to reduce the moisture content:

- Ensure water level within facility is below the material being treated
- Conduct additional aeration
- Cover the soils during high rainfall periods

2.6 Amendments

The nutrients needed for accelerating bioremediation are added to the soil based on the level of total PHC concentration for the microbial cells to replicate and survive. In cold region soils, nitrogen and phosphorus are the nutrients that typically limit microbial activity. Nitrogen and phosphorus are to be added to the constructed biopiles in the form of granular agricultural fertilizers urea and diammonium phosphate. The amount of urea and diammonium phosphate applied is based on the volume of soil being treated and the concentrations of PHC. While the cells are loaded samples are to be collected and tested to enable a Qualified Professional to recommend the dosage ratio. The optimal range of carbon: nitrogen: phosphorus (C:N:P) is 100:10:1 (BCME 2013).

Technical Guidance 14 on Contaminated Sites also recommends pH levels ranging from 6 to 8, these levels can be raised by adding lime or lowered by adding elemental sulphur (BCME 2013).

Monitoring of the microbial population may be conducted if remediation progress is suspected to be inhibited. Microbial amendments are not expected to be required. Commercial inoculates are available in Canada, however, cold-adapted microorganisms are not (PWGSC 2013). Any microbial amendments considered may be subject to the New Substances Notification (NSN) Regulations, pursuant to the Canadian Environmental Protection Act. (CEPA 1999).

2.7 Remediation Performance Monitoring

Performance monitoring is conducted biweekly throughout the field season, May to October, using a portable gas detector and soil moisture meter when the site is active, otherwise during periods of inactivity during every site inspection. Laboratory results are to be obtained for PHCs at the start of each field season, mid-way through the season and then again at the end of the season or annually when the site is inactive.

2.8 Remediation Confirmatory Sampling

To confirm the performance of the bioremediation progress, representative soil samples are collected from the biopiles before the soil is classified as meeting the soil quality remediation objectives and removed from the area where it is being treated.

Soil quality remediation objectives for the treatment in the STF are listed in Table 1. As remediated soil is intended to be used for overburden covers over the waste dumps and covered by topsoil, the objectives are based on a reverted wildlands end land use as outlined in the Environmental Management Act Contaminated Site Regulation, Schedule 3.1 – Part 2.

Table 1: Hydrocarbon Soil Remediation Objectives

Substance	Wildlands Reverted Numerical Soil Standard (µg/kg)
HEPHs[1]	1,000[2]
LEPHs[1]	1,000[2]
VPHs[1]	200[2]

1. HEPHs - Heavy Extractable Petroleum Hydrocarbons in soil, as defined in 2015 British Columbia Environmental Laboratory Manual, as updated from time to time.

   LEPHs - Light Extractable Petroleum Hydrocarbons in soil, as defined in 2015 British Columbia Environmental Laboratory Manual, as updated from time to time.

   VPHs – Volatile Petroleum Hydrocarbons in soil, as defined in 2015 British Columbia Environmental Laboratory Manual, as updated from time to time.

2. Schedule 3.1 – Part 2 of BC Contaminated Sites Regulation (BCEA 2019) for protection of ecological health.

3 Water Management

3.1 Surface Water Management and Monitoring

The run-off water within the facility must be controlled to prevent migration of contaminants from leaving the facility. In order to facilitate drainage and collection of water, the base of the individual soil storage cells will be sloped at a minimum slope of 1% grade to sumps located in the corner of each cell.

Circulation of the water within the facility, and the application of additional water as required, will ensure the moisture content of the material is sufficiently high for dust control and PHC treatment. Circulation will be done manually by means of a water pump, hose and spray nozzle in the warmer months, when the freezing of waterlines is not a concern. Water is to be applied to the biopiles as described in Section 2.5.

Should water accumulation in the sumps increase to a level where it rises near the allowable freeboard of 0.5 m, the water must be sampled and analyzed for PHC constituents listed in the water licence prior to discharge. No water will be discharged to the environment from the STF until the results of the sample analysis confirm that the water is suitable for release and notifications in accordance with the water licence have been made. The results of this analysis will be retained on-site. Should the water fail to meet the discharge criteria, it can be transferred to the Plant Pond or an appropriate alternative such as a temporary PVC storage tank (size based on treatment requirements).

3.2 Groundwater Monitoring

Groundwater monitoring will entail sampling at three new monitoring wells, MW21-1 to MW21-3, as indicated in Figure 1. Groundwater samples will be taken minimum twice a year during operations, preferably at the beginning and end of the summer/“open-water” season. Additional sampling may be required based on the monitoring results and/or as specified in the water license.

All sampling data must be documented. The absence of water in a monitoring well is to be recorded if applicable.

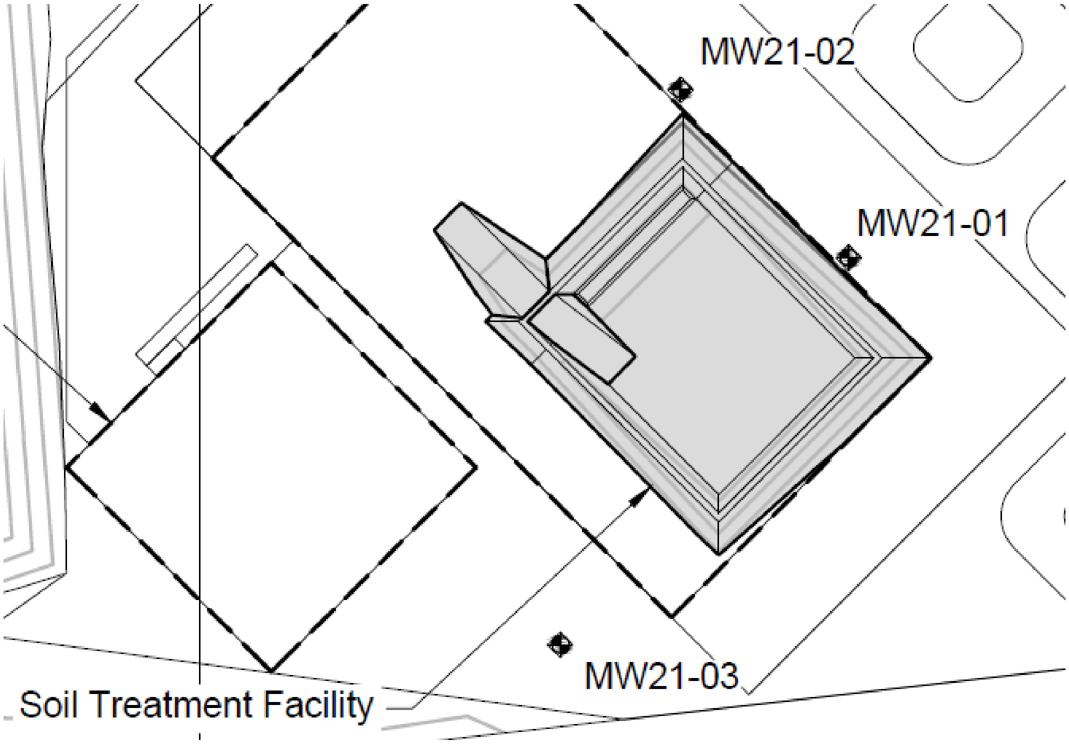

Figure 1: Groundwater Monitoring Well Locations

4 Inspections and Record Keeping

4.1 Inspections

4.1.1 Routine Visual Inspections

Weekly visual inspections are to be completed in order to prevent contaminate migration into the surrounding area. Visual inspections of the facility must include, but not limited, identifying the following:

- Erosion or sloughing of the facility berms
- Assess for evidence of deterioration, malfunction, leaks or improper operations of the surface water retention systems
- Exposed or damaged liner
- Contaminated material breaching the cells area
- Water accumulation levels
- Ensure all signage is visible
- New material has been labeled and staged in the appropriate location within the STF

All observation should be noted, and findings repaired as soon as possible to maintain the integrity of the facility.

4.1.2 Post-Precipitation Inspections

Following periods of significant rainfall additional visual inspections are to be completed to monitor water levels within the cell. The objective of the inspection will be to ensure that sufficient freeboard exists and to ensure that no hydrocarbon contaminated water exits the facility.

4.1.3 Post-Treatment Inspections

Following removal of treated soil and prior to refilling the STF with the new contaminated soil, the cover layer is to be inspected to ensure that the minimum thickness of 0.6 m is maintained above the liner and repairs made as required.

4.1.4 Engineer Inspections

Semi-annual detailed inspections are to be completed by an Engineer to inspect the STF works including the liners, berms, cover, and surface water drainage/collection system to ensure that the engineered components of the design are functioning as intended and are in good working order.

4.1.5 Seasonal Closure and Start-up Inspections

Prior to demobilization for winter and during freshet prior to resumption of operations, the condition of the ditches and berms are to be inspected and, if needed, reinforced in an effort to accommodate the spring runoff. At the end of the operational season the soil in the cells will be leveled and the sump backfilled to the height of the surrounding berm to prevent accumulation of snowmelt.

In the unlikely event of the facility overtopping or a berm failing, soil samples will be collected to determine if the contamination has spread.

4.2 Reporting

Record Keeping

Records are to be maintained of the following:

- STF inspections
- Work logs including: materials placed within the STF and treatments applied (ex. nutrient amendment, tilling, etc.).
- Sample history including: (to include the following):
  - Method of sample collection
  - Time and location of sampling
  - Name of sampler(s)
  - Chemical preservative added or other sample treatment
  - Type of sample containers used
  - Storage conditions
  - Time and condition of sample on receipt at laboratory
- Laboratory testing results

Annual Report

An annual report must be submitted to the Ministry of Environment and Climate Change Strategy (ENV) that summarizes the volume of soil treated, concentrations of VPH, LEPH and HEPH, metals, and any other site-specific potential contaminates of concern, maps of the disposal sites.

Additional submissions may be required by the Ministry of Energy, Mines, and Low Carbon Innovation (EMLI) as part of the Mines Act Permit.

5 Facility Reclamation and Closure

Decommissioning can commence once the PHC levels of all material is found to meet the acceptable levels outlined in this Management Plan. These materials can be removed and used for reclamation. The liner will be disposed in place or disposed off-site as required. All berms leveled and graded to promote positive drainage across the site. Soil samples to be taken and compared to baseline soil samples to confirm no migration of contaminants into the foundation or surrounding area.

References

British Columbia Ministry of Environment 2013 (BCME 2013). Technical Guidance 14 for Contaminated Sites: Operation of Soil Treatment Facilities for Bioremediation of Hydrocarbon Contaminated Soil. Prepared pursuant to Section 64 of the Environmental Management Act. April 2013.

British Columbia Ministry of Environment 1999 (BCME 1999). Protocol 3 for Contaminated Sites: Blending, Mixing, or Dilution as a Remediation Approach. Prepared pursuant to Section 64 of the Environmental Management Act. July 20, 1999.

British Columbia Environmental Act 2019 (BCEA 2019). Contaminated Site Regulation B.C. Reg 375/76. Last amended January 24, 2019.

Canadian Environmental Protection Act 1999 (CEPA 2019).

Public Works and Government Services Canada, 2013. Federal Guidelines for Landfarming, Petroleum Hydrocarbon Contaminated Soils. March 2006 (Editorial Update 2013).

SRK Consulting (Canada) Inc. 2021 (SRK 2021). Tenas Coal Deposit, Soil Treatment Facility Feasibility Level Design (Draft). Prepared by SRK Consulting for Telkwa Coal. February 2021.

Appendix A Tenas Coal – Soil Treatment Facility – Feasibility Design Memorandum

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Technical Memo

March 18, 2021

To	Dan Farmer, Telkwa Coal
From	Darryl Godley, SRK Consulting
Reviewed by	Peter Mikes, SRK Consulting
Subject	Tenas Coal – Soil Treatment Facility – Feasibility Design
Client	Telkwa Coal Limited
Project	1CT027.006

1 Introduction

Telkwa Coal Limited (TCL) is proposing to develop the Tenas coal deposit (the Project) in northwest British Columbia. The site is located approximately 25 km southwest of Smithers within the Telkwa River watershed and will comprise of an open pit, backfill, external stockpiles, water management ponds, control ponds, a process plant pad and rail load out pad. The Tenas Project's total mine life is 25 years including construction, operations, decommissioning, and reclamation phases.

SRK Consulting (Canada) Inc. was contracted to prepare a feasibility-level design of a petroleum hydrocarbon (PHC) contaminated soil treatment facility (STF). The design will be submitted for internal review and construction budget approvals by TCL and is anticipated to support the facility permitting process.

This technical memorandum describes the STF design and includes discussion of the design considerations and assumptions, design rationale, as well as construction and operational requirements to ensure that the facility functions as intended. This memo is intended to be read along with the appended design drawings.

2 Design Basis and Considerations

2.1 Regulatory Requirements

The STF has been designed in accordance with the BC Ministry of Environment (ENV) technical guideline, “Protocol 15 for Contaminated Sites – Soil Treatment Facility Design and Operation for Bioremediation of Hydrocarbon Contaminated Soil (ENV 2012).

The design was also prepared in consideration of the following documents:

- Technical Guidance 1 for Contaminated Sites – Contaminated Sites Site Characterization and Confirmation Testing (ENV 2009)
- Technical Guidance 14 on Contaminated Sites – Operation of Soil Treatment Facilities for the Bioremediation of Hydrocarbon Contaminated Soil (ENV 2013)

2.2 Site Location

TCL has allocated a rectangular area measuring 160 m by 75 m for the proposed STF and other potential future related soil treatment activities. The area is situated between the sewage treatment plant and the run-of-mine stockpiles. The ground surface gently slopes downward to the northeast with a typical grade of 3%.

The area is not located near any watercourse and is not considered to be prone to flooding. The depth to groundwater is unknown but is expected to be deep based on the nearest groundwater well, W3, which is located approximately 300 m northwest where groundwater is measured to be approximately 34 meters below ground surface.

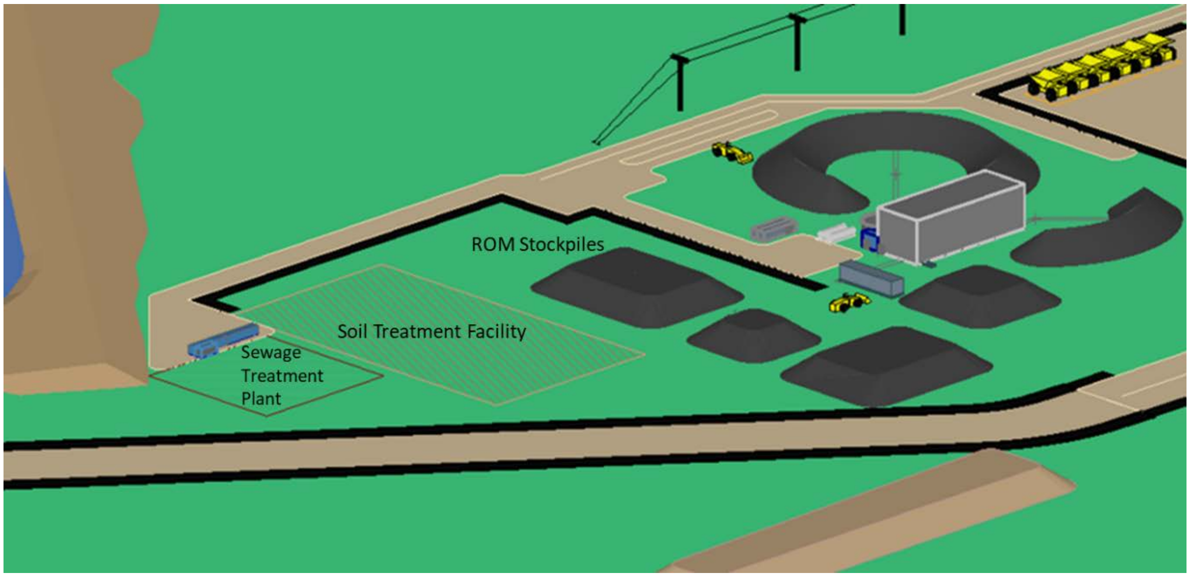

Figure 1: Site Location Overview

2.3 Base Topography

Site topography was provided by TCL that consisted of 0.5 m contour data based on 2018 LiDAR data. All coordinates are in NAD83 UTM Zone 9.

2.4 Design Containment Capacity

The STF was designed to accommodate an operational volume up to 250 m³. The design capacity was selected in consultation with TCL based on a benchmarking comparison to other mine sites in BC based on milling capacity. As a contingency, the soil treatment area has been designated for the construction of a second STF cell should it be required to be constructed.

2.5 Fill Material Sourcing

No site investigations have been completed in support of the STF design. Based on a groundwater monitoring well (W3) located approximately 300 m to the northwest and geotechnical boreholes and test pits completed in the plant area (SRK 2019), the foundation soil is expected to consist of glacial till (gravelly lean clay) that is suitable for the STF subgrade and for bulk fill. At this time, sources for liner bedding and protection layers are unknown but are assumed to be available at site. Material specifications for the bedding and protection layers will be determined in detailed design, but they are likely to consist of sandy material free of sharp gravel-sized particles that could damage the liner.

2.6 Stormwater Management

BC ENV guidance does not specify criteria for minimum storage capacity for stormwater and snowmelt. The design of the STF adopted the following criterion based on Northwest Territory guidelines (LWBMV

2020): The facility is designed to contain the 24-hour, 10-year frequency precipitation event plus the snowmelt equivalent to the average annual snow accumulation.

Mean annual precipitation for the Project was evaluated using comparisons between measured and interpolated data to generate a Project-specific record; hydrometeorological information can be found in the Tenas Coal – Hydrometeorological Baseline and Model Development Report (SRK 2020). The precipitation data tabulated below is relevant to the STF design.

Table 1: Project Precipitation Summary

Event	Depth (mm)
24 hour, 10-year return period precipitation	61
Average Annual Snow Accumulation	248

2.7 Berm Stability

The berm has a typical height of 2 m, with 2H:1V (horizontal to vertical) slopes and is to be constructed using component, locally available till material (SRK 2019). A berm stability analysis was determined not to be required because of the till competency encountered during the geotechnical investigation (SRK 2019) and because the STF is lined resulting in no significant pore water pressures in the berm. Should conditions of the fill materials be different, the berm stability should be assessed by an engineer prior to construction.

2.8 Settlement

Borehole and test pit logs, as well as Standard Penetration Testing data (SRK 2019) indicate that the glacial till in the plant area is dense, and as a result, no significant settlement is expected and a settlement analysis is not required. Any settlement would be within the tolerance limits of LLDPE liner. Should conditions be found to be significantly different during drilling in support of the monitoring well installation (Section 3.6) or construction, the engineer is to be notified and a settlement is to be assessed if required.

2.9 Design Criteria Summary

Table 2 provides a summary of the design criteria for the STF construction. The criteria listed in the table have been classified based on the following types of Design Inputs:

- Technical Criteria (C): an established norm or requirement.
- Objectives (O): a specific result to be achieved based on verifiable evidence or facts.
- Parameters (P): a defining characteristic.
- Assumptions (A): considered adequate with the appropriate level of accuracy; should be confirmed during the engineering process.

Table 2: Design Criteria

No.	Item	Value/Description	Design Input	Source	Comment
1	Design life	50 years	P	SRK	Based on an assumed mine life of 25 years, plus an additional allowance for closure.
2	Maximum land surface slope	< 9%	C	ENV (2012)	Exiting ground has a slope that is typically less than 3%.
3	Seasonal high-water table	> 1 m below ground surface	C	ENV (2012)	Depth to groundwater table at facility is unknown. Regional groundwater ~30m below ground surface.
4	Located in an area prone to flooding?	No.	C	ENV (2012)	STF is not located near any identified watercourse and is not considered prone to flooding.
5	Access to STF restricted?	Yes.	C	ENV (2012)	STF located in a secured area of the mine site adjacent to plant area with no public access.
6	Minimum slope of the base of the STF	2%	P	SRK	ENV (2012) specifies a minimum base slope of 1%.
7	Minimum bedding layer thickness	0.15 m	A	SRK	
8	Maximum base liner permeability	$1x10^{-6}$ cm/sec	C	ENV (2012)	
9	Minimum liner thickness	0.5 mm (20 mil)	C	ENV (2012)	
10	Minimum over-liner sacrificial layer	0.6 m	P	SRK	ENV (2012) specifies a minimum thickness of 0.3 m. A thicker layer has been adopted based on the adopted design life.
11	Design stormwater containment capacity	90 m3	P	SRK	Volume of the 24-hour, 10-year return period precipitation event plus the average annual snow accumulation.
12	Minimum berm freeboard over design stormwater containment capacity	0.5 m	P	SRK	ENV (2012) specifies a minimum berm height of 0.5 m.
13	Minimum berm height	1 m	P	SRK	Minimum berm height needed to contain design flood event plus 0.5 m freeboard.
14	Maximum soil height	3 m	C	ENV (2012)	
15	Maximum lift thickness	0.3 m (base of STF) 0.5 m (berms)	A	SRK	
14	Berm slope angles (XH:1V)	2.0	A	SRK	
15	Minimum Berm crest width	1 m	A	SRK	
16	Number of monitoring wells required	3	A	SRK	

No.	Item	Value/Description	Design Input	Source	Comment
17	Maximum access ramp slope (XH:1V)	5	A	SRK	i.e. slope must be 5H:1V or flatter.
18	Minimum access ramp width	6 m	A	SRK	
19	Maximum permissible vehicle ground pressure	373 kPa	A	SRK	Based on 1.5 mm thick Linear low-density polyethylene (LLDPE) liner and with minimum liner protection layer thickness of 0.6 m.

3 Design Description

Construction of the STF will be carried out in accordance with the lines, grades and specification indicated on the drawings. The following provides a summary of the design. The design assumes that suitable construction fill has been identified and is available on site.

3.1 Site Preparation

Site preparation activities will consist of clearing of trees, stripping of topsoil and soft soils from within the construction footprint, and bulk regrading of the site to achieve the grades indicated on the drawings.

Native parent material in the area expected to consist of competent glacial till that is suitable as bulk fill for the foundation. The fill is to be compacted in maximum 0.3 m lifts and compacted to 95% Standard Proctor density. The base surface is sloped at 1 to 5% to promote drainage to the collection sump location at the northeast corner of the STF adjacent to the access ramp.

At this time, the subsurface soils are expected to provide a stability foundation with minimal settlement. This will be confirmed during drilling for the installation of the monitoring wells (Section 3.6).

3.2 Containment Berms

The berms for the treatment cells will be constructed to a minimum height of 1.0 m above the inside floor of the STF (top of indicator layer). The berm is to have a minimum crest width of 1 m with a 2H:1V inside and outside berm slope. The berm fill is expected to be constructed of the locally available till and is to be compacted in maximum 0.3 m lifts and compacted to 95% Standard Proctor density.

3.3 Liner System

The cells will be lined with a 60 mil (1.5 mm) thick LLDPE liner sandwiched between two 12 oz non-woven geotextiles. The liner is to be anchored at the top of the berm as indicated in the drawings (STF-03) and installation will be done in accordance with the manufacturer's specifications.

A minimum 0.15 m thick sand bedding layer is to be located below the liner that is compacted to a minimum 95% Standard Proctor Density. Prior to geosynthetic deploy the bedding layer is to be inspected to ensure it is free of protruding, sharp objects.

A minimum 0.6 m thick cover layer is to be located above the liner. The cover layer is to be placed in lifts not exceeding 0.3 m thick. The placement method is to ensure that segregation and nesting of coarse particles is avoided. Equipment must not operate directly on the liner system during the placement of the cover material with low ground pressure equipment used during placement of the first lift. The type and size of the mobile equipment will be approved by the site engineer before initiating the work. Compaction of the first lift is not to exceed 95% Standard Proctor to avoid liner damage. Subsequent lifts may be compacted to suit trafficability within the STF. An indicator layer of recycled woodchips, geotextile, straw, gravel etc. will be placed above the cover material to prevent over excavation and damage to the liner system when turning soils during treatment operations.

3.4 Access Ramps

A 6 m wide access ramp for the placement and removal of soil will be constructed. Appropriate cover material must be placed to prevent damage to the liner system. The slope of the access ramps must not exceed 5H:1V (~11.3%). The cell berms may not be lowered for access into the facility.

3.5 Drainage/Collection Sump

A single drainage/collection sump will be constructed at the northeast side of the STF adjacent to the access ramp. The sump will collect surface water within the confines of the STF where it can be pumped and managed in accordance with the STF Management Plan.

The sump is 0.5 m deep with a total capacity of approximately 30 m³ to accommodate regular rainfall events and to ensure treated soils are not submerged for long periods of time as the bioremediation process does not occur if the material is fully saturated. The sump also provides a low point for water collection and redistribution over the soil to increase moisture content if needed during treatment.

3.6 Monitoring System

Groundwater monitoring is required during operation of the facility to identify possible PHC leachate from the facility. Three monitoring wells will be installed along the periphery of the STF to enable monitoring of the groundwater below the STF. The wells are to be installed at least one year prior to construction of the STF to allow for collection of baseline data as per ENV guidelines (2012).

The proposed monitoring well locations are shown in the design drawing package in Attachment 1. Figure 2 illustrates the general layout and design of the monitoring wells at the STF; final design to be completed based on drilling results. The wells will be drilled using HQ sized drill rods, cased with a 2" screen above and below the water table.

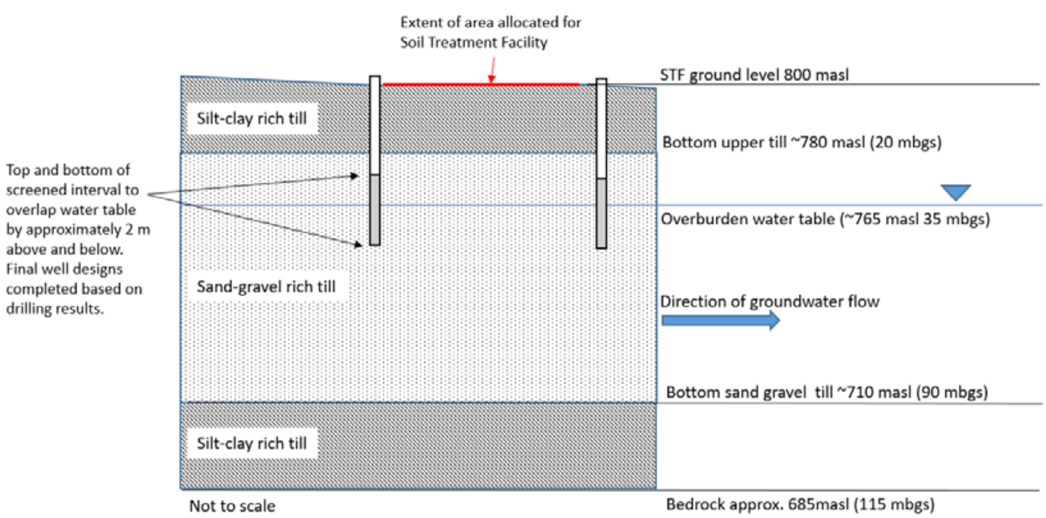

Figure 2: Groundwater monitoring wells

3.7 Quantity Estimates

Table 3 provides the earthwork volumes and geosynthetic quantities for the STF design estimates. All quantities are to neat lines, with no allowance for bulking factors or geosynthetic wastage/overlap.

Table 3: List of Preliminary Quantity Estimates

Description	Unit	Quantity
Berm Bulk Engineered Fill	m^3	1,900
Liner Bedding Material	m^3	250
Liner Cover Material	m^3	1,000
LLDPE Liner [1]	m^2	2,000
Non-woven Geotextile [1]	m^2	4,000
Monitoring Well Depth (Each) [2]	m	37

Notes:

[1] 25% additional area to account for overlap and general waste.

[2] Assumption based on depth to regional water table, may vary based on actual depth to water table.

4 Operation

This section presents operational requirements that are relevant to ensure the engineered structures function as designed and remains in operational conditions. Further details on the bioremediation treatment operational requirements can be found in the STF Management Plan.

4.1 Equipment Access Restrictions

Table 4 specifies the maximum allowable equipment ground pressure within the STF based on liner thickness. In general, provided that the 0.6 m cover is maintained with no rutting observed, most commonly used small to medium sized heavy equipment will be permissible. The proposed equipment to be used in the facility should be reviewed by an Engineer prior to use.

Table 4: Allowable Equipment Ground Pressures

LLDPE Thickness (mm)	Max Pressure (kPa)[1]	Comment[2]
1.5 (60 mil)	370	CAT 730 ADT and smaller

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.006_Soil_Treatment_Facility\!500_STF_Engineering\STF_Design\Telkwa_STF_LinerCover_DG.xlsx

Notes:

[1] Max pressures based on an 8 mm diameter pin test, ASTM 4833, as specified on product data sheet

[2] Approximate equipment sizing to generate maximum ground pressures, linear movement along lined area with a minimum cover of 0.6 m. Equipment size can be increased with increased cover material thickness.

4.2 Operational Procedures

Refer to the STF Management Plan.

4.3 Water Management

Refer to the STF Management Plan.

4.4 Monitoring and Maintenance Requirements

Refer to the STF Management Plan.

5 Closure

This Design Memorandum, "Tenas Coal - Soil Treatment Facility - Feasibility Design" has been prepared by SRK Consulting (Canada) Inc.

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P. H. MIKES
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BRITISH COLUMBIA
ENGINEER
May 18/2021

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Principal Consultant

Attachments:

Attachment 1 Design Drawings

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The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

References

[BC EMA] British Columbia Environmental Management Act, 2019. Contaminated Site Regulation B.C. Reg 375/76. Last amended January 24, 2019.

[ENV] British Columbia Ministry of Environment, 1999. Technical Guidance 1 for Contaminated Sites: Site Characterization and Confirmation Testing. Prepared pursuant to Section 64 of the Environmental Management Act. July 20.

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[ENV] British Columbia Ministry of Environment, 2012. Protocol 15 for Contaminated Sites: Soil Treatment Facility Design and Operation for Bioremediation of Hydrocarbon Contaminated Soil. Prepared pursuant to Section 64 of the Environmental Management Act. July.

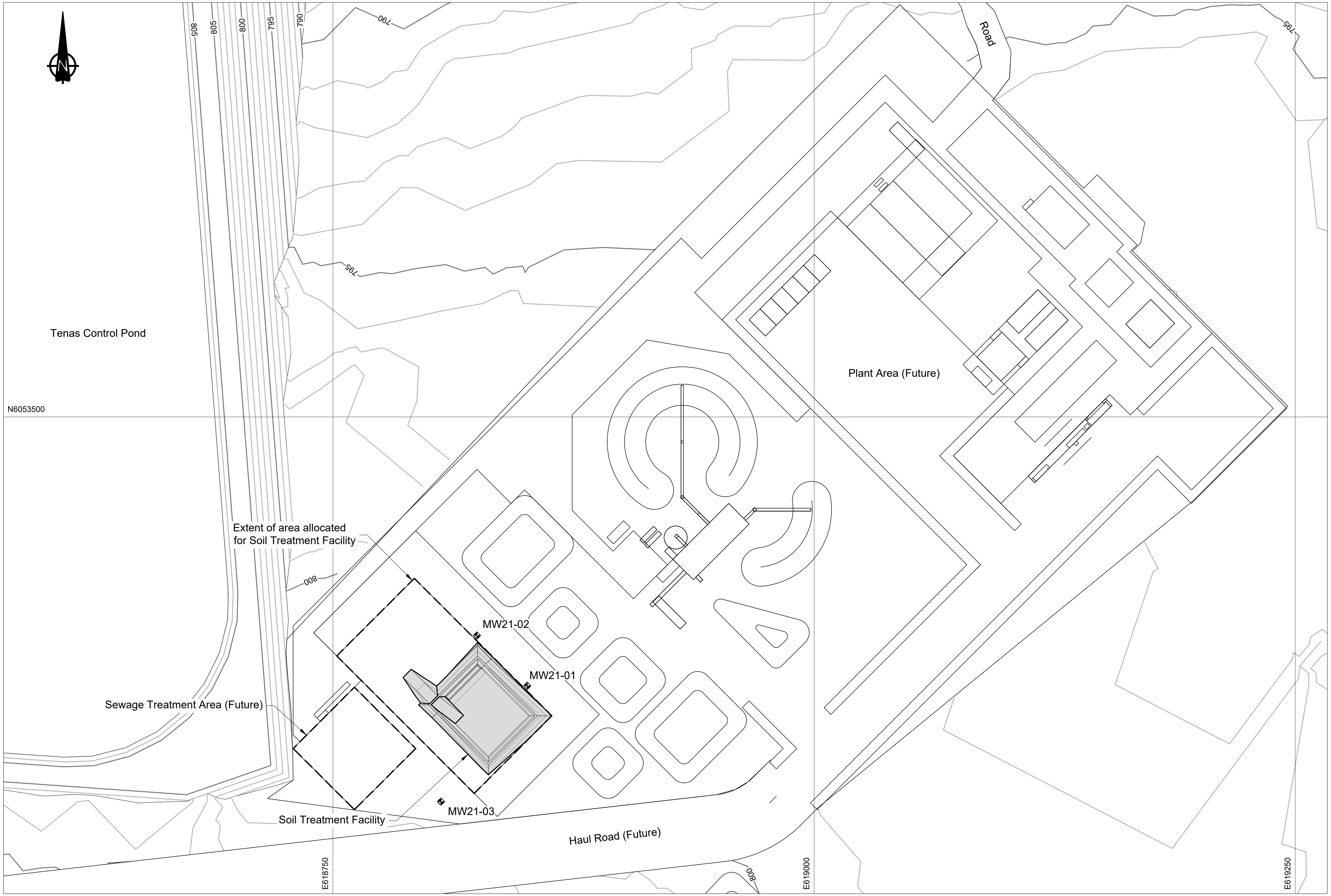
[ENV] British Columbia Ministry of Environment, 2013. Technical Guidance 14 for Contaminated Sites: Operation of Soil Treatment Facilities for Bioremediation of Hydrocarbon Contaminated Soil. Prepared pursuant to Section 64 of the Environmental Management Act. April.

[LWB] Land and Water Boards of Mackenzie Valley, 2020. Guidelines for the Design, Operation, Monitoring, Maintenance and Closure of Petroleum Hydrocarbon-Contaminated Soil Treatment Facilities in the Northwest Territories. January 10.

SRK Consulting (Canada) Ltd., 2019. Tenas Project – Factual Data Report for 2019 Field Investigation. Prepared for Telkwa Coal Ltd. SRK Project Number 2CT025.006, July.

SRK Consulting (Canada), 2020. Tenas Project – Hydrometeorological Baseline and Model Development Report DRAFT. Prepared for Telkwa Coal Ltd, October.

Attachment 1 Design Drawings



LEGEND

Monitoring Well

NOTES

1. Contours shown at 1.0m intervals.
2. All dimensions shown in meters unless otherwise stated.
3. Monitoring Well locations approximate and may change upon further groundwater investigations.

REFERENCES

NAD83 UTM Zone 9.

NOT FOR CONSTRUCTION

0m 20 40 60 80

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	--	--	2021-02-01
A	Issued for Discussion	--	--	2021-01-08

REVISIONS

DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: DG	DRAWN: JAB	REVIEWED: --
CHECKED: --	APPROVED: --	DATE: 2021-02-01

FILE NAME: 1CT027.006 STF Overview.dwg

TELKWA COAL LIMITED

Environmental Assessment

SRK JOB NO.: 1CT027.006

Soil Treatment Facility

DRAWING TITLE: General Arrangement

DRAWING NO.: STF-01 | SHEET 1 OF 3 | REVISION NO. B

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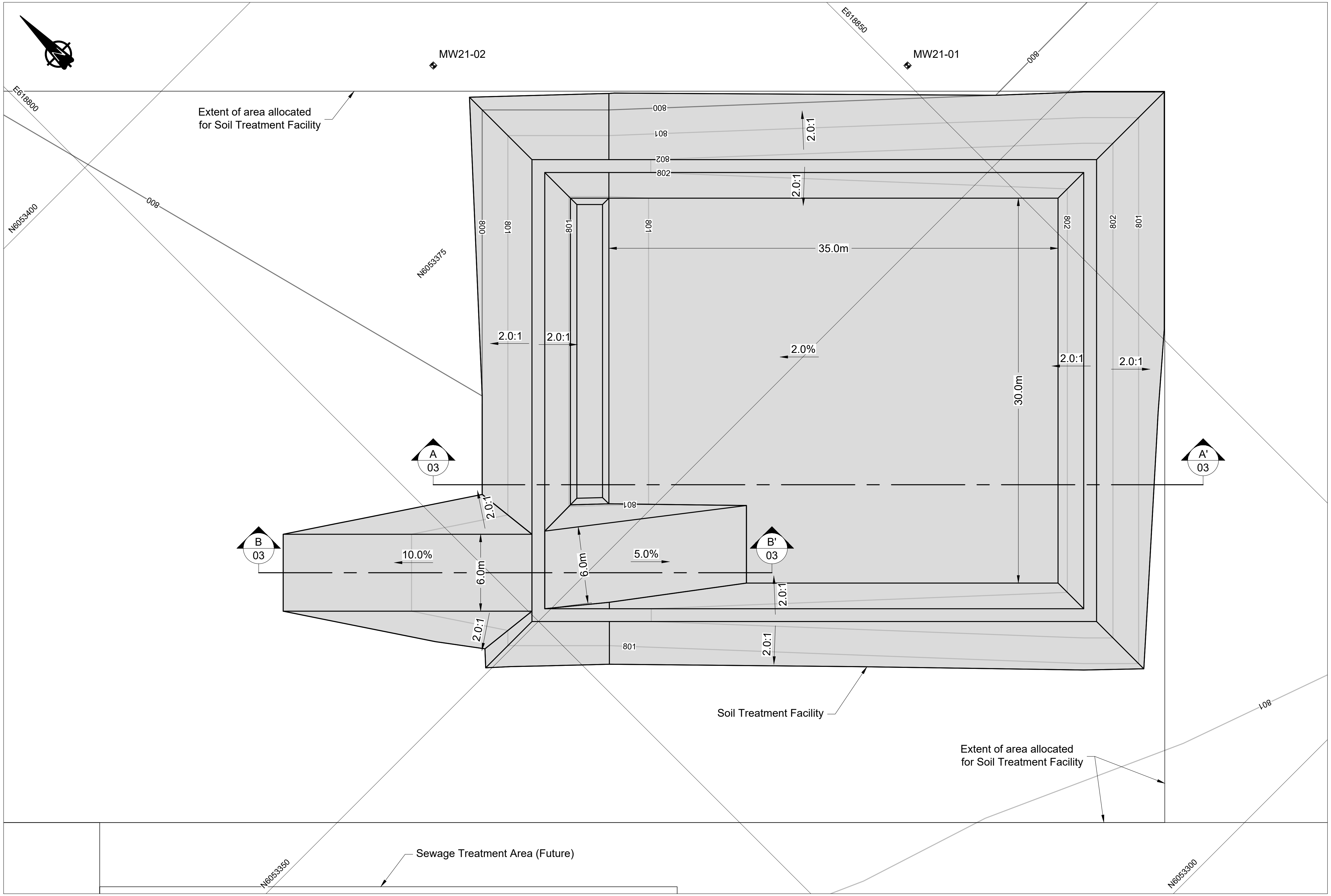

LEGEND

Monitoring Well

NOTES

1. Contours shown at 1.0m intervals.
2. All dimensions shown in meters unless otherwise stated.
3. Indicated slope ratios are horizontal (H) to vertical (V) (ex. 1.5H:1V).
4. See additional notes on Drawing STF-03.

REFERENCES

NAD83 UTM Zone 9.

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0m 3 6 9 12

DRAWING NO.	DRAWING TITLE
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NO.	DESCRIPTION	CHK'D	APP'D	DATE
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FILE NAME: 1CT027.006 STF Detail.dwg

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Environmental Assessment

SRK JOB NO.: 1CT027.006

Soil Treatment Facility

DRAWING TITLE: Site Plan

DRAWING NO.	SHEET	REVISION NO.
STF-02	2 OF 3	B

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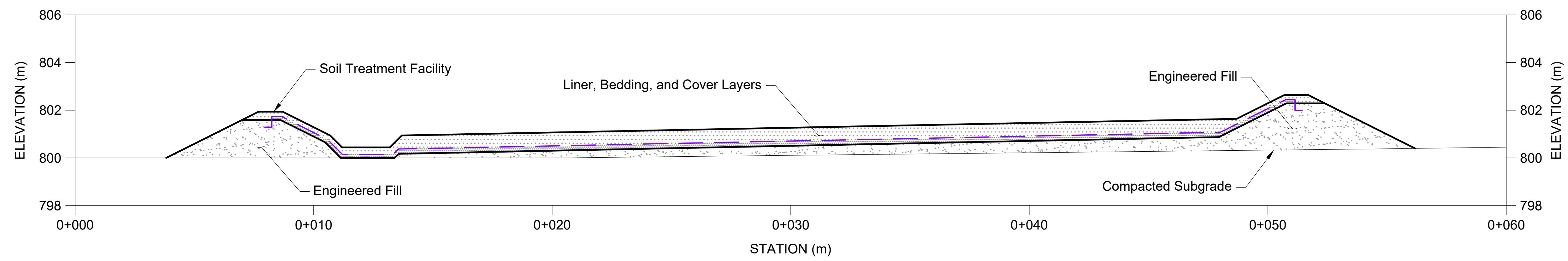
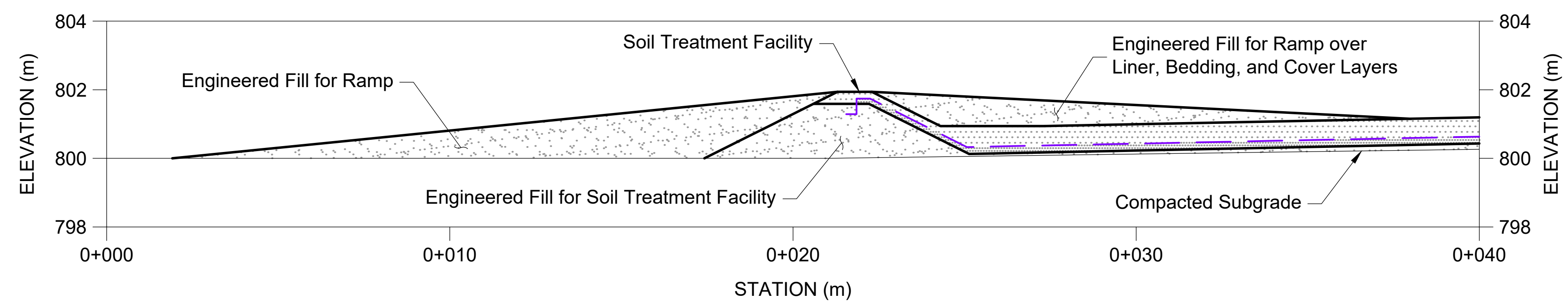


A
02
Soil Treatment Facility Section

0m 2 4 6 8



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02
Soil Treatment Facility Ramp Section

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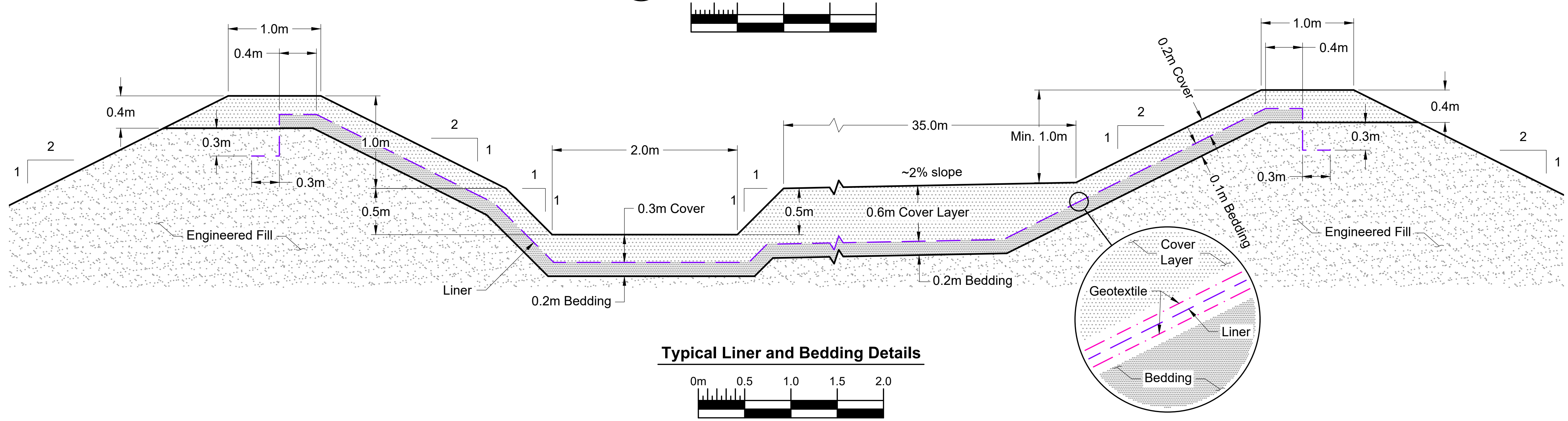

Typical Liner and Bedding Details

0m 0.5 1.0 1.5 2.0

NOTES

1. All dimensions shown in meters unless otherwise stated.
2. All vegetation, organics, topsoil, and soft soils are to removed prior from the facility footprint until a competent, dense material is exposed as directed by the Engineer.
3. The existing ground surface shown does not consider stripping of the foundation. The facility elevations are to be field to the encountered conditions provided that a minimum berm depth of 1.0m is maintained.
4. All fill materials are to be approved by the Engineer prior to use and must be non-acid generating, free of organics debris, snow, ice and all other deleterious materials.
5. The liner bedding and protection layer are to consist of well graded sand and have a maximum particle size of 100mm.
6. Compaction of materials to be completed in 300mm lifts to 95% standard proctor density.
7. All geosynthetic products are to be handled, stored, and installed as per manufacturers specification.
8. Prior to geosynthetic deployment, the subgrade surface must be inspected and be free of vegetation, sharp-edged rocks, stones, debris, and other foreign material that could contact the geosynthetic liner.
9. No direct operation of any equipment on unprotected liner and geotextile, minimum 0.6m cover.
10. Berm crest width may be increased (extended outward) if required to accommodate compaction equipment.
11. As-built survey to be taken at all material changes.

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A	Issued for Discussion	--	--	2021-01-08

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DATE: 2021-02-01
FILE NAME: 1CT027.006 STF Detail.dwg

TELKWA COAL LIMITED

Environmental Assessment

SRK JOB NO.: 1CT027.006

Soil Treatment Facility

DRAWING TITLE: Typical Section and Details

DRAWING NO. STF-03
SHEET 3 OF 3
REVISION NO. B

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