Rio Tinto Iron Ore (WA)

Brockman 4: Spontaneous Combustion and ARD (SCARD) Management Plan for Operations

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1 Purpose

The Spontaneous Combustion and Acid Rock Drainage (**SCARD**) Management Plan for operations outline the groups accountable and activities for the management of the environmental, safety and health risks associated with Black Shale (**BS**)

2 Assessing if a Site needs to implement this Management Plan

The RTIO (WA) Mineral Waste Management Plan describes the AMD, spontaneous combustion and mineral waste work that must be undertaken in the development of new deposits or significant expansions of current operations. A detailed AMD Risk Assessment should be undertaken for any new deposits or significant expansions of current operations to identify whether excavated sulfides will represent a risk to health, safety and environment. If risks are deemed to be minimal then a management plan will not be required. If a risk assessment has already been undertaken at a site then for any additional significant resource drilling or expansions of the operation the risk assessment should be updated. For any mine site that exposes or could potentially expose sulfidic material (with a S content >0.1%) then this SCARD Management Plan will need to be implemented.

3 Requirements, Accountabilities and References for Black Shale

The accountability for the management of Spontaneous Combustion and ARD issues associated with black shale are listed at superintendent and manager level in the following section. Figure 1 provides an overview of black shale management at Pilbara Iron from initial characterisation and modelling, through project development; mine planning, production and closure.

Pilbara Iron's black shale management strategy is broadly based upon the following principles:

1. identification of black shale distribution and character;
2. minimising the exposure and mining of black shale to the extent possible;
3. identification and special handling of black shale that must be mined;
4. encapsulation of black shale inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated; and
5. placement of black shale below the water table in backfilled open pits to limit oxygen contact.

Black shale management during mining operations is conducted in accordance with Figure 2. The mining protocols are designed to:

1. minimise the risk of unplanned detonations in charged blast holes;
2. ensure that hot and cold black shale truck loads are transported and placed in designated black shale dumps according to design requirements;
3. ensure that the location and geometry of all black shale repositories is recorded; and
4. refine geological block models and block-out procedures.

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Requirements

3.1 Resources Studies and Technology / Technical Services

3.1.1 For significant modification to the pit shell within MCS, use geological block models to predict hot and cold BS production volumes for different whittle shell, production and final pit designs.

3.1.2 Life of Mine Plans and Reserve Models must include estimates for hot and cold BS production.

3.1.3 Ensure that black shale dumps are sited to minimise long term environmental impacts and financial liabilities. Obtain signoff from Environment, Hydrogeology, and Hydrology.

3.1.4 Ensure that final pit and dump designs are consistent with Appendix 1, 0 and Appendix 3. Obtain signoff from Environment and Hydrogeology.

3.1.5 When planning open pits that will intersect black shale, the possibility of dewatering becoming acidic must be considered so that appropriate mitigation infrastructure can be installed.

3.2 Planning

3.2.1 Five year plans must estimate hot and cold BS production and compare to inert waste production to ensure that sufficient material will be available for dump construction.

3.2.2 Ensure that annual and quarterly (short and medium term) plans predict hot and cold BS production from each pit and delivery to each dump. Ensure that sufficient inert waste will be produced for encapsulation in accordance with the specifications in Appendix 1 and that sequencing will allow dump construction to occur as required.

3.2.3 Major changes to waste dump designs must be receive sign-off from Environment, Rehabilitation team; Hydrogeology and Hydrology before major modifications to BS dump designs are implemented.

3.2.4 Plan and design works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, 0 and Appendix 3.

3.2.5 Black shale exposures on the waste rock dumps must be minimised during the rainy season (Appendix 1).

3.2.6 During the five year planning process identify areas that are available for rehabilitation and inform the rehabilitation specialist.

3.3 Geology

Blasting

3.3.1 Identify BS in drill hole cuttings and blue flag holes that contain BS. Place a white flag on holes that do not contain BS.

3.3.2 Alert key personnel in Operational Planning and Pit Operations of the location of BS blast holes via e-mail.

Dumping

3.3.3 Based on visual inspection, total S values and stratigraphy, designate holes as cold BS, hot BS or inert waste. Create Block-outs that show contacts between waste types within blast pattern.

3.3.4 Enter Block-out data into the Modular Mining system to allow BS waste to be tracked.

3.3.5 Perform periodic reconciliations between the Block-outs and the geological block model.

3.3.6 Periodically provide representative samples of upper, middle and lower MCS for full ABA and NAG analysis. Also provide unoxidised black shale within Whaleback Shale and other black shale found within the BIF units. Ensure results are communicated to the site environment team.

3.3.7 Review as necessary the boundary between cold black shale and hot black shale to ensure it is still valid and has not changed as mining progresses deeper. Advise the

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Requirements	
	Mineral Waste management team of the results and undertake change management if necessary.
3.4	**Survey**
3.4.1	Maintain as-built dump designs in Vulcan that include a 3D plan showing approximate locations and volumes of BS.
3.4.2	Ensure contacts between hot BS, cold BS and inert waste are pegged on the blasted bench consistent with the Mine Geology Block-outs.
3.4.3	Ensure that monthly face pick-up surveys are conducted on all active BS waste dumps
3.5	**Operational Planning**
3.5.1	Create a “Waste Dump Progression Plan” at least every three months to implement the detailed dump designs in the field.
3.5.2	Create “PLOD” sheets to aid dig operators in waste assignment and check that the modular mining system is working.
3.5.3	Monitor and adjust to reconcile rehabilitation plans with original designs as appropriate.
3.5.4	Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.
3.5.5	Ensure monthly reports from PowerView contain hot and cold BS volumes delivered to every dump.
3.5.6	In consultation with Mine Geology perform six-monthly reconciliations between Block-outs, survey and Modular Mining data for hot and cold black shale volumes.
3.5.7	Black shale exposures on the waste rock dumps must be minimised during the rainy season.
3.6	**Drill, Blast and Development**
Drill and Blast	
3.6.1	Ensure all safety procedures related to BS management are followed during the charging and firing of blast holes i.e. temperature logging, timing.
3.6.2	Maintain site specific Drill and Blast SWPs and ensure it is consistent with this management plan and other SWPs and guidance notes.
Dewatering	
3.6.3	Runoff water in the open pits should be diverted around black shale exposures to the extent possible.
3.6.4	Any acidic contact water (pH of less than 5.0) will require special handling for both health and safety, operational and environmental reasons.
3.6.5	Acidic contact water must be contained on site and it should be segregated so it does not contaminate clean water. Acidic contact water must be stored in a manner that will not lead to groundwater quality degradation and potential loss of the beneficial use of down gradient aquifers. Where possible acidic water should be treated and put to a beneficial use rather than stored and discharged.
3.7	**Load and Haul**
3.7.1	Ensure that BS is properly identified and placed in the correct dump location consistent with PLOD sheets, modular mining assignments and the Waste Dump Progression Plan from Operations Planning.
3.7.2	Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.
3.7.3	Ensure that “Exclusions” in Modular Mining are reviewed and corrected in the field as

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Requirements	
	required.
3.7.4	The time between blasting and hauling of black shale should be minimised and generally should occur within three weeks or less during the wet season and within 12 weeks during the dry season. This will limit the amount of time the material has to oxidise in an uncontrolled manner.
3.7.5	Whenever possible the outer inert waste rock "skin" of a black shale lift should be constructed first. This will ensure that black shale lifts are not extended beyond the design footprint of the black shale dump, will limit convective oxygen transport through the uncompacted sides of the black shale dump lift, and will help contain contaminated contact water on the dump.
3.7.6	Hot black shale lifts should be covered as rapidly as possible with the overlying inert waste rock layer, particularly during the wet season. Ideally, hot black shale should be covered within two weeks of placement in the waste rock dump. If rapid covering is not possible the paddock-dumped hot black shale piles should at least be dozed into a planar surface as soon as possible. This will help minimise infiltration and oxygen transport into the material.
3.7.7	Modular data that are entered into the Vulcan system should be used to record the location and volume of all black shale repositories so that a three dimensional plan of black shale distribution within each dump is maintained by the survey group.
3.8	**Hydrogeology**
3.8.1	Maintain and implement a site specific plans and SWPs to deal with poor quality water that has contacted BS exposures or waste dumps.
3.8.2	Ensure that water management and storage practices do not cause offsite surface water impacts or groundwater quality degradation in down gradient aquifers.
3.8.3	Provide technical overview and support during planning for above-ground and in-pit BS waste disposal.
3.9	**Environment**
3.9.1	An annual documented ARD inspection program of all black shale dumps and open pits with black shale exposures should be performed. This should occur during the wet season or immediately after a significant rainfall event. Samples of key runoff water flows should be collected.
3.9.2	Perform field inspections to ensure BS management, dump construction, rehabilitation and store and release cover performance is consistent with the requirements of the SCARD Management Plan. Register non-conformances in SAP.
3.9.3	Ensure that routine sampling and visual inspection is performed of groundwater monitoring wells (surrounding black shale dumps and pits), dewatering water and surface water bodies (including inactive open pits that contain black shale exposures). The sampling should occur at least quarterly.
3.9.4	Ensure routine sampling for water quality and visual inspection of permanent or seasonal natural water bodies surrounding the mine. The sampling should occur at least quarterly.
3.9.5	Interpret the environmental data that is collected and ensure it is stored in a user-friendly database. All monitoring data should be assigned a unique sample number and sampling date. Ensure problems are brought to the attention of the Mineral Waste Management team and that corrective actions are taken if required.
3.9.6	Analysis of water quality trends for, at a minimum, sulfate, pH and dissolved metals should be made on an annual basis to monitor the long-term behaviour of the system. Significant changes in water quality, infiltration rate or other key parameters should be investigated and mitigation actions should be instituted if required.
3.9.7	Ensure that the SCARD Management Plan is periodically refined and updated so that it is

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Requirements
consistent with the latest characterisation data and current best practice. Alert the Mineral Waste Management team at other mine sites of any changes that are necessary to this plan and that may impact other sites. Any changes to this management plan need to be approved by the Mineral Waste Steering Committee.
3.9.8 Perform all required reporting, permitting notifications and other external communications relating to ARD, closure and general black shale management issues.
3.9.9 Training modules on dust management and ARD should be presented every 2 years to groups working with black shale. The IEMS modules should be updated annually to reflect the current management plan and should describe the hazards, incident reporting and the relevant procedures to each working group that has responsibilities for any aspect of black shale management.
3.9.10 Report the tonnes of sulfidic material excavated and dumped at the end of each year.
3.9.11 Record black shale environment risks in a site risk register and annually review these risks.
Rehabilitation
3.9.12 Plan and implement rehabilitation works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, 0 and Appendix 3.
3.10 Rehabilitation
3.10.1 In consultation with relevant stakeholders identify monitoring requirements (e.g. lysimeters) for waste dumps following rehabilitation.
3.10.2 Coordinate the review and approval of the rehabilitation design by relevant stakeholders.
3.10.3 Complete a risk assessment for the rehabilitation design focussing on the SCARD risks.
3.11 Health and Safety
3.11.1 Monitor the occupational gas and dust exposures surrounding black shale. Ensure data is captured in a user friendly database. Ensure problems are brought to the attention of the Mineral Waste Management team.
3.11.2 Train occupational exposure groups on the correct use of respiratory equipment and monitors. Competency should be assessed and recorded in SAP.
3.11.3 Perform field inspections particularly during the wet season to ensure black shale health and safety procedures are followed. Register non-conformances in SAP.
3.11.4 Ensure the site specific guidance notes on acceptable gas levels, monitoring and demarcation are periodically refined and updated so it is consistent with current best practice.
3.11.5 Record black shale health and safety risks in a site risk register and annually review these risks.
3.12 Mineral Waste Management Team
3.12.1 A Mineral Waste Management Team must be formed and meet on a regular basis. It must include representatives of every Department that has responsibilities related to BS management.
3.12.2 The primary function of the Mineral Waste Management Team is to ensure on-going improvement and implementation of the SCARD Management Plan.
3.12.3 Agenda items and meeting minutes must be produced for every meeting.
3.12.4 Develop emergency and contingency plans related to spontaneous combustion, ARD and black shale management on an as need basis.
3.12.5 Coordinate a technical review of BS management by an external expert every four years. Track progress against outstanding actions at each meeting.

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Requirements	
3.12.6	Coordinate all research related to black shale characterisation, black shale management, spontaneous combustion and ARD.
3.12.7	Ensure the SCARD management plan, related SWPs and guidance notes represent current practise and are up to date.
3.13	**Management**
3.13.1	An overview of black shale issues must be included in any introductory environmental training provided to new employees and contractors. To aid in the training, role descriptions should include ARD-related responsibilities.
3.13.2	Ensure progress is made against outstanding spontaneous combustion and ARD audit actions.

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Figure 1: Black Shale (BS) management overview.

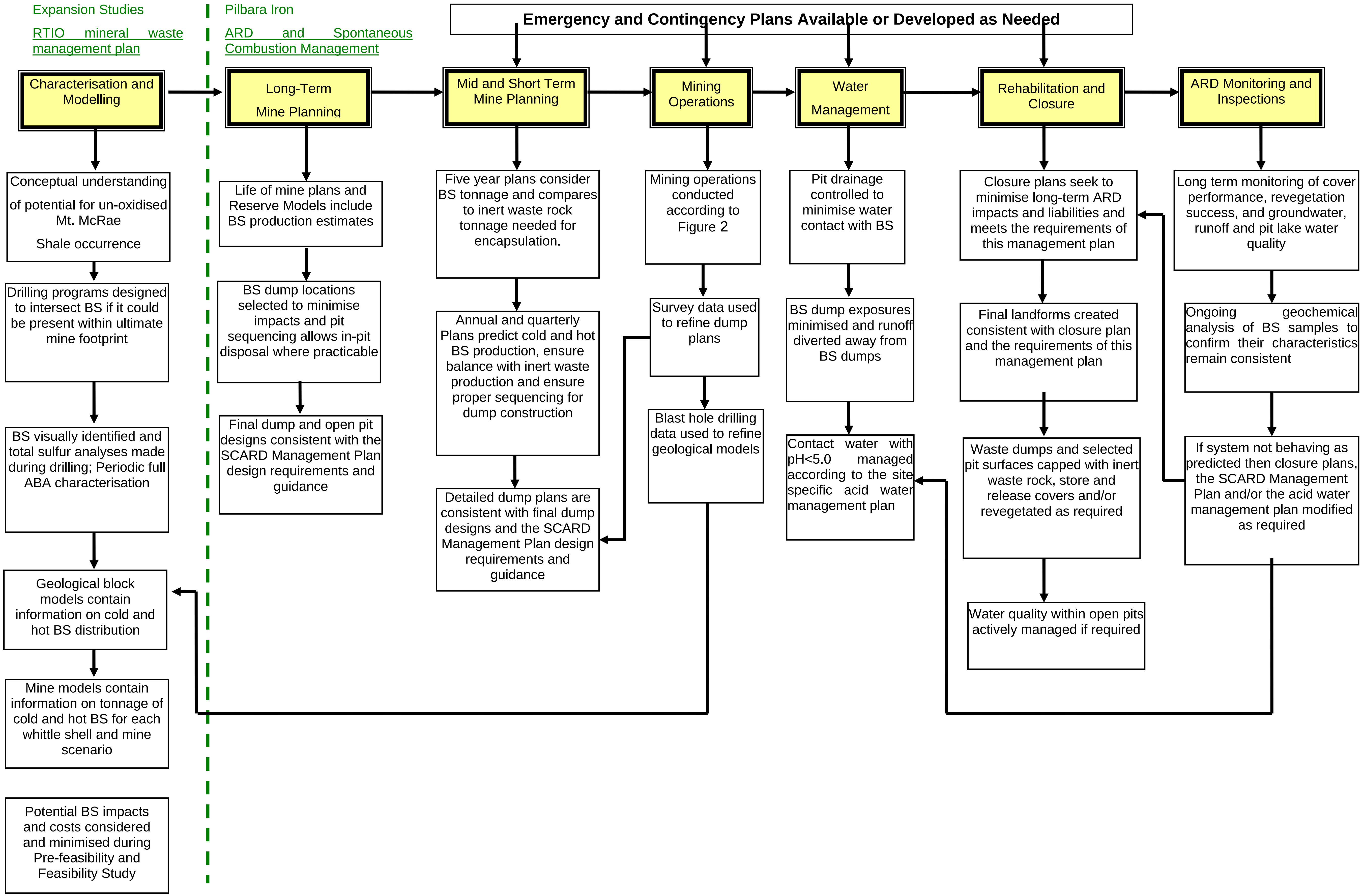

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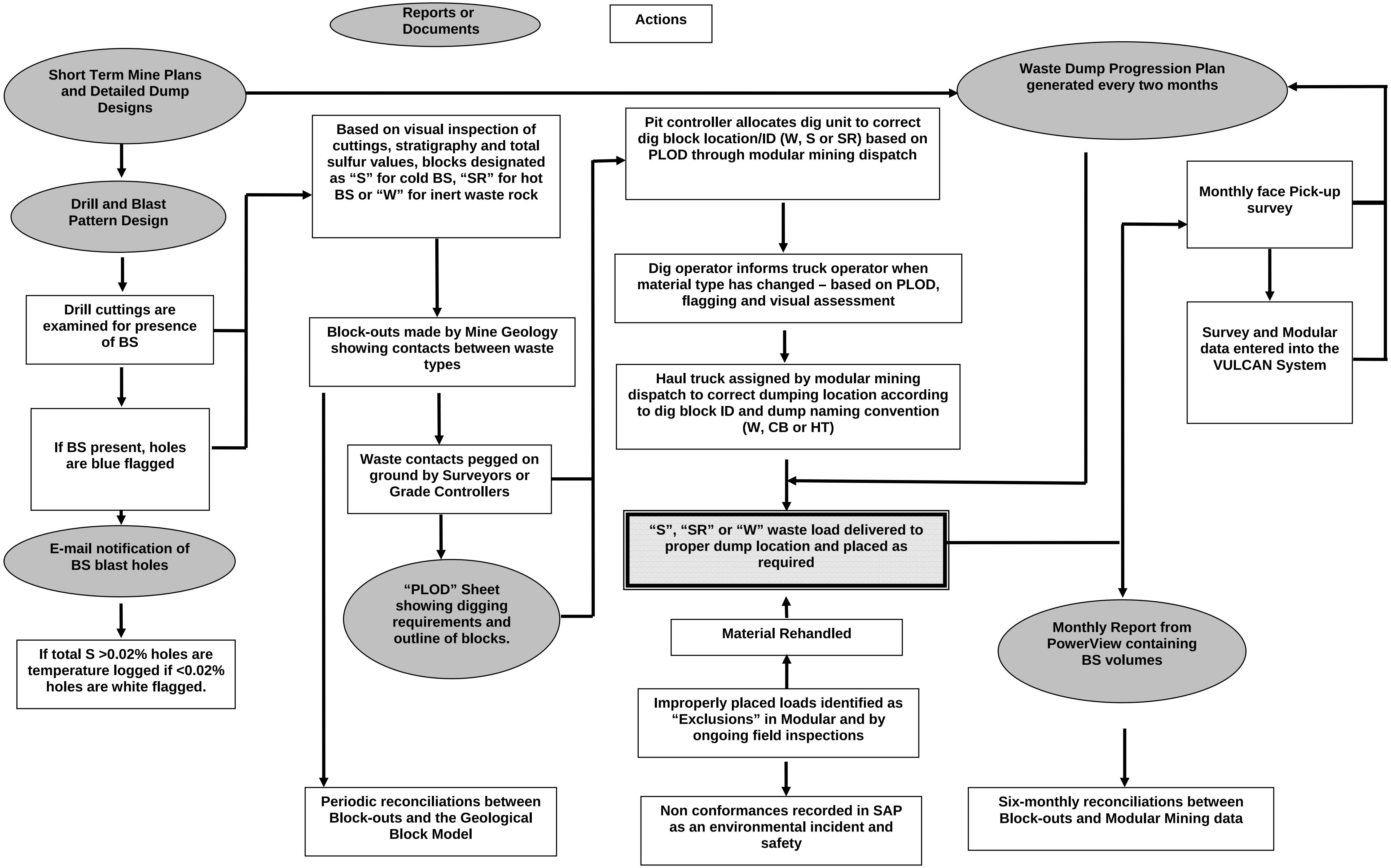
Figure 2: Black Shale (BS) management during mining operations



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Appendix 1 Dump Specifications for Category S and Category SR Material

Management of sulfides within black shale, BIF and detritals needs to be considered during all phases of waste rock dump design, from initial selection of dump locations during the long-term planning process (five year and longer time horizon) to the detailed dump designs generated during short term planning (time horizon less than a year).

A1.1 Selection of Dump Locations

When designing new sulfide dumps, the dump location and footprint should be selected to minimise potential long term environmental impacts and financial liabilities. Selection and design criteria that must be considered include:

- Under no circumstances should material containing sulfides be used for works such as windrows, construction fill, ramps, fantails, roads or any other use that would disperse the material over a broad area in an uncontrolled manner.
- The sulfides dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments.
- In pit disposal should be considered a priority instead of the construction of above ground waste rock dumps.
- Placement of sulfides in pits that already contain sulfide exposures is preferable to placement in pits that do not have sulfides exposed on the pit walls.
- Sulfide dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom formation.
- Sulfide dumps should not be placed over ore grade or near ore grade CID or BIF-derived deposits. These not only have potential economic value, but may act as significant local aquifers.
- Sulfide dumps should not be placed over or adjacent to significant seeps or springs.
- Avoid sitting new sulfide dumps in catchment basins that do not already contain sulfide dumps.
- The number of sites containing sulfides and the footprint of the sulfide dumps should be kept to a minimum.
- Sulfide dumps should be located near sources of clean waste rock for encapsulation.
- Background groundwater quality surrounding the dump location must be measured before any material is dumped. This will require the installation of groundwater monitoring bores. These bores will be used to provide a temporal record of groundwater quality in the vicinity of the dump.

A1.2 In-Pit Disposal Requirements

In pit disposal of sulfides is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal should be considered the preferred disposal alternative because it:

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- Reduces the risk of erosion exposing sulfides in the long term,
- Inhibits convective oxygen transport because the waste is surrounded by relatively impermeable rock walls,
- Reduces the footprint of the waste disposal facilities,
- Reduces the volume of inert or net neutralising waste needed to encapsulate the sulfides, and
- May help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Note that in some pits it may be possible to place sulfides both above and below the water table with a minimum 10 metre thick inert waste layer placed against the predicted mean post-mining water table.

A1.2.1 In Pit Disposal Below the Water Table

If sulfides are placed below the post-mining water table, they will become permanently flooded and control subsequent pyrite oxidation and acid release. In the long term, placement below the water table is the most secure and low risk disposal option available for sulfidic material. It is particularly beneficial for Category SR material because it completely removes the long-term risk of spontaneous combustion. If a pit can be backfilled so that the fill elevation is above the pre-mining water table elevation, it is likely that the water table will eventually rebound to at or near the pre-mining elevation. If it is only partially backfilled to below the pre-mining water table, it is likely that a very shallow intermittent, seasonal or permanent pit lake will form on top of the fill material.

For sulfides placed below the post-mining water table the following minimum design criteria apply:

- For pits backfilled above the predicted post-mining water table, the top of the sulfide backfill must be at least 5 metres below the mean predicted post-mining water table (Figure 3).

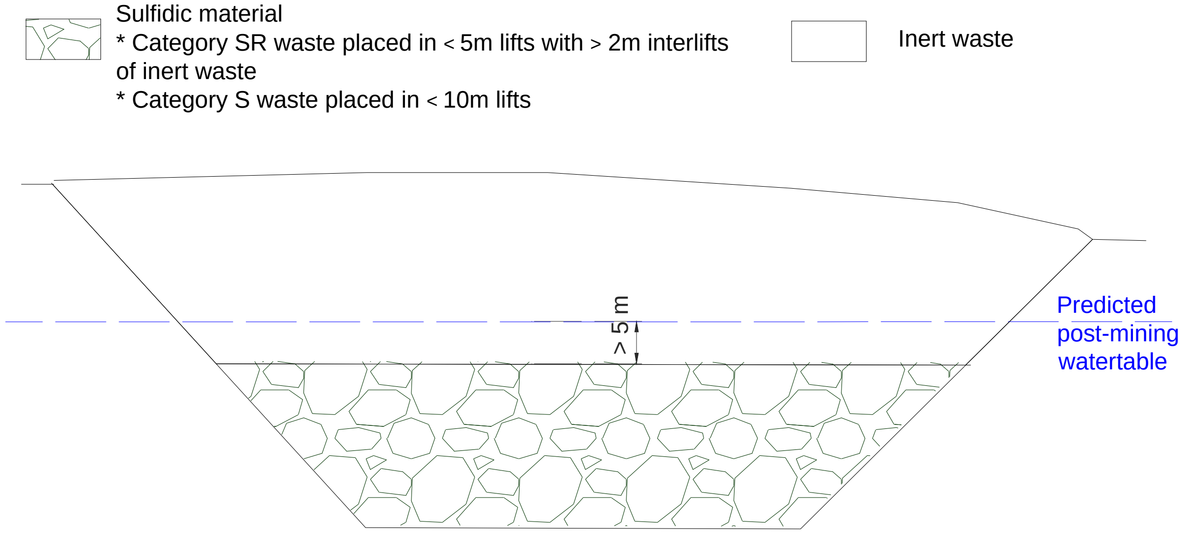

Figure 3: Example of sulfidic material placed below the water table and with the pit completely backfilled.

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- For pits that are only partially backfilled to below the pre-mining water table, the top of the sulfide backfill must be at least 5 metres below the estimated mean pre-mining water table and at least 5 metres below the predicted post-backfilling water table (Figure 4). In this situation it can generally be assumed that the mean post-mining water table will be at the top of the backfill. Thus, the sulfidic waste will be covered by at least 5 metres of inert waste.

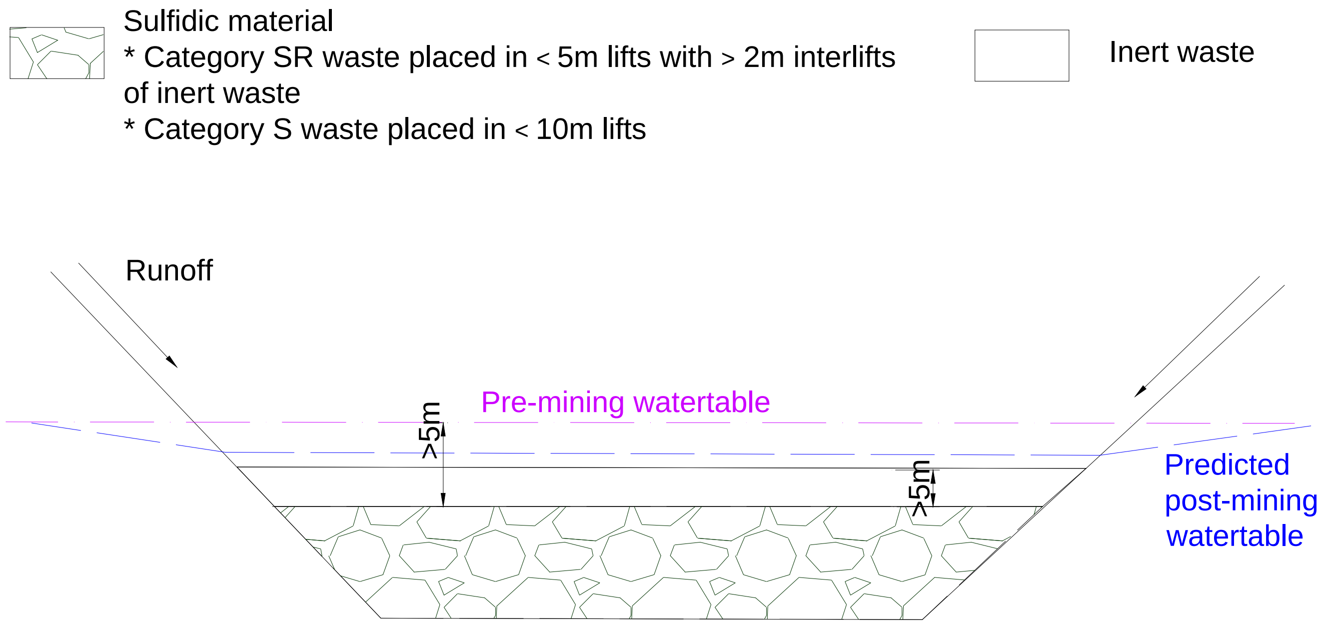

Figure 4: Example of sulfidic material placed below the water table and with the pit partially backfilled.

- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 5 metre layer of inert or net neutralising waste rock.
- Each lift must be placed so that it ties into the pit walls on all sides to minimise the risk of convective oxygen transport until the waste is flooded.
- If backfilled to above the post-mining water table, the upper inert waste rock surface must be revegetated.
- A store and release cover is not needed if all sulfidic material in a pit is placed below the water table.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal below the water table also includes:

- Enough inert or net neutralising backfill should be placed on top of the sulfidic waste to raise the fill level to at least above the post-mining water table (preventing the formation of

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a pit lake) and preferably above the pit walls so that runoff is not directed into the pit fill. Figure 3 is an example of this preferred alternative.

- If required, flooding of the backfilled waste should be enhanced by diverting surface water flows into the pit or directing dewatering water from active open pits into the backfilled pit. The more rapidly the waste can be flooded, the less pyrite will ultimately oxidise. Rapid flooding will minimise the build up of soluble sulfide oxidation products in the material. As long as geotechnical safety requirements are met, construction of waste lifts into standing water on the pit floor is acceptable.

A1.2.2 In Pit Disposal Above the Water Table

If sulfidic material is placed above the post-mining water table it must be ensured that long-term variations in the water table elevation do not allow water to rise into the overlying sulfidic material. Intermittent contact with infiltrating water from above must also be minimised. For sulfidic material placed above the post-mining water table the following minimum design criteria apply:

- The base of the sulfidic material backfill must be at least 5 metres above the predicted mean post-mining water table.
- At least 5 metres of inert or net neutralising waste rock must be placed at the base of the open pit before sulfidic backfill is placed. The most likely location for a perched water table to form is at the base of the backfilled pit because of the permeability contrast between the bedrock and the backfill.
- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S material lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 2 metre layer of inert or net neutralising waste rock. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- If the pit can be completely backfilled so that no high walls are exposed above the inert waste rock fill, then each inert, Category S and Category SR material layer should tie into the pit walls on all sides to minimise the risk of convective oxygen transport (see Figure 5 and Figure 6 for examples).

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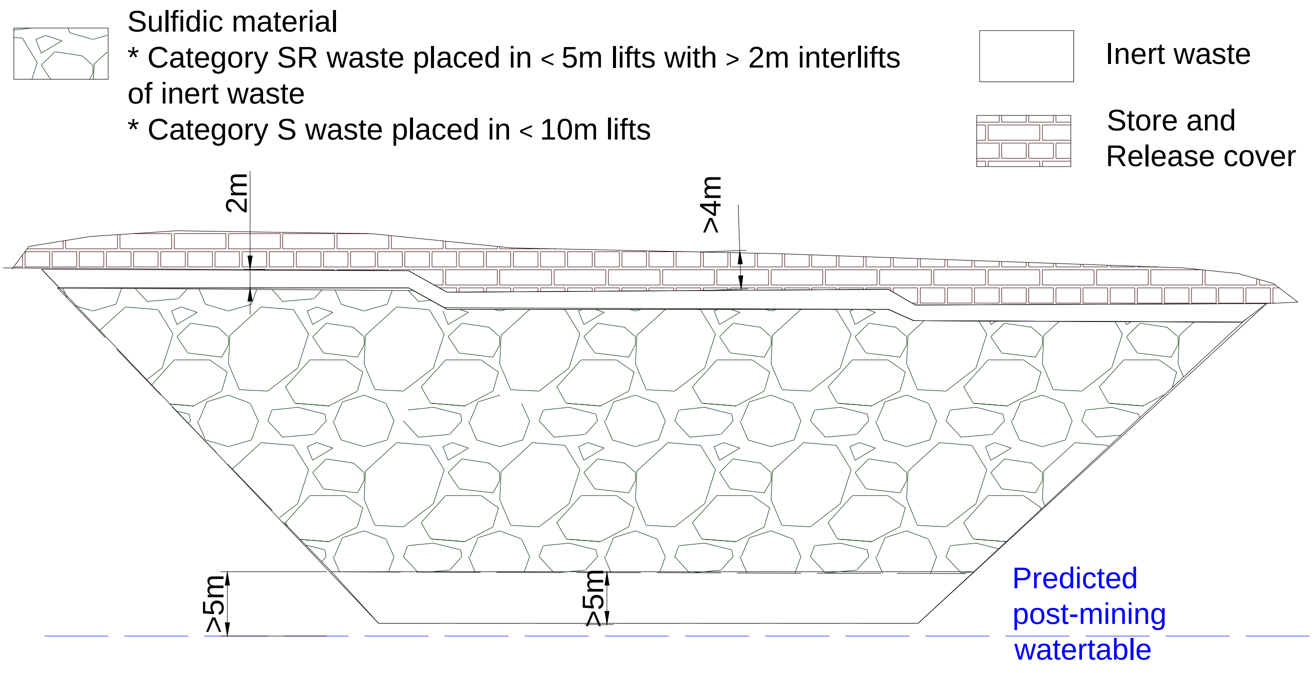

Figure 5: Example of sulfidic material placed in a dry pit that is completely backfilled.

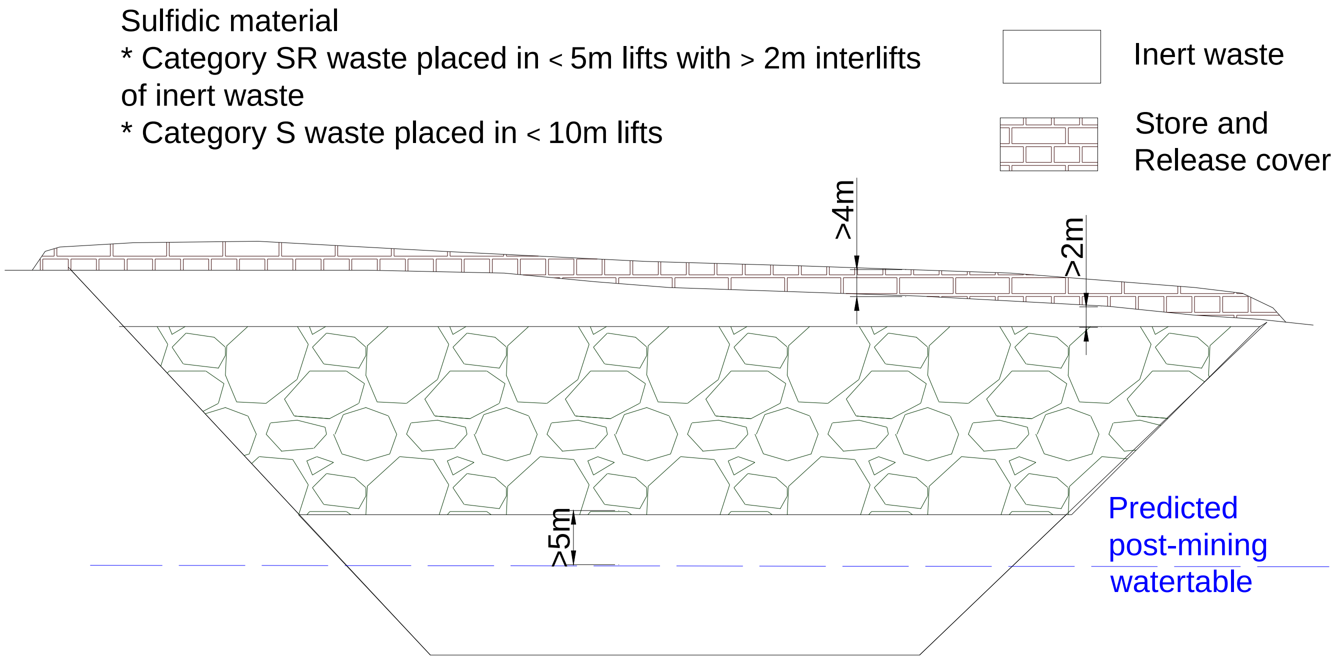

Figure 6: Example of sulfidic material placed above the water table and with the pit completely backfilled.

- If the pit will only be partially backfilled so that some highwalls are exposed above the final backfill surface and so that runoff from the remaining highwalls will flow towards the backfill, then a minimum five metre (measured both horizontally and vertically) buffer of inert waste rock must be placed between the pit walls and each sulfide material lift where possible (see Figure 7 for an example). A 2 meter high by 5 metre wide abandonment bund will also need to be placed adjacent to the exposed high walls to prevent run on water from infiltrating into the cover over the sulfidic material.

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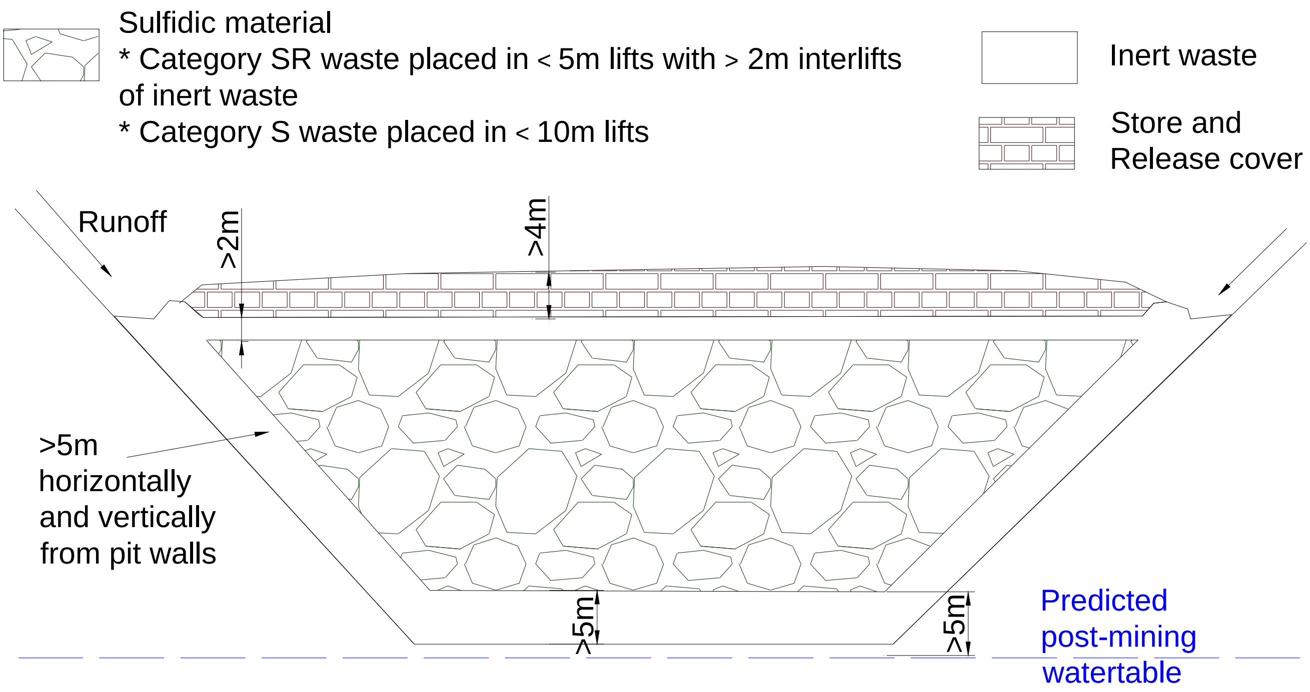

Figure 7: Example of sulfidic material placed above the water table and with the pit partially backfilled.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal above the water table also includes:

- If possible, the pit should be backfilled above the lowest point on the pits walls so that the final backfill surface can be sloped to allow runoff water to flow out of the pit footprint.
- The optimum design would be to backfill the pit so that there are no highwalls exposed that could direct runoff onto the store and release cover and underlying sulfidic material (Figure 5 and Figure 6).

A1.3 Above Ground Disposal Requirements

If sulfidic material waste rock dumps are to be constructed on top of the original ground surface, more stringent design criteria are required than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and because of the likelihood of the convective transport of oxygen through the side slopes of the dump. Design criteria for Category SR dumps are also more stringent than for Category S dumps.

A1.3.1 Design of Outer Waste Rock Dump Slopes

To the extent possible, Category S and Category SR material should be excluded from beneath final waste rock dump slopes. There are several issues associated with the placement of Category S and Category SR beneath waste rock dump slopes:

- There is an increased risk of slope erosion damaging vegetation and covers in the short term, or in the long term exposing the underlying material.
- The probability of convective oxygen transport to the sulfidic material is higher than for Category S and Category SR material only placed in the dump interior.
- Store and release covers cannot be built on slopes because they must be constructed with more erodable fine-grained materials. It is likely that infiltration rates into the

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underlying Category S and Category SR material will be higher on slopes than on flat surfaces with a store and release cover, which could result in increased ARD.

- Uncertainties with the requirements for final dump slopes may require the importation of additional inert material to allow slopes to be reduced to less than 20 degrees if required while preserving the minimum 5 metres of inert cover over the sulfidic material.

The minimum design criteria in the following section reduce but do not completely mitigate these risks. For this reason, the volume of Category SR, and to a lesser extent Category S, material placed beneath final dumps slopes should be minimised wherever possible. The greatest benefit can be derived from excluding Category SR material from beneath the slopes because it not only has the potential to spontaneously combust, but also has anywhere from 2 to 70 times more acid producing potential on average than the Category S material.

A1.3.2 Category SR

Figure 8 shows the optimum design for the waste rock dumps in which Category SR is completely excluded from beneath the footprint of the final re-contoured slope.

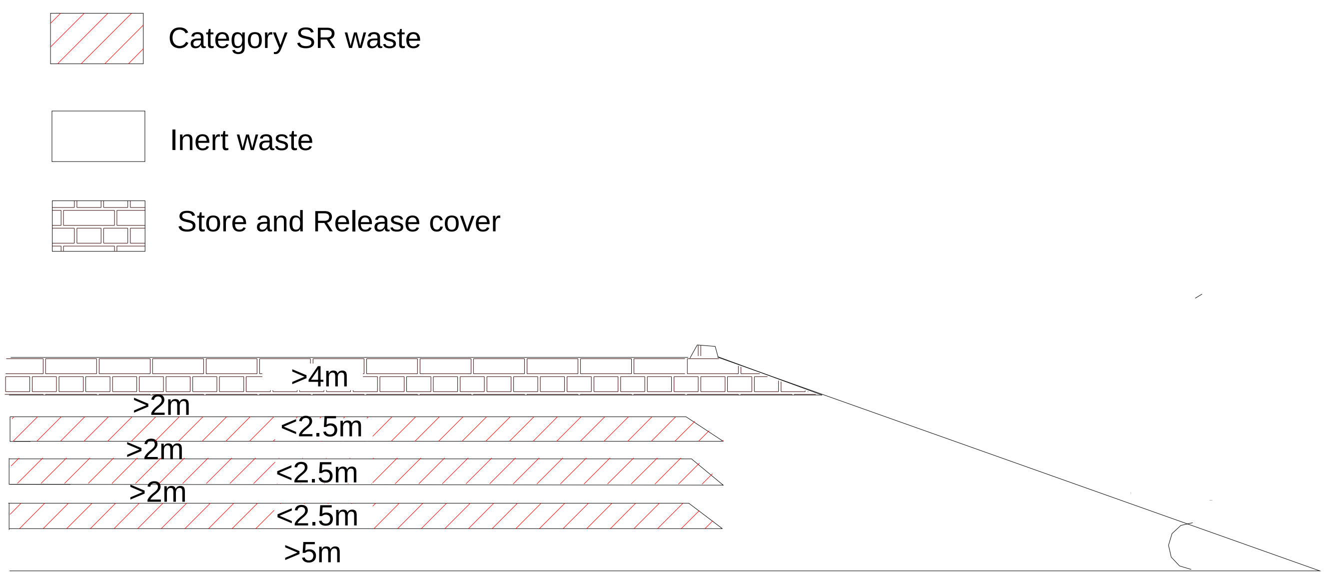

Figure 8: Example of optimum design for Category SR dumps.

An example of a Category SR waste rock dump constructed according to the minimum dump design criteria is shown in Figure 9. The minimum design criteria for Category SR dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that sulfidic material is not located within 5 metres of the hillside as measured both vertically and horizontally.
- The thickness of each Category SR sulfide material lift must not exceed 2.5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock. Lifts are to be constructed by paddock dumping so that Category SR sulfidic material can cool and so

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that incident vehicle traffic helps create a compacted layer every 2 to 2.5 metres to inhibit water movement and convective oxygen transport.

- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category SR sulfidic material waste rock dump so that no sulfidic material is located within 5 metres (measured across the shortest distance) of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dump slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category SR sulfide material waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category SR sulfidic material waste dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

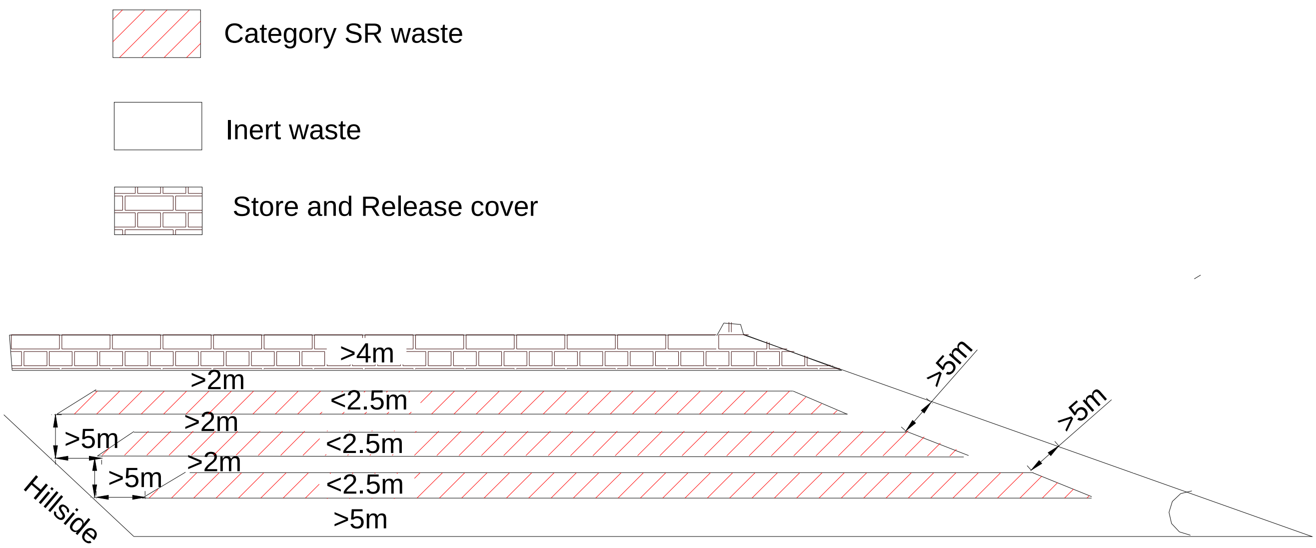

Figure 9: Example of the minimum design criteria for Category SR dumps (if Figure 8 can not be constructed).

A1.3.3 Category S

An example of a Category S waste rock dump constructed according to the minimum dump design criteria is shown in Figure 10. The minimum design criteria for Category S dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that Category S material is not located within 5 metres of the hillside as measured both vertically or horizontally.

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- The thickness of each lift of Category S material must not exceed 10 metres. This will create a vehicle compacted layer every 10 metres in the dump to inhibit water movement and convective oxygen transport[1].
- No inert or net neutralising waste rock layer is needed between Category S lifts.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category S waste rock dump so that no material is located within 5 metres of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dumps slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category S waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category S dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

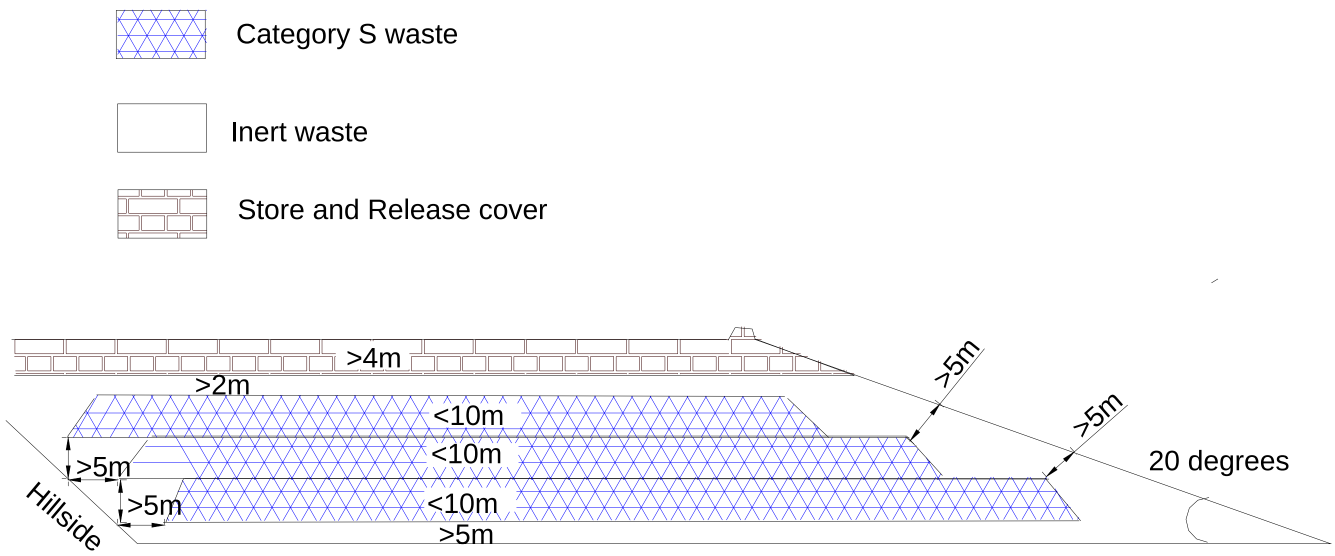

Figure 10: Example of the minimum design criteria for Category S dumps.

A1.3.4 Composite Designs

Figure 11 shows an example of a composite Category SR and Category S dump in which Category SR material is excluded from the beneath the slope and Category S material is placed below the slope. Composite dumps of this kind may significantly reduce the residual risk associated with the dump slopes without significantly reducing the total storage capacity for sulfidic material within the dump. There must be at least a one metre buffer (measured

[1] Note that this has been changed from 5 m lifts as the gas movement through waste dumps has been shown during ANSTO testing to be diffusive and it is likely that the difference in ARD generation between 10 and 5 m lifts will be negligible.

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horizontally or vertically) between the Category SR and Category S material where they are in close contact on the outer slopes of the Category SR repository.

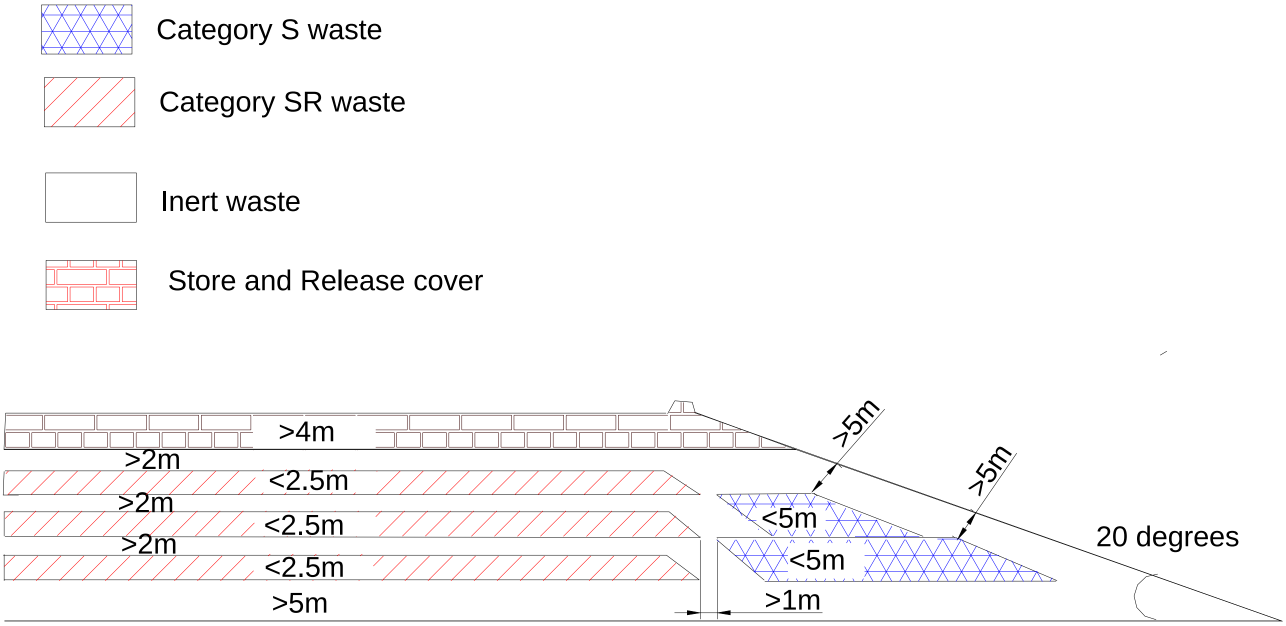

Figure 11: Example of optimum composite designs for Category S and SR dumps

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Appendix 2 Rehabilitation and Closure

A2.1 Final Landforms

To reduce the risk of erosion and to minimise infiltration, final landforms should be designed in accordance with the following criteria:

- Final waste rock dump slopes should be designed taking into consideration the properties of the material. Designs of slopes will require signoff by key stakeholders.
- No sulfidic material should be within 5 metres of the shallow dipping recontoured dump slope as measured perpendicular to the slope. This will most likely require that inert waste rock fill be imported and placed at the toe of the slope rather than significantly expanding the cut made at the top of the slope.
- Final landforms must be designed so that runoff is not directed onto surfaces that are underlain by sulfidic material.
- A 2 metre high by 5 metre wide abandonment bund must be placed around the top of each dump slope. This will prevent runoff water flowing from the dump surface over the slopes and causing erosion.
- If sulfidic material is exposed during the recontouring of waste rock dumps that were created before waste rock segregation was practiced, it must be covered with at least 2 metres of inert waste rock. This will help ensure that the entire final dump surface is able to support vegetation.
- Wrapping of a sulfide dump is preferred rather than dozing down the slope.

A2.2 Store and Release Covers

Store and release covers must be constructed on all flat surfaces over Category S and Category SR repositories and over some sulfide/black shale exposures within open pits. Store and release covers are designed to limit infiltration into the underlying waste rock by maximising the evapo-transpiration of incident rain water. The cover is designed to store water near the surface during the wet season so that it can be removed from the cover material and returned to the atmosphere during the dry season by evaporation and plant transpiration.

Waste rock that is used to construct store and release covers must contain sufficient fine-grained material to have both a high moisture retention capacity and a relatively low permeability (i.e. large boulders should not be placed on the cover). Waste rock composed of well-graded clayey, silty, sandy gravel or clayey silty gravely sand makes the best store and release cover material. As a rough guide, waste rock containing more than 1/3 coarse sand size and finer particles (< 5 mm) will make a suitable cover material. **Blocky BIF composed of gravel with very little silt, sand or clay** is not ideal for use in cover construction and should be avoided if another more suitable waste type is available (Figure 12). When possible, oxidised shale should be used in preference to BIF on covers.

During construction there should be regular quality control checks to ensure large boulders have not been placed into the cover.

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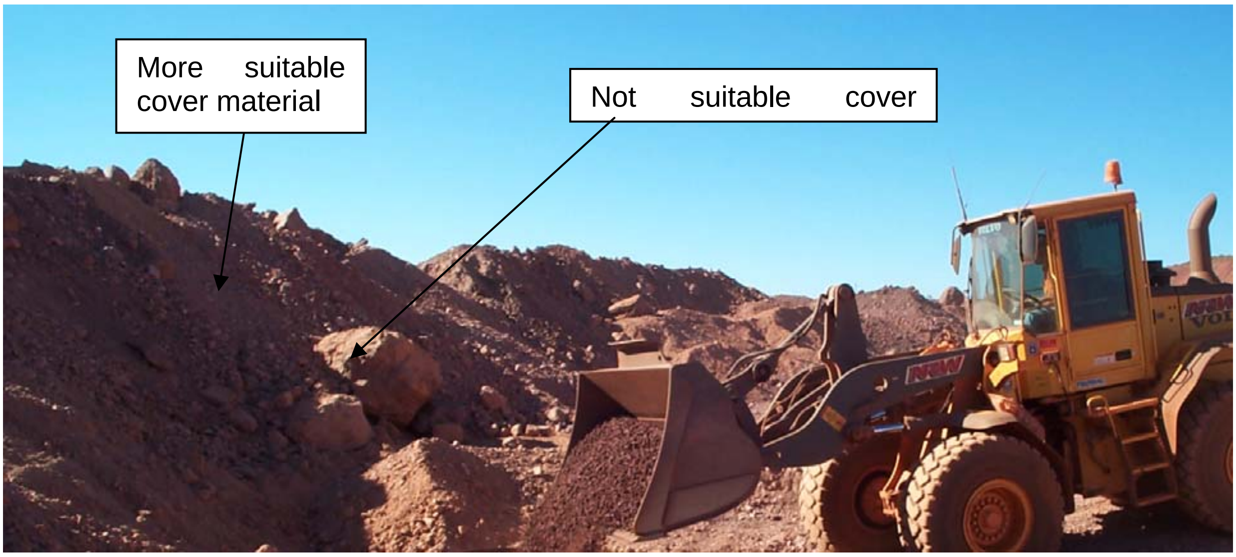

Figure 12: An example of suitable and not suitable material to be used in the construction of a store and release cover.

Waste rock that is used to construct store and release covers must also be able to support vegetation, so materials with high salinity, and acidic or very basic pH should be avoided. The waste rock should be placed in a manner that minimises segregation of the material into coarse and fine particles. For this reason covers should be paddock dumped, they should never be constructed by dumping in two or four metre lifts.

Store and release covers should be constructed as follows (Figure 13):

- Paddock-dump store and release cover material on top of a vehicle compacted surface so that the average depth of the cover material is greater than 2 metres.
- A dozer should then be used to knock down the crest of each paddock dump pile and to fill in the depressions between piles to create a trafficable surface.
- Paddock-dump a second layer of store and release cover material on top of the first lift so that the average depth of the second lift is greater than 2 metres. Vehicle traffic during this dumping will create a compacted layer on top of the first store and release cover layer.
- A dozer should again knock down the crest of each paddock dump pile in the second layer and fill in the depressions between piles to create a surface that is nearly planar.
- Topsoil should be placed on top of the second store and release cover layer. The surface should then be ripped and seeded. Ripping needs to be deep enough (> 0.3 metres) to mix in the topsoil and to ensure that there are not compacted zones that could inhibit plant growth and rooting on top of the upper layer.

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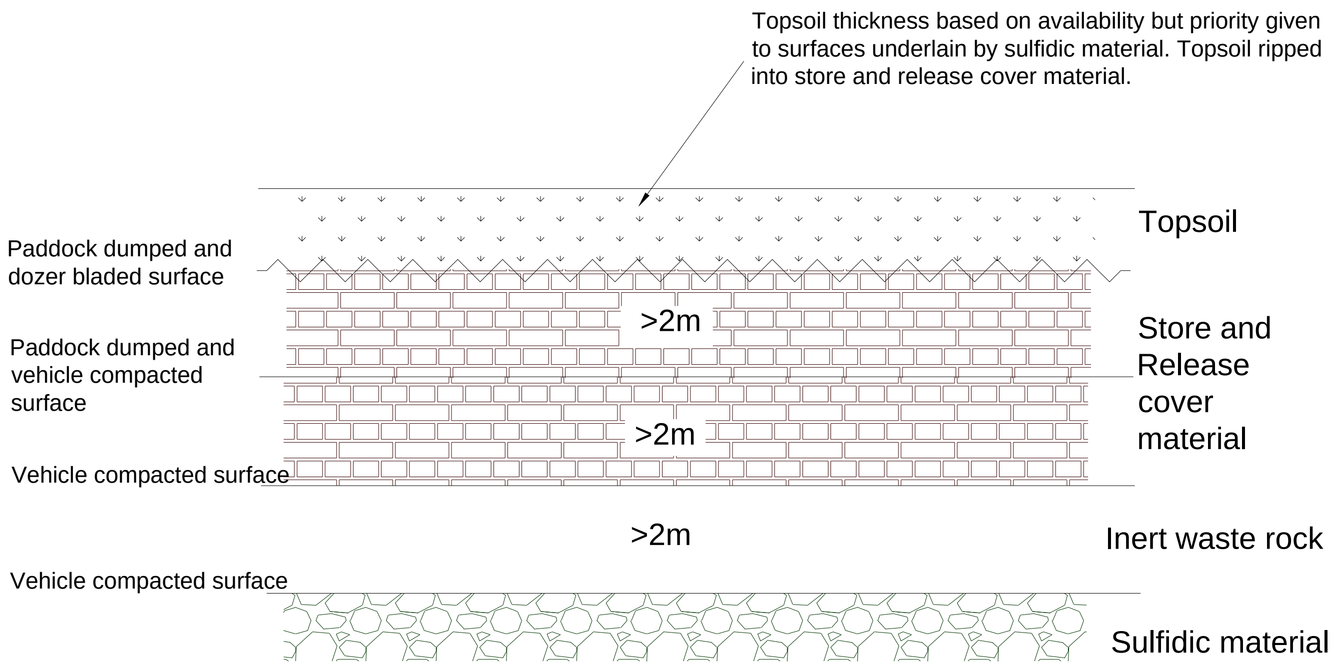

Figure 13: Detail of store and release cover design.

A2.3 Topsoil Management

Although direct planting into inert waste rock is feasible, topsoil placement can greatly accelerate the establishment of native vegetation on waste rock surfaces. This in turn will help to maximise evapo-transpiration, minimise infiltration into the underlying waste rock and inhibit erosion on dump slopes. If topsoil resources are limited, the most benefit for ARD management can be gained by preferentially utilising topsoil for the revegetation of waste rock dumps that contain sulfidic material. In decreasing order of importance, topsoil should be placed on:

1. Dump slopes underlain by Category SR material;
2. Dump slopes underlain by Category S material;
3. Flat store and release cover dump surfaces underlain by Category SR material;
4. Flat store and release cover dump surfaces underlain by Category S material;
5. Store and release covers within open pits;
6. Waste rock dumps that were created before waste rock segregation was practiced and which may contain dispersed black shale or material containing sulfides;
7. Assessable inert waste rock surfaces within pits that contain black shale or sulfidic material exposures; and
8. Waste rock dumps that do not contain any black shale or sulfidic material.

A2.4 Open Pit Closure

The geology and hydrogeology of an open pit will largely control the potential closure issues associated with the final void. Open pits that are located above the water table and which do not contain any black shale or sulfidic material exposures should not pose any geochemical risks at closure. Open pits that intersect the water table but do not contain any black shale or sulfidic material exposures may ultimately contain saline water bodies with neutral pH that could

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impact down gradient groundwater. Open pits that contain black shale or sulfidic material exposures will likely contain ephemeral or permanent acidic and potentially saline water bodies that could impact down gradient groundwater and could represent a direct exposure risk to wildlife or humans.

Government guidance clearly indicates that hypersaline pit lakes are considered acceptable as long as down-gradient beneficial use is not impacted. However, the existing guidance also indicates that mitigation measures are required if net acid generating materials such as pyritic black shale are exposed on the final pit walls. In pits with extensive exposures of pyritic black shale that will not be backfilled to above the water table, long term mitigation measures will likely be required to attain the proposed water quality criteria.

The hydrogeological and geochemical behaviour of each pit should be predicted so that it can be managed appropriately at closure to minimise significant groundwater impacts and surface water exposures to wildlife and humans. As discussed in Sections A1.2.1 and A1.2.2 the most protective pit closure strategy is to completely backfill the pit or to backfill the pit to above the estimated pre-mining water table where practicable. Backfilling to above the pre-mining water table should lead to a near complete recovery of the water table elevation and should cut off oxygen to the majority of black shale or sulfidic material exposed on the pit walls.

In order of decreasing benefit, pit backfilling should be prioritised as follows: 1) pits with black shale or sulfidic material exposures that intersect the water table and will discharge to groundwater at closure, 2) pits with black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, 3) pits with black shale or sulfidic material exposures that are above the water table, 4) pits without black shale or sulfidic material exposures that intersect the water table and that will discharge water to groundwater at closure, 5) pits without black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, and 6) pits that do not contain any black shale or sulfidic material exposures and that are above the water table. The proximity to nearby regionally significant aquifers or ecologically significant seeps and springs should also be considered when evaluating potential pit closure issues.

Extensive backfilling is not practicable for many open pits because of the size of the final void and because of pit sequencing issues. Where backfilling is not practicable the following actions should be taken:

- Haul roads and accessible benches that are underlain by inert waste rock should be ripped and seeded to minimise runoff, to promote vegetation establishment and to maximise evapo-transpiration.
- A minimum 4 metre store and release cover system should be constructed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located above the water table and that will not be periodically flooded by cyclone events.
- A minimum 5 metre lift of inert or net neutralising rock should be placed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located below the water table or that will be periodically flooded by cyclone events.
- Consideration should be given to covering black shale or sulfidic material exposed on pit highwalls with inert or net neutralising material pushed or dumped from the sides.

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An example of these pit closure strategies is illustrated in ***Figure 14***.

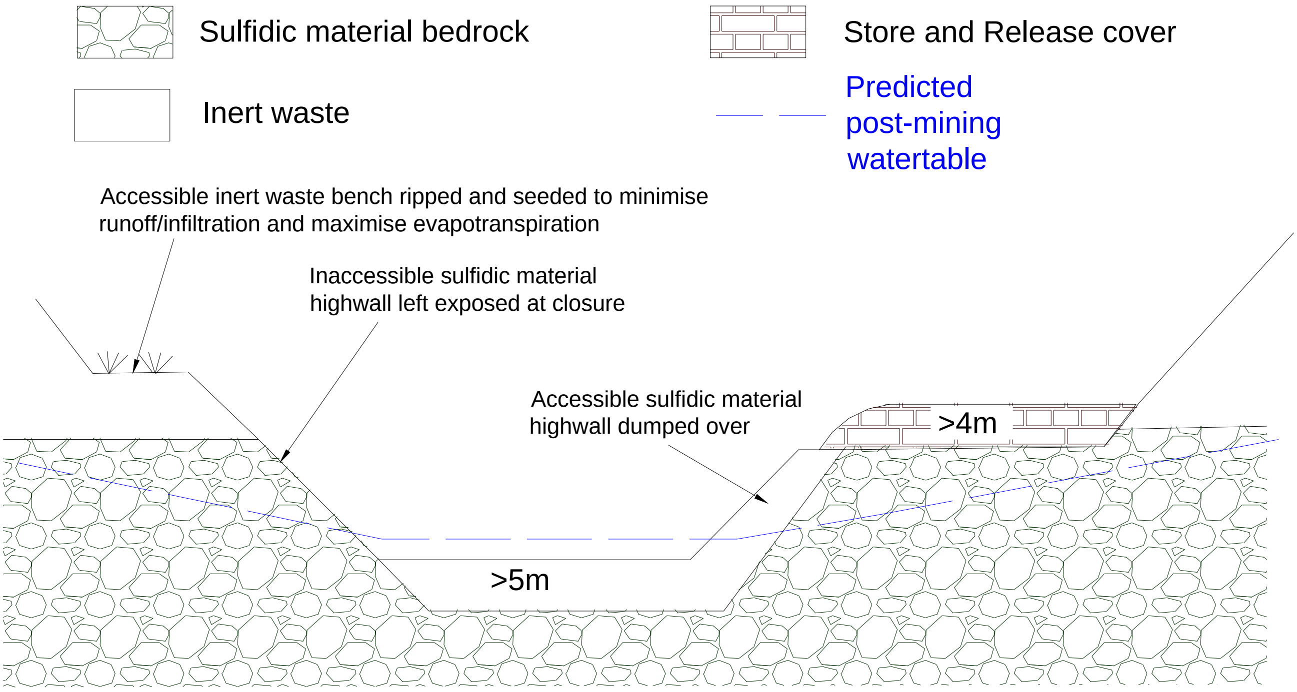

Figure 14: Examples of closure strategies for a pit with sulfidic material that will not be backfilled

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Appendix 3 Contingency Planning

Contingency plans for most upset conditions and unexpected impacts related to sulfidic material management will need to be developed on a case by case basis. Contingency plans will generally be developed by the site Mineral Waste Management team or at a minimum they must be approved by the Team. Contingency plans for spontaneous combustion and inert materials shortages are outlined in the following sections.

A3.1 Spontaneous Combustion

Site specific pit safety procedures should be followed.

All occurrences of burning black shale or lignites must be reported to Mine 2 and the pit safety team as soon as possible. If possible, fires should be extinguished by rapid burial of the burning material under at least five metres of inert waste rock. For locations where this may be difficult such as beneath pit ramps, the black shale or lignite should be covered with as much inert material as practicable. The inert material should be placed so that the upper surface is well compacted and so that side slopes are adequately covered to prevent lateral convective transport of oxygen to the burning rock mass. If rapid coverage is not an option, the material can be excavated and transported to the toe of an advancing inert dump lift where it can be rapidly buried. Water should not be used to extinguish the fire because this could actually enhance the spontaneous combustion risk of black shale or lignite that is not already burning and because the volumes of water that would be required are generally prohibitively high.

A3.2 Inert Materials Shortages

Medium and short term mine plans should be designed so that inert waste rock is produced in adequate volumes and at appropriate times to allow timely encapsulation of sulfidic material. Category SR material requires the highest volumes of inert material (approximately 1:1) because of the requirement for an inert interlayer every 2.5 metres. If there were temporary shortages of inert material, Category SR dumps could be designed with Category S material if it contains a low sulfide concentration, some neutralising potential and low organic carbon (i.e. no black shale or lignite) material. The appropriate material to use in the heat dissipating interlayer should be confirmed as appropriate by Mine Geology. But under no circumstances should Category S material with both elevated sulfide and organic carbon concentrations (i.e. sulfidic shale or lignites) be used. If acid base accounting tests prove the material to be non-acid forming, coarse tails could be used as inert waste in dumps (i.e. EGi 2007). If there is a shortage of inert material then inert waste in other waste dumps may need to be rehandled and transported to the black shale waste dump.

A3.3 Surface Water Management

Every endeavour should be made to divert surface water runoff from contacting black shale or sulfides exposed on pit walls. Site specific cyclone water management plans should be developed for the appropriate disposal of potentially acidic water in pits with black shale exposures. Some strategies to manage surface water runoff include:

- Slope pit floor away from pit sulfide exposure
- A sump should be constructed below the sulfide exposure to collect acidic water.
- Surface water runoff from inert exposures should be segregated from coming in contact with acidic water.

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- Bund upper catchment to run over competent material such as BIF rather than sulfide exposures.

Waste dumps should have all sulfide exposures covered with inert material during the wet season. A bund at the top of the waste dump surface will reduce any surface water from travelling over the sulfidic material and transporting contaminated drainage into the surrounding environment.

Pipelines transporting acidic water should be shut down and repaired if there is a leak. Acid water pipelines should be labelled with purple stripes and non-acidic pipelines can be labelled with green stripes (as per Australian Standards).

A3.4 Geotechnical Stability

A3.4.1 Pit Walls

Pit walls excavated in Mt McRae Shale are designed with the same concept as for other stratigraphic units. That is, generally we design for a Factor of Safety of at least 1.20 and a Probability of Failure of around 10% on the inter-ramp scale and up to 30% for the batter scale. The management of slopes excavated in Mt McRae Shale is therefore no different from that of any other stratigraphic unit, whereby a process called Geotechnical Design Management is utilised. This involves identifying hazards and hence risks associated with the geotechnical design and undertaking a risk management strategy to minimise these risks. Actions include design review, geotechnical investigation, mapping, conformance to design and monitoring. Contingency plans are established through Slope Management Plans in consultation with mine management.

The occurrence of Mt McRae Shale is of little consequence to the geotechnical management process.

A3.4.2 Dump failures

Whilst no specific stability analyses have been undertaken on Black Shale Waste Dumps, they can generally be considered stable due to the process of encapsulation of the material well within a dump. Also, the process of undertaking earthworks to prepare the encapsulation is considered to add a significant contribution to the stability of the dump location. It is anticipated that future stability analyses may be documented in a Waste Dump Management Plan.

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