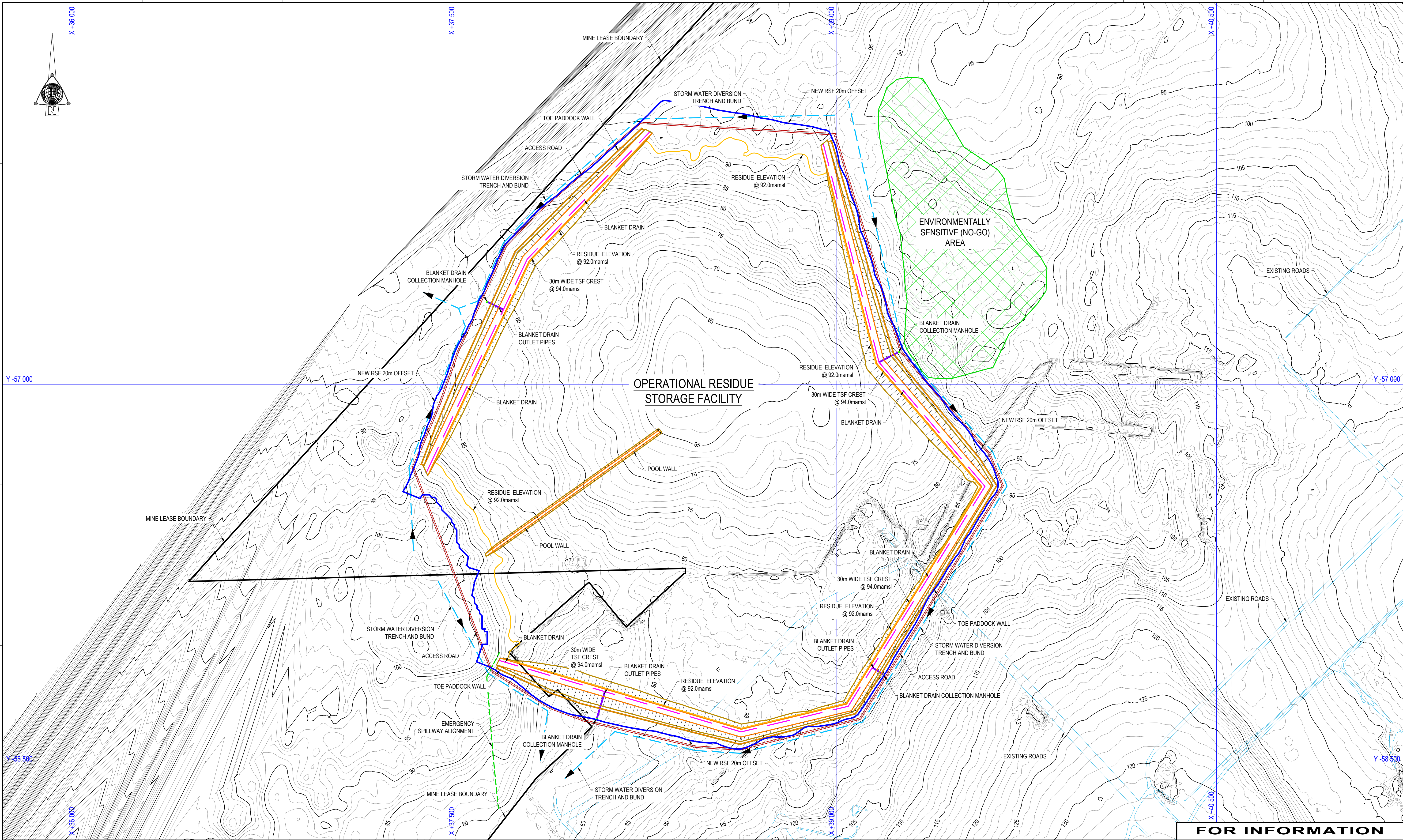

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mine residue and environmental engineering consultants

TITLE
TRONOX PFS
RESIDUE STORAGE FACILITY
OPERATIONAL GENERAL ARRANGEMENT

DRG No. 126-003-900A
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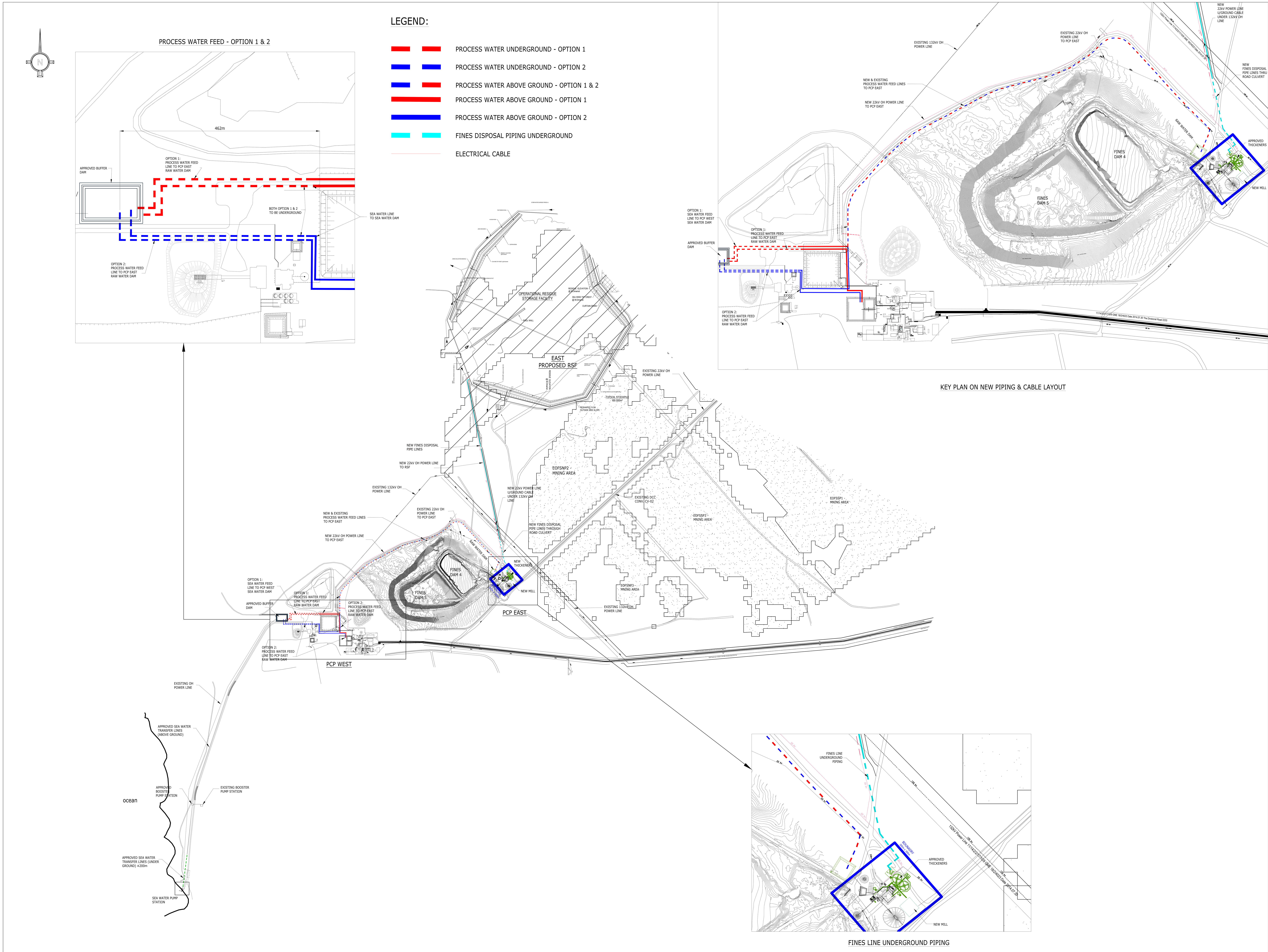

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TRONOX MINERAL SANDS (PTY) LTD
EAST OFS PROJECT FS

REV.	DATE	REVISION DESCRIPTION	DRAWN BY	CHECKED	DESIGN ENG	LEAD ENG	ENG MGR	PM (If Req'd) FLUOR	PM (If Req'd) CLIENT
A	23.09.20	ISSUED FOR INTERNAL REVIEW	Byl	A.S	.	.	.	.	.
B	01.10.20	ISSUED FOR CLIENT REVIEW	Byl	A.S					
C	05.10.20	UPDATED TO CLIENT COMMENTS – SAVE AS OPTION 1	Byl	A.S					
0	05.10.20	ISSUED FOR CLIENT APPROVAL	Byl	A.S					
0A	08.10.20	SEA WATER FEED LINE OPTIONS ADDED	Byl	A.S					

REFERENCE DRAWING NUMBER	REFERENCE DRAWINGS
T1FS-3100-250-PP-001	FINES DISPOSAL PIPE LINE – LAYOUT
T1FS-4163-250-PP-001	SEA WATER TRANSFER LINES – LAYOUT
T1FS-4444-250-PP-001	PROCESS WATER FEED LINE TO PCP EAST – LAYOUT

FLUOR

FLUOR SA (PTY) LTD – Reg Nr 1987/000377/10

TRONOX MINIRAL SANDS (PTY) LTD
EAST OFS PROJECT FS
OVERALL SITE INFRASTRUCTURE
PLOT PLAN - OPTION 1

SCALE	FLUOR DRAWING NUMBER	REV.
1:15000	T1FS-0000-99-PP-001	0A

3.9.2.2 Capacity and Lifespan

The Overburden stockpile will have a capacity of approximately 3.29 Mm^3. Although the stockpile will remain for the life of the East OFS project, it is an interim facility that will only be used until portions of the mined out East OFS pit become available to receive RAS tailings overburden (at which stage disposal at the Overburden stockpile will cease, and overburden will be returned to the pit).

3.9.2.3 Base Preparation

Based on the findings of specialist and technical assessment, Tronox motivate that the “no liner” alternative is the only reasonable and feasible containment design alternative for the Overburden stockpile (see Section 3.8.3) and the “no-liner” alternative is assessed in the EIA.

3.9.2.4 Establishment / Construction

Overburden will be excavated with excavators and loaded onto ADTs in advance of mining, and transported to the Overburden stockpile and back-tipped here during initial stages of mining until portions of the mined out East OFS pit has been opened sufficiently to receive the overburden material.

3.9.3 Upgrades to Seawater Intake

Currently seawater is abstracted at the seawater intake and pumped to the seawater dam located at the SCP. This dam supplies seawater to reservoirs servicing processing plants. Although Tronox is authorised in terms of NEMA to upgrade seawater intake infrastructure and increase the seawater abstraction volume to 57.6 Ml/day for the East OFS project the existing intake does not have the capacity to supply the upgraded PCP East with enough water, and therefore a number of upgrades to the seawater intake and infrastructure have already been authorised (by DMRE) for the East OFS project[19]. A new de-aeration sump with a footprint of ~50 m^2 is also required and is a subject of this application. Two additional high-lift pumps area also required, but will be installed on the approved footprint of the intake (and therefore do not require authorisation in terms of NEMA, NEM:WA or the MPRDA.

The sump is required to de-aerate seawater and improve the capacity of the intake. The sump is indicated in red in Figure 3-20 and would be located on the landward side of existing infrastructure at the intake.

3.9.4 Process (Sea) Water Pipelines

Tronox are authorized to install an additional 4.9 km long pipeline from the seawater intake to the proposed seawater Buffer Dam, in the existing pipeline corridor. This line will be installed _*either*_ below or _*above*_ ground from the seawater intake to the Buffer Dam (Tronox are currently authorized to install this line below ground).

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[19] The following additional or upgraded infrastructure is required and is approved:

- Installation of more effective pumps (including a <50 m^2 expansion of the existing pumpstation);
- Enlarging the gully and suction cage;
- Excavation (by blasting) of the intake gully;
- An additional below ground pipeline from the seawater intake to the proposed seawater Buffer Dam, in the existing pipeline corridor (4.9 km);
- A new booster pumpstation mid-way between existing booster station and proposed Buffer Dam;
- Additional lined seawater Buffer Dam with a capacity of up to 40 000 m^3 south-west of West Mine Fines Dam 1;
- New pipeline from the seawater dam to the PCPE in the existing pipeline corridor within the Mine footprint;
- Raw Seawater dam for PCPE with a capacity of 20 000m3; and
- Associated pumping infrastructure at the proposed new PCPE Raw Seawater dam.

This infrastructure is authorised in amended EMPrs – DMR Reference Numbers: WC30/5/1/2/3/2/1(113) EM and WC30/5/1/2/3/2/1(114) EM - and EA - DEA&DP Reference Number 16/3/1/1/F3/10/3033/14 dated September 2015.

Tronox now propose to install process (sea) water pipelines 1) between the approved seawater Buffer Dam and the Seawater dam (~1 200 m) and 2) between the seawater Buffer Dam and the PCP East (~3 300 m).

Two alternative layouts (routes) for these pipelines are considered feasible by Tronox and are therefore presented as alternatives (see Section 3.8.1.3 and Figure 3-19).

The pipeline between the Buffer Dam and Seawater dam will have Ø513 mm and a maximum throughput of 1 200 m^3 / hour (i.e. 333 l/s). The pipeline between the Buffer Dam and PCP East will have Ø407 mm and a maximum throughput of 1 098 m^3 / hour (i.e. 305 l/s).

3.9.5 PCP East Ancillary Infrastructure

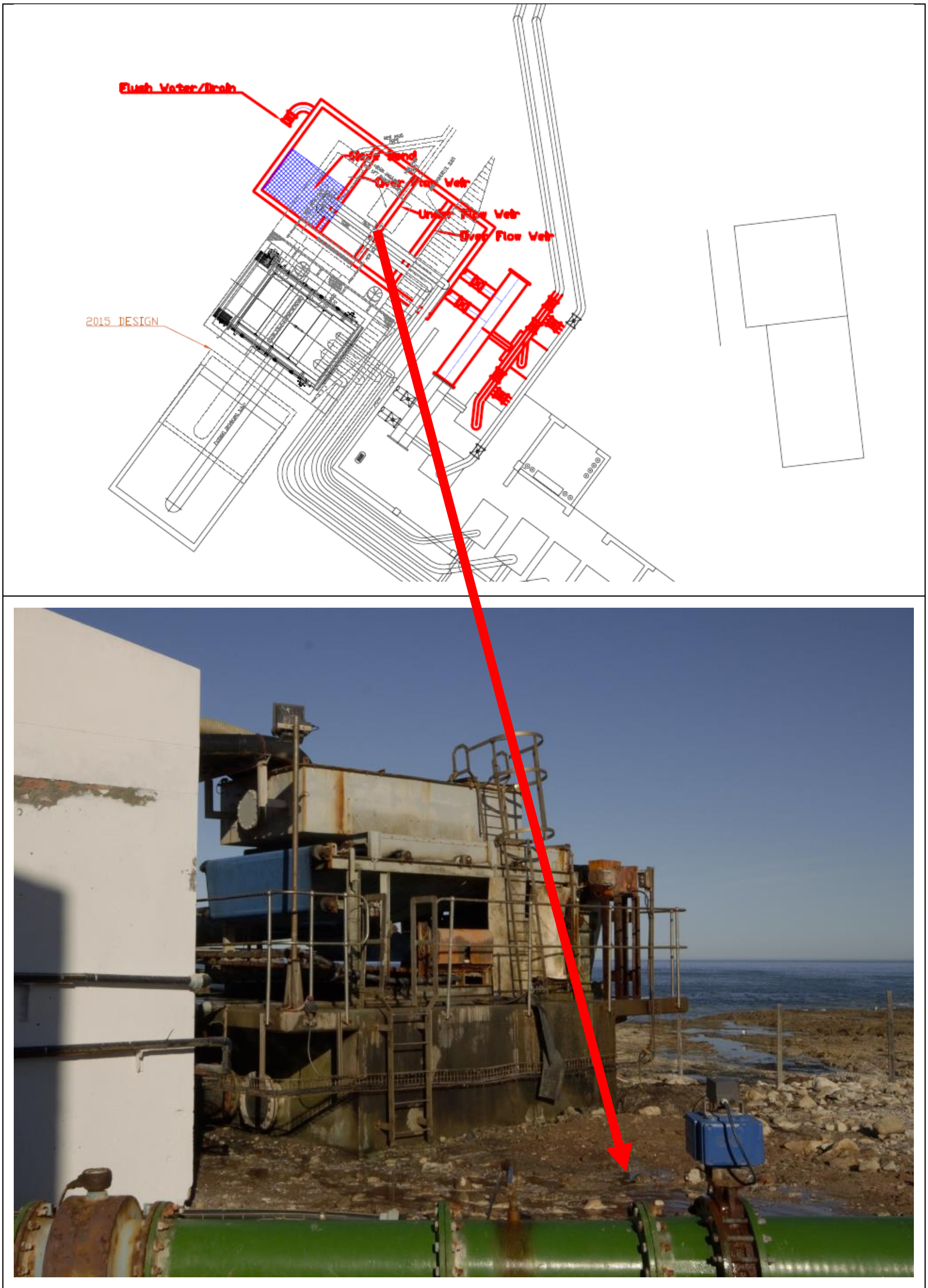
Tronox are authorized to install various infrastructure at the PCP East[20], and will continue to modify and supplement processing infrastructure within the PCP East plant boundary indicated in Figure 3-19.

Unless infrastructure modifications require specific licensing (e.g. relating to the storage of a dangerous good), infrastructure will be installed and modified within this area without the need for Tronox to apply for EA / EMPr amendments for these activities.

[20] The following additional or upgraded infrastructure is required and is approved:

- New ROM stockpile feed conveyor;
- New ROM stockpile with a withdrawal tunnel and belt feeders to three withdrawal points (2ha, 17000t live volume);
- New mills in the Feed Preparation Plant;
- Upgraded cyclones with new spigots and vortex finders;
- New thickener system including two new 35 m diameter thickeners and a new Flocculant Plant;
- New Thickener Feed Tank;
- Two scrubbers to liberate oversize feed from the new ROM stockpile;
- Additional tailing spirals for dewatering;
- Small annex building for new spirals; and
- New Raw Seawater dam for that the East CPE with a capacity of 20 000m^3.

This infrastructure is authorised in amended EMPrs – DMR Reference Numbers: WC30/5/1/2/3/2/1(113) EM and WC30/5/1/2/3/2/1(114) EM - and EAs - DEA&DP Reference Numbers 16/3/1/2/F317300713 and 16/3/1/1/F3/10/3033/14, dated March 2012 and September 2015 respectively.



srk consulting	**TRONOX EOFS DISPOSAL REPORT** Modifications to the seawater intake	Project No. 548215

Figure 3-20: Modifications to the seawater intake

3.9.6 Construction of Powerline

A ~3.5 km long, 22 kV overhead powerline from the Main Consumer Substation to the PCP East will be constructed north of East Mine RSF4 and RSF5 (see Figure 3-19). The powerline will also be extended to the RSF as an underground line in the same corridor as the fines disposal pipelines (see Figure 3-19).

3.9.7 Demolition of Farmhouses

During RAS mining, two farmhouses and an outhouse were retained in the East Mine in order to enhance the post-mining visual character of the Mine. This was technically feasible because RAS mining is a relatively shallow operation. However, the structural integrity of these houses will be compromised by deep OFS mining in the surrounding area and Tronox therefore proposes to demolish them prior to East OFS mining.

3.9.8 Construction Traffic

Very limited additional (public) road traffic will be generated by vehicles delivering new equipment, which will include pipelines, other minor plant and equipment (e.g. new stackers and spreaders).

Baseline road traffic in the area surrounding the Mine is exceptionally low (almost exclusively associated with Mine operations), and the increased road traffic is very conservatively estimated to be an average of fewer than three additional deliveries per week over a one-year period. At times however, the frequency of deliveries may increase to two delivery trucks per day for periods of no longer than one month at a time.

3.9.9 Water Demand and Supply

Tronox utilises water from two sources, namely freshwater from Koekenaap and saline water from the seawater intake located on the coast.

As civil works for the project (the modifications to the disposal plan) will be limited to the construction of the RSF and seawater intake, little additional water will be required for construction, and will not differ significantly from water requirements for mining and processing at the Mine. Additional water supply and storage capacity is not necessary for construction.

3.9.10 Air Quality Management

Sources of emissions during the construction phase include dust generated by construction vehicles and bulk earthworks, as well as exhaust emissions. These will not add to normal operational emissions are already generated during mining operations. Furthermore, the nearest sensitive receptor (the Cawood Saltworks) is located more than 3 km from proposed construction areas.

Dust suppression measures implemented at the Mine will be used during construction. Seawater or non-contaminating chemicals will be applied to active construction areas to prevent entrainment of dust by vehicles.

3.9.11 Noise and Vibration Management

Sources of noise and vibration during construction include construction vehicles and machinery. Mining, processing and the operation and vehicles are already sources of noise and vibration at the Mine and there have been no complaints about operational noise. It is very unlikely that construction activities will materially affect noise receptors, which are located more than 3 km away.

3.9.12 Workforce

An additional ~25 people will be employed as staff members from Feasibility Phase to Implementation Phase. An estimated 300 temporary construction jobs will be generated over the one year construction period.

3.9.13 Investment

Tronox estimates the CapEX to modify the East Mine and construct additional infrastructure required for the East OFS project at R162.5 million. The proposed development will allow the Mine to continue its operations and procure approximately R900 million worth of goods and services annually from within the local economy and contribute approximately R100 million annually in royalties.

3.9.14 Construction Schedule

The RAS resource in the East Mine will deplete in mid-2024, and therefore the East OFS project must come online by this date. Detailed design and construction will take two years and two months, and one year and two months respectively (i.e. a total of 3 years and four months). Tronox therefore aim to receive all of the necessary approvals for the project by mid-2021.

3.10 East OFS Project Operations

Although this application relates only to changes in the East OFS project disposal plan (referred to as the project), it is necessary to provide a description of existing overall operations and/or authorised but not yet implemented operations of the East OFS project in order to describe how the proposed modifications fit in to the overall East OFS project mine plan.

3.10.1 Site Preparation

Mining areas will be cleared of all vegetation and a minimum of 5cm of topsoil will be harvested with bulldozers before mining takes place. Topsoil will either be stockpiled temporarily or transported directly to backfilled areas where it will be used for rehabilitation.

Overburden (RAS tailings from previous mining in the area) will be excavated in advance of mining and initially stored in an Overburden stockpile east of the proposed RSF (see Figure 3-21). Once the mining pit has been mined sufficiently for safe backfill operations to take place overburden material will be backfilled to the pit (to a minimum depth of 1m) prior to rehabilitation (see Section 3.11.2).

Two semi-mobile ROM tips will be constructed in the East Mine during initial site preparation – ROM Tip 1 near the Start-up Pit, and ROM Tip 2 near the site of STF 2. Sacrificial conveyors will connect the ROM tips to branch conveyors and thereafter trunk conveyors which discharge to the DCC.

Semi-mobile ROM tips will be moved to the active mining face periodically over the life of the mine.

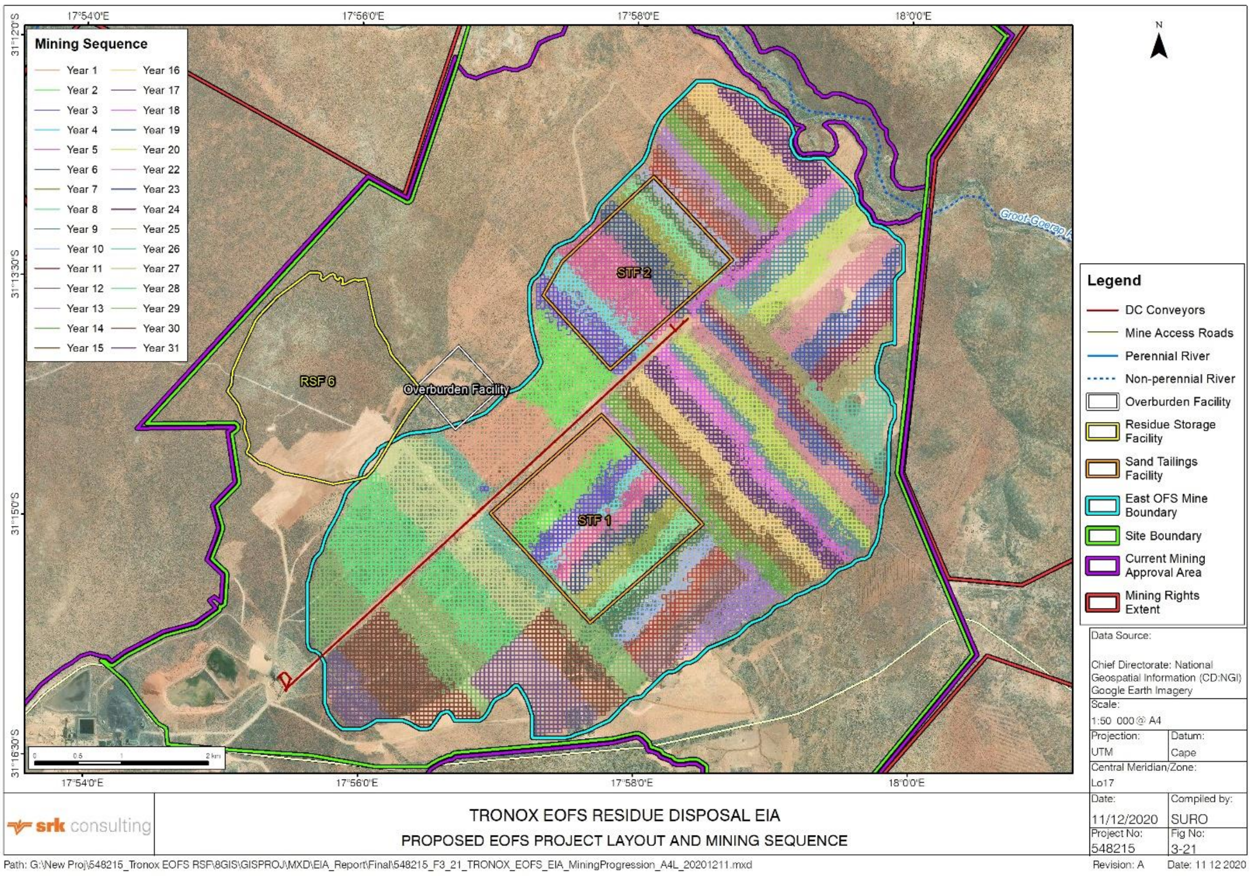


Figure 3-21: East OFS project layout and indicative mining sequence

3.10.2 Ore Extraction and Transport

Following site preparation (topsoil clearing and RAS tailings overburden removal), front end loaders will excavate OFS ore to an average depth of 7 m and will load the ore to haul trucks, which will transport the ore to the nearest ROM Tip. ROM will be conveyed from the tips to the DCC, and on to the PCP East ROM Stockpile.

East OFS mining will start simultaneously on the footprint of STF 1 and at the Start-up Pit[21]. From the Start-up Pit, mining will advance perpendicular to the DCC in a north-easterly direction towards the footprint of STF 2 towards the Groot-Goeraap River (see Figure 3-21). Mining at STF 2 will proceed across the footprint of this facility in a south-easterly direction parallel to the DCC before moving in a southerly direction (see Figure 3-21).

Tronox plans to mine 8.6. Mtpa of East OFS for the life of the project.

The mining sequence presented in Figure 3-21 will depend on operational and economic conditions and is therefore subject to change.

3.10.3 Seawater Abstraction and Storage

Seawater will be abstracted at the seawater intake and pumped to the approved seawater Buffer Dam located south-west of West Mine RSF1, near the PCP West and SCP (see Figure 3-4 and Figure

[21] A pit that will be excavated (mined) by Tronox in the initial stages of the East OFS project to create airspace for the disposal of tailings at the start of the project.

3-19), from where it will be pumped to the PCP East for processing East OFS ore in new pipelines proposed as part of this project (see Section 3.8.1.3 and Section 3.9.4).

3.10.4 Processing

3.10.4.1 Primary Concentration

Ore on the DCC will be transported to the new ROM stockpile via a new ROM feed conveyor. A withdrawal tunnel at the ROM stockpile will convey ROM to the existing PCP East feed conveyor and ultimately to the Feed Preparation Building at a wet setpoint[22] of 1 066 tonnes per hour (tph) (1 345 tph dry). Process (sea) water will be added in the Feed Preparation Building (from the existing Process Water Storage Dam) and the ore milled and screened. Oversize will be transported back to the PCP East feed conveyor for further milling.

Fine residue will then be removed from the slurry in cyclones. Overflow and excess water from the cyclones will gravitate to the new thickener feed tank. Slurry from the thickener feed tank will then be pumped to a new thickener system where flocculant will be added. Overflow from the thickener system will be gravity fed to the existing process water dam and underflow will report to the fine residue transfer tank before being re-slurried and pumped initially to the existing East Mine RSF 4 and RSF 5 and ultimately to the new East Mine RSF (see Section 3.10.6).

The concentrate from the fines removal cyclones will be fed to spirals where tailings will be extracted. Concentrate from the spirals will then be pumped to the SCP for further processing. Tailings will be dewatered (as far as possible) in cyclones and sent for disposal (see Section 3.10.5).

No chemicals other than flocculant are used in processing; however, seawater elevates salinity levels in residue (sand tailings and fines).

Note that the OFS material in the East Mine has a higher fines content and a lower grade than the RAS material. It is also “sticky” and contains lumps composed of agglomerated mineral sands particles. Due to the difference in ore characteristics, processing of OFS ore at the existing PCP East (as-is) is not possible and upgrades/modifications are therefore required and are already authorised.

3.10.4.2 Secondary Concentration

Secondary concentration is undertaken at the SCP at the Mine (see Figure 1-2). The SCP will receive concentrate from the upgraded PCP East at a predetermined grade and separates the magnetic (ilmenite) from the non-magnetic (zircon, rutile and leucoxene) material. During separation, valuable heavy minerals are upgraded.

Fine residue is also produced at the SCP and is disposed of at the authorised, active fines disposal facility in the West Mine.

3.10.4.3 Mineral Separation

Mineral separation is currently undertaken at the MSP near Koekenaap, where the magnetic stream from the SCP is treated to produce ilmenite for the Smelter and the non-magnetic stream is treated to produce zircon and rutile final products. This process will remain unchanged.

[22] The design, or target, throughput.

3.10.5 Sand tailings management

3.10.5.1 Sand Tailings Transport

Dewatered, moist tailings will be conveyed from the dewatering cyclones onto a dewatering screen circuit and then to the DCC on an existing tailings conveyor. The DCC will then transport sand tailings to the active mining block.

Prior to the commencement of mining, tailings will be transported to the RSF site in ADTs to commence wall construction. The current planning is that in the initial stages (first ~4 months) of mining, tailings will be conveyed to a spreader unit at the RSF and used to build the RSF walls. Thereafter, ADTs will continue to haul sand tailings from load-out bins at the DCC and backfill mined out areas of the East OFS pit to a minimum depth of 1 m (therefore leaving an on average 8 m void in most of the East OFS Mine pit) or the STFs.

Following the initial advance (excavation) of the mining face within the designated STF sites, crawler mounted stackers and spreader units will be mounted on ~1.6km long branch conveyors, installed perpendicular to the DCC, which will feed tailings to the stacker. Spreader units on the stackers will disperse sand tailings at the STFs. As the mining face advances, the branch conveyors (and mounted stackers) will be moved forward. Establishment of the STFs (i.e. deeper sand tailings deposition) will therefore follow the progression of mining (parallel to the DCC at STF 1 and perpendicular to the DCC at STF 2 – see Figure 3-21).

Each STF will be on average 6 m above the highest, pre-mining, topographical point at their respective footprints (i.e. a minimum of, on average, 14 m above current ground level as at least 1 m of RAS overburden and on average 7 m of OFS will be excavated in the STF footprints). The STF outer walls will have a slope (angle of repose) of 35^o and will have a flat surface. STF walls will be sloped to an angle of 1:5 prior to closure.

STF 1 will have an approximate footprint of ~290 ha and a length and width of 1 700 m, at the location indicated in Figure 3-21. STF 2 will have an approximate footprint of ~250 ha and a length of 1 900 m and a width of 1330 m, at the location indicated in Figure 3-21.

STF 1 and STF 2 will have storage capacities of approximately 97 Mm^3 and 60 Mm^3 respectively. The combined capacity of these facilities is sufficient to accommodate approximately 31 years of sand tailings production from the East OFS project (see Table 3-13). Both STFs will be operational throughout the life of the East OFS project.

Table 3-13: Sand tailings and overburden balance

Material	Unit	Value
Dry tailings produced	Mm^3	125.5
Wet tailings produced	Mt	251.8
Overburden	Mt	56.8
Total to be backfilled into pit	Mt	308.6
RSF walls deposition	Mt	6.5
Start-up pit deposition	Mt	16.5
STF1 deposition	Mt	167.8
STF2 deposition	Mt	80.8
Pit backfill	Mt	40.3
Total backfill / deposition	Mt	312.1
Balance	Mt	-3.5

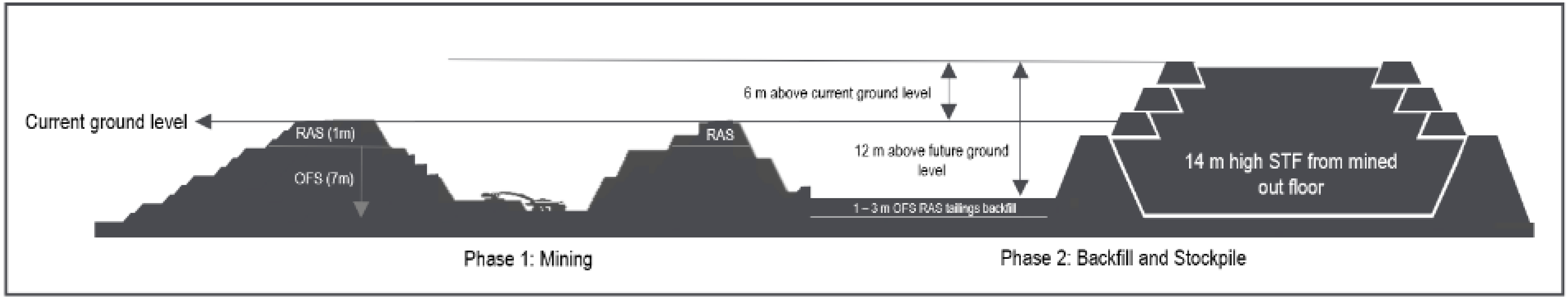


Figure 3-22: Indicative schematic of EOFS approach to sand tailings disposal

3.10.5.2 Pit Dewatering

Sand tailings will have maximum 20% moisture content at disposal, and Tronox estimate that 60% of this water seeps out and evaporates over time, the remaining 40% infiltrating to groundwater. SRK has calculated that ~3 600 m^3/d of process water will be deposited with tailings (into the pit and STFs – Appendix D1) but has conservatively assumed that only 40% of process water will evaporate or be returned to the RSF, and 60% will infiltrate.

Pit dewatering is required to remove the water seeping from tailings and return it back to the PCP East. Excavated trenches will capture seepage water from STFs. This water will then be pumped to the RSF and returned to the plant (or pumped directly into water bowsers to dampen mining access roads).

The systems will consist of submersible pumps in the pit pumping to a transfer tank, and transfer pumps pumping the water back to the RSF or to the PCPE.

3.10.5.3 Erosion Management

Wind will erode the walls of the STFs and wind erosion protection (netting) will be placed on embankments on inactive slopes.

3.10.6 Fine Residue Management

3.10.6.1 Fine Residue Transport

Following thickening at the PCP East, fine residue will initially be pumped in existing pipelines to East Mine RSF 4 and RSF 5[23]. Once the new RSF has been constructed, fine residue will be pumped to the new RSF in two new fines transfer pipelines (see Figure 3-19).

Tronox anticipates that a fines density of 1.13 t/m^3 will be maintained and that the mass of seawater in fines will be ~80%.

3.10.6.2 Fine Residue Deposition

The RSF will be designed to accommodate ~1.945 Mt / 0.73 Mm^3 per annum of dry-fine residue (slurried with 11.2 Mt / 10.47 Mm^3 of seawater) over a 20 year period.

An open-ended deposition pipeline with multiple flexible hoses (“lay flats”) directing residue into the facility will be installed on the crest of the RSF walls (see Figure 3-23).

3.10.6.3 Fines Deposition Management

As fines are deposited in the RSF, a beach is formed by the consolidated material, providing a profile in which the supernatant pool is controlled by the operator. The tailings beach profile provides a form of freeboard that prevents the pool from encroaching on the upstream face of the containment wall, thereby reducing the risk of seepage, environmental spillage, and overtopping.

Fine residue will be hydraulically placed from “open ends” and “lay flats” at the top of the RSF inner-crest into the depression so that natural segregation of coarse(r) and fine(r) material is achieved (see Figure 3-23), and the supernatant pool forms at the centre of the facility, and the coarse(r) residue “beaches” or settles at the discharge points / walls.

[23] The East Mine RSFs 4 and 5 are estimated to have 300 000 m^3 and 2.5 Mm^3 of capacity remaining and available at the termination of RAS mining in the East Mine respectively. This storage capacity would provide approximately 12 months of residue storage for the East OFS project.

	TRONOX EOFS DISPOSAL REPORT Reside deposition in RSF	Project No. 548215

Figure 3-23: Reside deposition in RSF

3.10.6.4 Process Water Recovery

Capturing and removing water from RSFs is a high priority, to increase the rate of compaction/consolidation (the smaller the supernatant pool is kept, the higher the rate of surface consolidation), reduce the demand for seawater and electricity, and minimise percolation of seawater into the environment.

Tronox anticipate that ~60% of process water (~17 700 m^3 per day – 6.4 Mm^3 per annum) will be recovered from the RSF in an average rainfall year - on average 800 m^3/h of water will be recovered from the RSF supernatant pool by a floating barge system operating for ~22.5 hours a day.

The RSF must hold at least 20 000 m^3 of process water in the supernatant pool during normal operating conditions (Epoch, 2020) to prevent damage to the floating barge. Pumps at the facility have the capacity to return all of the process water available for return during normal operating conditions, thereby maintaining the minimum volume.

Pumps will have sufficient capacity to return 860 m^3/hr (see Section 3.10.7).

3.10.6.5 Freeboard Limit

A freeboard limit of 1 m will be applied at the new RSF.

As the facility will be constructed to its final elevation before deposition takes place, this results in a substantial freeboard that slowly decreases as fine residue is deposited within the basin of the RSF. Geometric modelling of the RSF indicates that the minimum available freeboard between the surface of the maximum operating pool and the non-overflow crest of the facility is estimated to be 2.61 m, with a beach freeboard of 1.61m and a primary freeboard of 1m.

3.10.6.6 Stability and Erosion Management

The loose composition of the tailings will lead to some settling of the RSF walls, mostly while under construction. Deposition of fines may increase the loading of the internal embankment slope, causing further settling.

The RSF will be designed in order to achieve a Factor of Safety (FoS) of 1.5 as required by GN R632 of 2015. Initial slope stability analyses of the RSF were carried out to determine the FoS, based on anticipated material properties of the soils and tailings, and the phreatic surface characteristics from the seepage results. The results of the slope stability assessment indicate that the RSF will be stable under the conditions modelled, with the preliminary strength parameters and geometry used.

The stability of the internal embankments (i.e. the inner slope of the RSF walls) will be maintained by:

- Spreading the fines away from the walls to promote beaching of coarser material against the walls, to ensure that supernatant water does not undermine the slopes[24]; and
- Pumping as much excess water from the supernatant pool as soon as possible to minimise wave action.

Wind will erode the walls of the facility and wind erosion protection (netting) will be placed on outer embankments, and the RSF crests must be inspected, surveyed for elevation and maintained at the design height.

3.10.7 Surface and Stormwater Management

The RSF would be located in an enclosed basin (non-draining catchment) (see Section 4.1.7). Most of this non-draining catchment will be remined for the East OFS project and backfilled with RAS and sand tailings (with high infiltration rates). Therefore, only very little runoff towards the facility is anticipated. Nevertheless, both the Mine and MSP are compliant with the requirements of NWA Regulation 704 which require that clean and dirty water streams are kept separate to prevent contamination and minimise the use of clean water. Therefore, stormwater diversion berms and bunds will be installed to divert stormwater away from the RSF (see Appendix C2) – stormwater emanating from the east and south west of the RSF will be discharged to the south, and stormwater emanating from the north and west of the RSF will be discharged to the north west) and Overburden stockpile (see Figure 3-17).

3.10.7.1 RSF

The ~311 ha top surface of the RSF effectively comprises a “catchment”. Assuming a conservative design storm event (1:50 year, 24 hr period) of 69 mm (see Section 4.1.4.1) at the Mine, the maximum water level expected in the RSF during operations (i.e. ~43 000 m^3) plus the design storm event would result in total water volume in the RSF of ~258 000 m^3. In the event of such a storm event, the RSF could temporarily safely store a maximum of 1.80 million m^3 of water without overtopping the primary freeboard, far exceeding the volume required to store the operating pool volume and run-off from the design storm event.

At a pumped discharge rate of 860 m^3/hr, the pond would be returned to normal operating conditions in approximately 277 hours.

3.10.7.2 STFs

STF 1 will be located in a basin and STF 2 will be partially situated in a catchment that drains towards the Groot Goeraap River (see Section 4.1.7.1 and Appendix D2). During extreme storm events, runoff from STF 2 could therefore reach the river, carrying sediments. Ultimately STF 2 will be revegetated, but until that time large storm events may mobilise sediments, particularly on the steep side slopes of the STF. Therefore a few very short diversion berms to contain or divert water away from the Groot Goeraap River and thus prevent any transported sediment from reaching this point will be installed.

3.10.8 Ancillary Mine Facilities

Tronox office, ablution, medical and workshop facilities will be used as appropriate.

[24] GN R632 of 2015 indicates that supernatant pool must be kept at least 50 meters from the walls

3.10.9 Electricity Demand

Eskom currently supply the Mine with 30 MVA electrical supply capacity. An additional 3.5 MVA will be required for the project.

Initial communications with Eskom indicate that this additional capacity is available (see Appendix E).

3.10.10 Water Demand

Tronox utilises water from two sources, namely freshwater from Koekenaap and seawater from the seawater intake located on the coast (see Figure 3-4).

Water use requirements are as follows:

- Freshwater for domestic purposes as well as make-up water used to remove salt from the magnetic and non-magnetic concentrates produced at the SCP; and
- Seawater in the PCP West and East as well as for magnetic and non-magnetic separation at the SCP.

No additional freshwater will be required for the project.

3.10.11 Effluent and Wastewater Management

As only relatively few additional employees will be employed (taking into account total employment at the Mine), very little additional domestic effluent and wastewater will be generated by the project.

Domestic wastewater at the East Mine is collected and treated in the existing sewage treatment plant.

Process water from the primary and secondary concentration plants is recycled, with some water losses to evaporation and seepage from (moist) fines and tailings deposited in STFs, the RSF and mined out areas.

3.10.12 Solid Waste Management

Hazardous waste will be collected and temporarily stored on-site for collection by registered waste management companies.

Domestic waste, defined as waste that does not pose an immediate threat to man or the environment, will be collected and taken to the existing private, licensed solid waste disposal site.

3.10.13 Air Quality Management

Tronox implements dust suppression measures to reduce dust emissions from exposed areas such as haul roads, areas under rehabilitation, the mining face and stockpiles. This practice will continue for the East OFS project.

The Mine currently experiments with different types and combinations of dust control measures and is in the process of determining the most sustainable method.

The following general dust mitigation measures will continue to be applied in the East Mine:

- Water or non-contaminating chemicals will be applied to un-surfaced roads to prevent entrainment of dust by vehicles;
- The size of areas exposed by the removal of topsoil and vegetation will be minimised as far as possible;
- Mined-out areas as well as other disturbed areas will be revegetated and stabilised with windbreaks as soon as practically possible;
- Windbreaks will be constructed in dusty areas, as required;

- Windbreaks (750 mm high shade netting) will be installed 5 m apart on RSF and STF walls, rehabilitated areas, buffers for sensitive areas and edge effect buffer areas in order to minimise sand drifts and dust generation; and
- Dust will be monitored in different areas of the site in order to improve the effectiveness of the dust and sand control program.

3.10.13.1 Dust Monitoring

Tronox monitors dust at the boundary ("fence-line") of the Mining Right Area as depicted in Figure 3-24. Dry monitoring "buckets" are collected monthly and sent to a laboratory and analysed in accordance with procedures in the Dust Control Regulations, 2013.

The fence-line dust fallout limit is 1 200 mg/m^2/day (average over 30 days), with allowance for two exceedances each year. Actions to correct exceedances must comply with the requirements of NEM:AQA and the Dust Control Regulations, 2013.

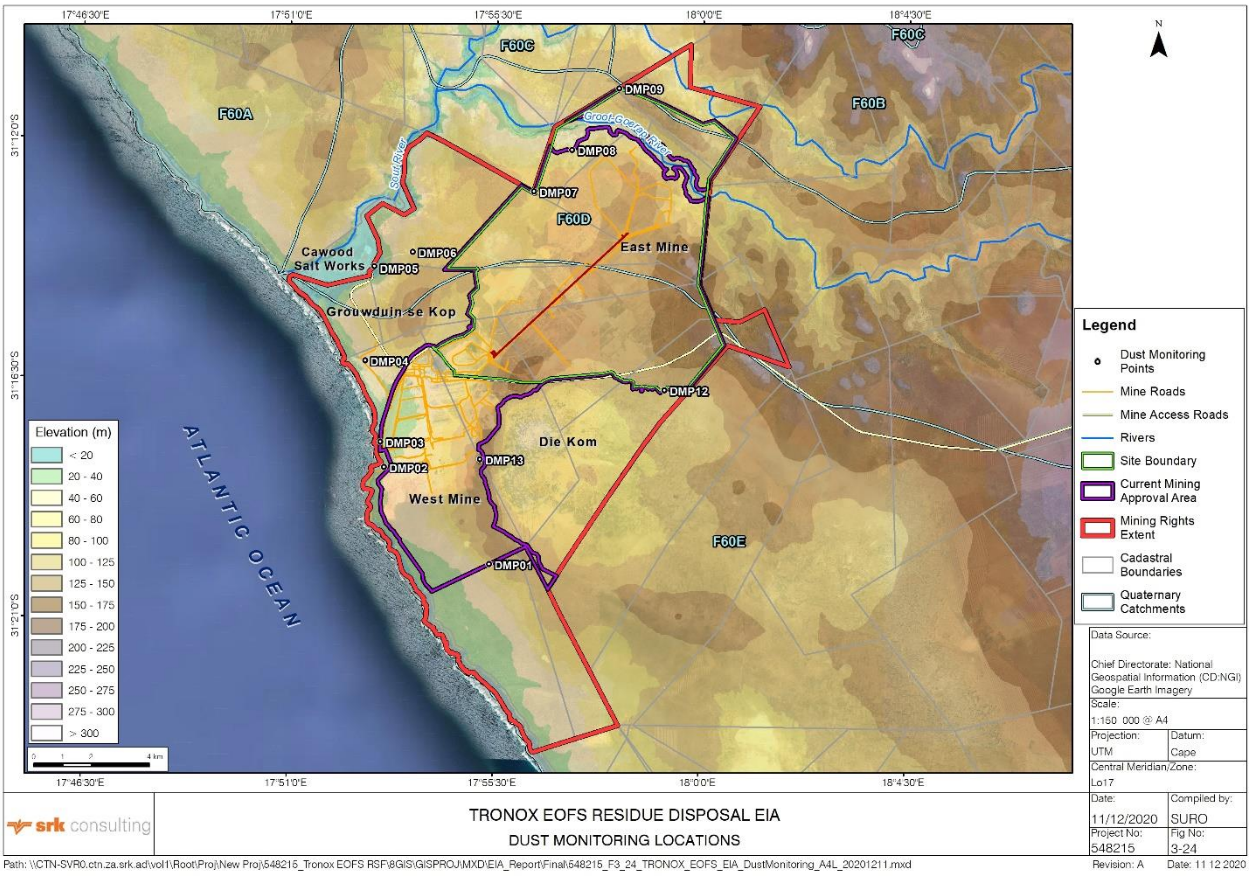


Figure 3-24: Dust monitoring locations

3.10.14 Workforce

The Namakwa Sands operation (including the smelter in Saldanha Bay) employed approximately 1 200 people as at May 2019; of which, ~80% fall within the category of Historically Disadvantaged (South African) Individuals.

Relatively few additional permanent jobs will be generated by the East OFS project.

According to the previous Matzikama SDF (2010), in 2010 the Namakwa Sands mine was estimated to employ, either directly or indirectly, up to 60% of people employed in the local municipality (Headland Planners, 2014).

3.11 Decommissioning and Closure

Tronox's closure Plan for the Mine addresses all operational sites. The Closure Plan has been compiled in accordance with the commitments contained in the approved EMPrs and the requirements of the MPRDA.

This plan is reviewed, and independent verification of the closure cost estimate is done on an annual basis. The last independent verification of the closure cost was completed in 2019. The closure cost estimate for the East OFS project is appended as Appendix C4. The closure cost estimate for the Mine will be increased by this amount.

When the holder of a Prospecting or Mining Right, Mining Permit or Reconnaissance Permission intends closing operations, EA is required in terms of NEMA, informed by an EIA process. Furthermore, an Environmental Risk Report (including an Environmental Impact Assessment) and up to date Closure Plan must accompany the application for closure. The requirements of such a risk report are contained in Regulation 60 of the MPRDA Regulations. Tronox will need to comply with these requirements at closure.

Closure methods that will be employed are described below.

3.11.1 General Closure Activities

General closure activities that are undertaken as part of closure, and will continue to apply to the East Mine are as follows:

- Consult with various stakeholders as required by NEMA in the period prior to decommissioning in order to determine the best end land use and what infrastructure could be reutilised;
- Demolish facilities and infrastructure. Sell recoverable material and bury other rubble and material *in situ*;
- Assess sites for contamination and, as far as practicable, treat wastes *in situ* or remove for appropriate disposal;
- Establish vegetation through rehabilitation and monitor until self-sustaining on all areas (see Section 3.11.2.1) so that the agreed final post closure land use (small-stock grazing) is achieved;
- Fill and shape all mining voids (to 1:5 edge slopes or less steep slopes) as appropriate, reshape stockpiles to an approximately 1:5 slope and institute erosion control measures by profiling the shape of constructed slopes to mimic natural landforms where possible (see Section 3.11.3); and
- Monitor all areas to confirm whether rehabilitation has been effective such that a closure certificate can be issued. Aspects to be monitored could include physical stability and re-vegetation success. The duration of monitoring required prior to the issuing of a closure certificate is unclear at this point in time.

3.11.2 Rehabilitation of Backfilled Areas

The objective of rehabilitation at the Mine is to landscape and revegetate mined out areas with indigenous vegetation in conjunction with active mining while ensuring the safety of workings, minimising erosion and restoring land to a condition capable of sustaining the pre-mining land use, namely dryland small-stock grazing.

The following methods will continue to apply at the East Mine for the East OFS project, including the STFs:

- Vegetation and topsoil are removed prior to mining;
- Mining proceeds (see Section 3.10.2);

- Tailings are returned to mined out areas during operations (see Section 3.10.5);
- Mined out areas are landscaped / re-profiled:
  - The mostly flat – perhaps slightly convex – STF top surfaces are to be profiled to be free-draining and stable without pooling of water;
  - Slopes (including that of STFs, pinnacles and pit edges) are to be profiled to a slope not exceeding 1:5 (see Figure 3-25); and
  - Surface water flow / drainage is taken into consideration during final profiling and sloping in order to prevent erosion;
- Windbreaks are installed;
- Profiled areas are revegetated during the growing seasons thereby minimising required area of rehabilitation on closure;
- Rehabilitated areas are monitored to establish rehabilitation success; and
- Ultimately mined out areas are returned to small-stock grazing.

3.11.2.1 Topsoil and Vegetation Removal, Reprofiling and Replacement

The following general procedures are followed for topsoil and vegetation removal prior to mining:

- At least the top 50 mm of topsoil is removed from mining areas prior to any major disturbance (e.g. haul road construction or mining);
- Following tailings and overburden backfilling, the backfilled pit is profiled to mimic the natural landscape form as far as possible;
- Topsoil and vegetation are either stored for the short term (less than three months), or returned immediately to mined out areas where tailings have been backfilled and profiled; and
- Topsoil is then spread in areas where tailings have been profiled.

3.11.2.2 Erection of Windbreaks

Windbreaks perpendicular to the prevailing wind direction are erected at 5 m intervals in order to control wind erosion and prevent loss of topsoil and the seedbank.

3.11.2.3 Re-vegetation

The current techniques used for revegetation are well documented. These include a combination of recruitment from seed, supplementation through the broadcasting of hand harvested indigenous seed and transplants harvested directly in the veld following rain events. Furthermore, topsoil is managed to ensure that maximum germination of indigenous species can occur.

3.11.2.4 Monitoring

Historically, vegetation has been sampled at a number of rehabilitation sites and natural (reference), but different techniques have been applied. As a consequence, previous studies provided only a subset of the biodiversity and ecosystem attributes required (principally plant species presence and cover).

In 2016 comprehensive monitoring protocols were developed for both rehabilitation and reference sites, drawing on established mine closure principles and integrating an understanding of key drivers of biodiversity and ecosystem functioning for the Sandveld and Sand Fynbos bioregions of Namaqualand.

The primary purposes of the monitoring protocols are to assess the success of the rehabilitation programme undertaken at Namakwa Sands to date, in terms of the recovery of biodiversity (plant species richness), ecosystem function and grazing value, and to demonstrate progress in achieving closure over time (i.e. through ongoing monitoring). The results of monitoring are also intended to inform adaptive management of rehabilitation practices on the Mine; and secondly, to monitor ecosystem recovery as an indicator of progress toward closure targets.

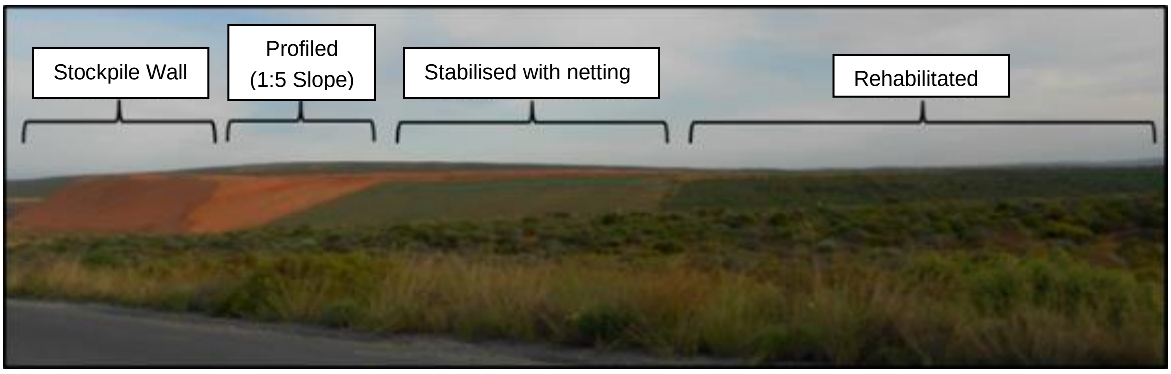
Thirty five rehabilitation sites and 15 reference sites were monitored using the new monitoring method for the first time in 2016. On-going monitoring at these sites were conducted again in 2020, including a more detailed assessment into soil chemistry in rehabilitated areas.

3.11.3 Rehabilitation and Closure of RSFs

The closure objective for residue stockpiles is to return these facilities to their pre-mining land use both physically and ecologically (i.e. low density stock agriculture) as soon as practically possible after the completion of residue deposition. In the case of RSFs, this will only be possible in the long-term.

The existing closure criteria for fine residue disposal facilities at the Mine, which will be applied to the RSF, are as follows:

- Cap RSF dam crests with tailings (in this case, RAS tailings overburden from the Overburden stockpile) to have a safe and stable surface;
- Profile side slope to a 1:5 or less steep to produce an overall profile that mimics the natural topography, eliminating any geometric patterns and/or profiles (see Figure 3-25);
- Take surface water flow / drainage into consideration during final profiling and sloping of fine residue dams wall in order to prevent erosion;
- Cover the profiled RSFs (walls and crests) with a growth medium (average depth of 50mm) and protect with windbreaks (see Figure 3-25); and
- Establish a sustainable indigenous vegetation cover on all fine residue dams (walls and crests) that will support the overall closure criteria for the Mine (see Figure 3-25).



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Residue stockpile wall rehabilitation at Namakwa Sands Mine | Project No. 548215

Figure 3-25: Residue stockpile wall rehabilitation at Namakwa Sands Mine

The key issue for RSF closure is how to gain access onto the unconsolidated fines **surface** (the top 5 m to 10 m of the fine residue body) to place the capping layer. Although financial provision has been made for the closure of RSFs and Tronox has made progress in capping RSFs in the West Mine, Tronox is yet to achieve full functional closure of any of their RSFs.

3.11.4 Rehabilitation Progress and Success to Date

Opencast mining results in the complete loss of established vegetation communities. In the East Mine where shallow RAS mining has already taken place for ~25 years, ~4 400 ha of the ~4 750 ha mined area are under active rehabilitation (including ~2 500 ha which are in an advanced stage of rehabilitation – i.e. vegetation has established to such an extent that it has been possible to remove windbreaks in these areas).

A 2016 rehabilitation monitoring study revealed that:

- All rehabilitation sites were on a path towards being restored (in other words no sites were deemed to be undergoing secondary degradation and negatively impacting surrounding areas);
- Rehabilitation sites have on average 54% of the species richness of all the reference sites (but all the rehabilitation sites only have 37% of the species composition of all reference sites);
- Rehabilitation sites have on average 33% of the mean plant species abundance of reference sites;
- Rehabilitation success was variable at rehabilitation sites in the East and West Mines, but plant species abundance and diversity are generally higher in the East Mine (and East Mine rehabilitation sites are more ecologically similar to reference sites);
- While mean grazing scores of all rehabilitation sites were only 32% of reference sites (i.e. on average it would require 23 ha to sustain one Small Stock Unit (SSU) in rehabilitated areas, compared to a baseline grazing value of 7.5 ha / SSU); and
- Mean grazing scores of rehabilitation sites in the West Mine were on average higher than rehabilitation sites in the East Mine.

4 Description of the Affected Environment

This chapter presents an overview of the biophysical and socio-economic environment in which the proposed project is located, to:

- Understand the general sensitivity of and pressures on the affected environment;
- Inform the identification of potential issues and impacts associated with the proposed project, which will be assessed during the Impact Assessment Phase;
- Identify gaps in available information to inform specialist study requirements; and
- Start conceptualising practical mitigation measures.

It is important to note that the project is located entirely in an area that was historically mined and/or is approved for mining. As such, the project description focuses more on a general overview of the surrounding baseline environment, with some specific focus on those aspects that could be affected by the project.

The baseline is based on literature review and previous studies undertaken in the study area, e.g. the EIAs for the West Mine Fines Dam 6 (SRK, 2017) and East Mine Expansion (SRK, 2015). Where appropriate, baseline information has been supplemented or generated by specialists appointed to undertake baseline and impact assessments for the proposed project.

The specialist baseline and impact studies undertaken for the EIA process are listed in Table 4-1.

Table 4-1: Specialist studies undertaken for the EIA

Specialist Study	Specialists	Organisation
Surface Water	Xanthe Adams	SRK Consulting
Groundwater	Ms Sheila Imrie	SRK Consulting
Biodiversity	Dr Liz Day	Liz Day Consulting
Heritage	Mr Tim Hart	ACO
Visual	Ms Sue Reuther	SRK Consulting

Final specialist baseline and impact assessment reports are attached as Appendices D1 to D6.

4.1 Biophysical Environment

4.1.1 Topography

The topography of the area, together with the semi-arid climate and the proximity to the coast, have determined the basic landscape features and visual elements of the study area. Local topography can be conceptualised as comprising four topographical units (see Figure 4-1):

- A coastal strip with rocky outcrops and wave-cut platforms, separated by isolated beaches in small bays, and a primary dune belt. Brand se Baai is one of the many small bays along the coast;
- Sand covered coastal plain with vegetated dunes rising steeply to a ridgeline east of the site;
- Moderately undulating inland plains and hills carved by ephemeral rivers, with north-south aligned vegetated sand-dunes with rocky outcrops more dominant to the north of the Mine; and
- A relatively steep-sided valley along the Sout River estuary, with the ‘Soutpan’ near the confluence of the Sout River, Groot- and Klein-Goeraap Rivers to the north of the site.

Coastal strip: Rocky coastline with small sheltered bays

Coastal plain: Sand covered, rising steeply from the coast to a ridgeline

Undulating inland plains and hills

Sout River estuary

srk consulting	**TRONOX EOFS DISPOSAL PROJECT** Topographical units	Project No. 548215

Figure 4-1: Topographical units

The landscape, other than near watercourses, is relatively flat but a number of hills or ‘koppies’ are evident, including Peddie-se-Kop (139 meters above mean sea level [mamsl]) and Grouwduin-se-Kop (147 mamsl) to the north of the Mine, Sandkop (216 mamsl) to the east of the Mine and Kalkbaken-se-Kop (158 mamsl) to the south of the Mine. A dominant ridgeline also exists between the Groot and Klein-Goeraap river systems. A local depression (calcrete pan) known as Hartebeestekom (or the Kom) is situated south of the East Mine.

Elevations at the Mine range from 150 mamsl in the east to less than 20 mamsl in the west. The highest elevation occurs along a ridge in the southeast of the mine site. The mine spans portions of the coastal plain and undulating inland plains and hills.

The topographical landscape of the study area has been significantly modified by current mining activities, through backfilling, rehabilitation and revegetation.

4.1.2 Soils and Land Capability

The soils throughout the area are predominantly red and yellow medium-grained sands and are mostly wind-blown sands originating from the marine deposition (Golder, 2008). Terra Africa Consult (2014) identified the following soil groups / forms: Clovelly / Pinedene, Garies / Oudtshoorn / Bloemdal / Tukulu, Katspruit, Mispah, Shallow Hutton, Red & yellow apedal soils on dorbank / carbonate horizons, Prieska form and Endorheic pans.

The soils generally have a low nutrient reserve and low fertility and have extremely low water holding capacity / drain well, making rehabilitation processes difficult but reducing stormwater flow potential and erodibility (which is considered low).

Land capability refers to the potential of the land to support activities. The dominant agricultural activity in the wider Namaqualand region is small livestock farming (mostly sheep and goat farming). The grazing capacity of the Namakwa Sands area is low at 10 – 20 ha per Small Stock Unit (the equivalent of one sheep or one goat). As the project area itself is located on land that has been mined or approved for mining, the only land capability of the site is the post-mining rehabilitated environment, i.e. small stock agriculture.

4.1.2.1 Soil Erodibility

The site has low stormflow erosion potential due to the relatively flat topography of the site and unconsolidated (readily draining) nature of soils (see Appendix D2).

4.1.3 Geology

4.1.3.1 General Geological Setting

The site is underlain by unconsolidated and semi-consolidated sediments (sand) of Quaternary age. These sediments overly meta-sediments of the Nama Group, described as the Vanrhynsdorp Group, as well as the metamorphic rocks of the Namaqualand Metamorphic Complex (see Figure 4-2), granites and dykes of the Koegel Fontein Complex.

The Namaqualand Metamorphic Complex consists of biotite gneiss overlying quartzites and augen gneiss, while the Nama Group metasediments consists of dolomitic marble and biotite schist overlying gritty and felspathic quartzite and pebbly quartzitic conglomerates (GCS, 1993).

Bedrock outcrops along the coast near Brand se Baai comprise pink Namaqualand gneiss, while further north outcrops of grey and white marble and gneiss can be found. Brand se Baai lies in an area that has been eroded due to faulting (GCS, 1993). The tectonic contact at Brand se Baai has been intruded by a dyke that is lithologically described as gabbro (Golder, 2007).

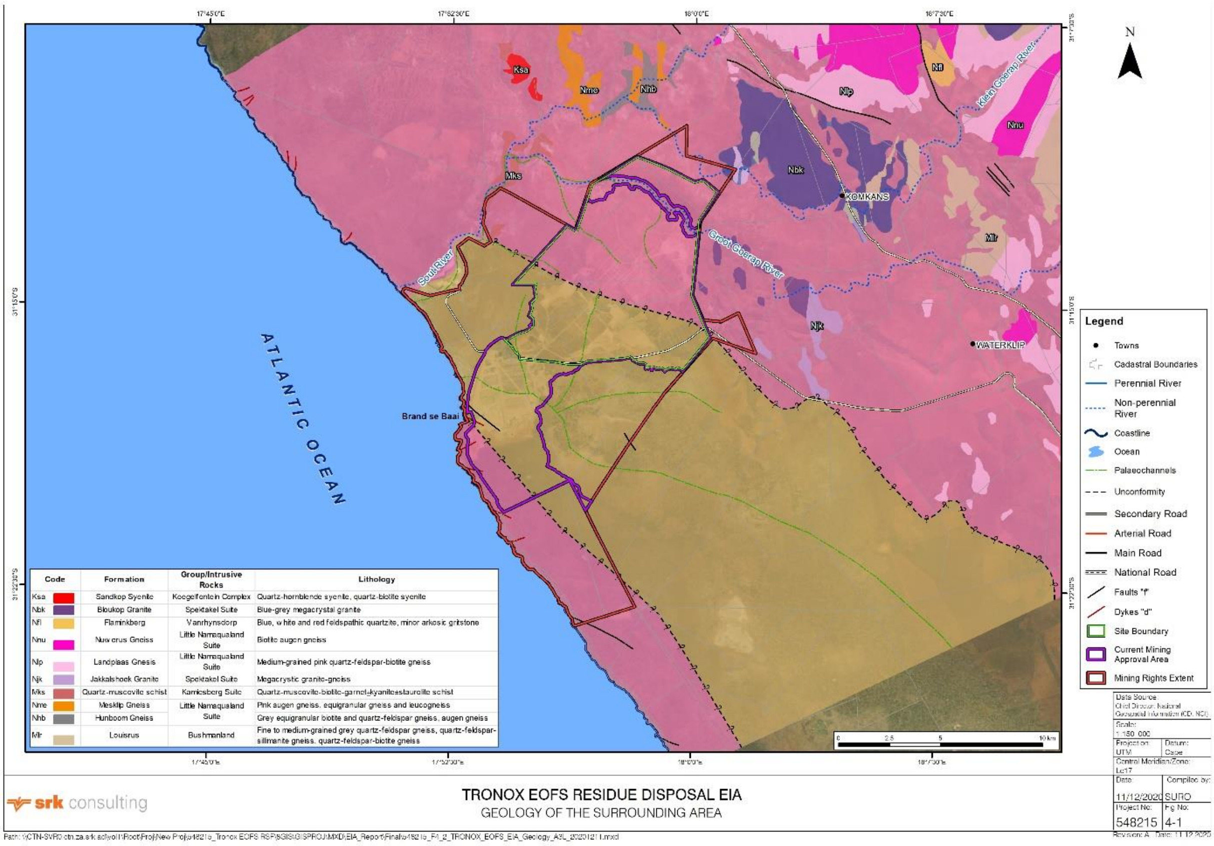

Figure 4-2: Geology of the study area

4.1.3.2 Heavy Mineral Sands: An Introduction

The term "mineral sands" normally refers to concentrations of heavy minerals in an alluvial (old beach or river system) environment. Most mineral sands deposits are found in unconsolidated fossil shorelines several hundreds of metres to tens of kilometres and occasionally hundreds of kilometres inland from the present coastline. Repeated storm erosion and reworking over centuries or millennia may progressively enrich a mineral sand deposit. This can be observed within individual deposits being mined today and can result in enrichment of heavy mineral through winnowing out of lighter trashy or gangue heavy minerals within a deposit (Jones, 2009).

Deposit preservation occurs over geologically longer periods through subsidence of coastal sediments, changing sea levels caused by ice ages or isostatic adjustment of continental margins. This may cause shorelines to migrate inland (marine transgression), potentially resulting in reworking older heavy mineral accumulations into larger deposits. Alternatively, migration seaward (marine regression) can occur leaving reworked deposits preserved inland (Jones, 2009).

The principal valuable minerals include ilmenite ($Fe.TiO_3$), leucoxene ($FeTiO_3.TiO_2$), rutile / titanium dioxide (TiO_2), zircon ($ZrSiO_4$) and monazite (Ce, La, Th, Nd, Y). Smaller volumes of garnet and staurolite are sold as niche products for specialised use.

Mineral sands represents less than one per cent of the value of the global resources sector. The mineral sands industry consists of two principal product streams (Jones, 2009):

- Titanium dioxide minerals – in the form of rutile, ilmenite and leucoxene. Ilmenite is also used to manufacture titanium slag and synthetic rutile products; and
- Zircon.

Titanium Dioxide

Titanium dioxide minerals are used mainly as feedstock for the world's titanium dioxide (TiO_2) pigment industry. As a pure white, highly refractive and ultraviolet light absorbing product, titanium dioxide pigment is commonly used in architectural and automotive paints, plastics, paper, textiles and inks. Titanium dioxide feedstock is also used in the manufacture of welding electrodes (Jones, 2009).

Titanium minerals are non-toxic, non-fibrogenic and biologically inert and can be used safely in foodstuffs, pharmaceuticals and cosmetics (Jones, 2009). Titanium feedstocks supply different markets; however world demand for ilmenite, leucoxene and rutile is determined by the demand for titanium oxide pigment. The pure white pigment is used as an opacifier in paints, plastics and paper, accounting for more than 90% of global titanium feedstock consumption (Jones, 2009). Titanium dioxide pigment is produced by two alternative process routes, *viz*. chloride and sulphate processes.

Rutile, synthetic rutile and titanium slag can be used to produce titanium metal. Due to the combination of strength and lightness of titanium metal, it is used for advanced engineering applications, including architectural coatings, the aerospace and defence industries as well as a range of other applications, including sporting equipment and jewellery (Jones, 2009). Titanium metal is also used in desalination plants and corrosive chemical industries and its non-reactive properties make titanium metal one of the few materials that can be used in the human body for hip replacements and heart pacemakers (Jones, 2009).

Zircon

Zircon is the other major product of the mineral sands industry and is a co-product of titanium mineral production. In most projects zircon is only a minor by-product and only rarely would zircon be considered the principal product, with titanium minerals as co-products. An increase in the importance of zircon has resulted from increased demand and the associated increase in prices (Jones, 2009).

The most important application for zircon is in the ceramics industry in the production of opacifiers used in surface glazes and pigments. Due to its high melting point (2 200°C) zircon is used as a foundry sand in moulds, and as a milled "flour", particularly in higher temperature applications where maintaining the quality of the surface of the casting is important (Jones, 2009).

Zircon is also used for the production of zirconia, zirconium metal and zirconium chemicals. These are high value and growing applications resulting in increased demand for zircon (Jones, 2009).

4.1.3.3 Geology of the Deposit at Namakwa Sands

At the Mine, the heavy mineral assemblages originated from pre-Cambrian age metamorphic rocks of the Namaqualand Metamorphic Complex and the Vanrhynsdorp Group. These assemblages formed under conditions of high pressure and temperature as discrete grains of ilmenite, rutile, zircon and leucoxene (the so-called valuable heavy minerals) as well as a number of non-valuable minerals.

The Namakwa Sands ore body has been divided into several lithological units varying in geological and geochemical characteristics formed over a long depositional period (Van Vuren, 2011) (see Figure 4-3):

i. *Basement:* the basement rocks consist of mainly granite / gneiss of the Namaqualand Metamorphic Complex, with fault-bounded graben blocks containing remnants of quartzite and marble belonging to the Van Rhynsdorp Group.

ii. *Other Sand Units*: other sand is a local term for a variety of well-sorted, fine grained, white to light yellow sands containing virtually no heavy minerals and occurring at the base of the ore body. The unit is also distinguished by a different geochemical and sedimentological signature.

iii. *Strandline Deposits:* super-matured Miocene heavy mineral assemblages were transported by proto-western fluvial systems into structurally controlled palaeo-bay environments (so-called J-Bays), maintaining sea level still-stands at respectively 35 and 20 mamsl.

iv. *Orange Feldspathic Sand (OFS):* the regression of the sea level from the still-stand position was followed by the westward progradation of the coastal dune-field during drier periods. Prevailing south-south west winds redistributed the massive sediment supply during the late Miocene, resulting in thick accumulations of aeolian sand represented by dunefield corridors. Bioturbation occurred, which has often destroyed the primary sedimentary features. Although of lower grade than the overlying RAS, these deposits comprise the bulk of the resource at the Mine, and are the only resource currently mined in the West Mine: Tronox now intends mining OFS at the East Mine as well. The deposits consist generally of dark yellow, moderately well- sorted quartzitic sands with a low feldspar content.

    The OFS horizon has been previously sub-divided into three economically separate units based on zircon grade. All OFS with greater than 0.20% zircon by point counting is termed 'Orange Feldspathic Sand – Mineralised' (OFSM). This forms the major part of the OFS unit.

    Sand containing less than 0.20 % zircon has been classified as 'Orange Feldspathic Sand – Waste' (OFSW).

v. *Red Aeolian Sand:* the formation of a resistant surface dorbank resulted in a cut off of fresh sediment supply from the underlying sand. Repeated reworking and winnowing by aeolian processes, as well as weathering of the more unstable heavy minerals, concentrated the heavy minerals to form a thin layer (1-3m) of relatively high grade aeolian sand over the ore body which is known as the RAS (see Figure 4-3). To date, this is the only unit mined at the East Mine.

    The most continuous (and problematic) hard layer occurs immediately below the RAS. This is termed 'Dorbank'. The upper hard layers contain higher zircon grades than the OFS horizon but the internal hard material has similar grades.

vi. *The Recent Emergent Terraces Dunes and Present Beaches:* the coastal foredunes and beaches, including the low-lying are the youngest of the geological units - strandline couplets responsible for the formation of the Namakwa Sands orebody.

For mine planning purposes, the deposit was split into two distinct ore bodies on the boundary between the deeper and more complex *OFS ore body of the West Mine*, and the shallower and relatively simpler *RAS ore body of the East Mine*. The Mine is similarly divided into the East Mine and the West Mine. **This project relates only to facilities and infrastructure required to support mining of OFS in the East Mine.**

4.1.3.4 Quaternary Sediments at the East Mine

Unconsolidated and/or semi-consolidated sediments overlying the basement rock formations at the East Mine comprise

- Dune deposits;
- Littoral (shoreline) deposits;
- Alluvial deposits (associated with the presence of preferential flow paths in the basement); and
- Wind transported deposits.

The sands decrease in age in a westward direction towards the coast.

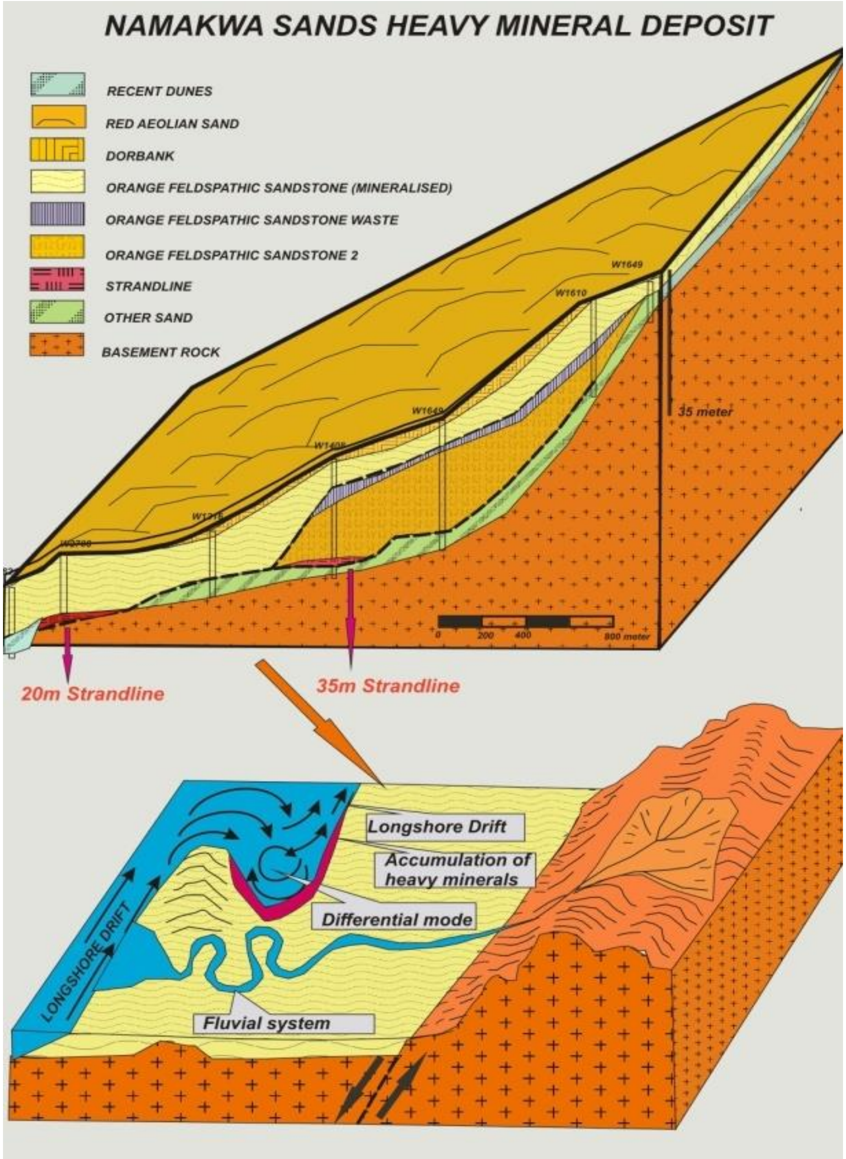

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Figure 4-3: Depositional environment of Namakwa Sands heavy mineral deposit

Source: (Van Vuren, 2011)

Surface RAS has a pre-mining thickness of between 1 and 3 m. This material is a dark reddish-brown, medium-grained sand that blankets the whole of the area inland of the rocky shore and younger dune fields.

The OFS unit underlies the RAS. This unit is a fine to medium-grained, somewhat clayey unit that comprises quartz sand with a significant proportion of feldspar and other silicates. It is generally a dark yellowish-brown to greenish colour with very little sorting (Figure 4-4). Pedocrete lenses (dorbank) are present in the upper OFS and were formed by upward migrating meteoric waters depositing silica and carbonate cementing agents during near-surface evaporation.

srk consulting	TRONOX EOFS RSF SCREENING STUDY East Mine OFS trial pit in the East Mine	Project No. 548215

Figure 4-4: East Mine OFS trial pit in the East Mine

4.1.4 Climate

The Western Cape Province has a Mediterranean climate with mild moist winters and warm dry summers. Summer temperatures rise from a low of 15 ˚C at the coast to 27 ˚C inland. The Mine lies in the drier northern part of the Western Cape, where climatic conditions are more typical of a semi-desert climate.

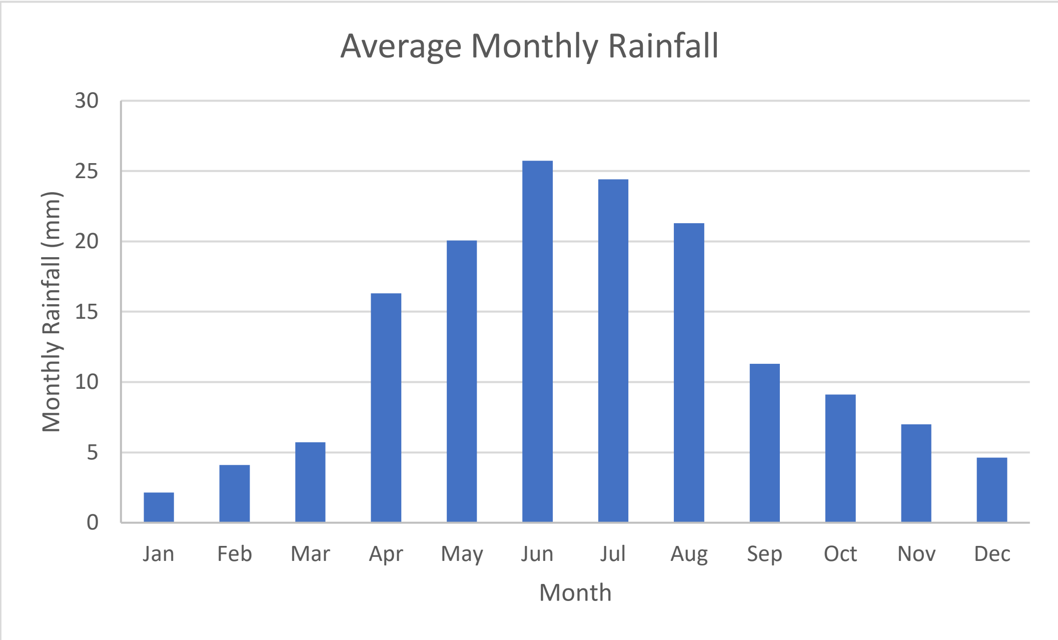
4.1.4.1 Rainfall

Rainfall in the area is seasonal, occurring mostly during the winter months (see Figure 4-5). Rainfall data was obtained from the on-site weather station at Namakwa Sands Mine for the period January 1995 to December 2019, and indicates that average annual rainfall in the area over this period was 152 mm.

Rainfall is usually less than 300 mm a year on the west coast of South Africa indicating that the average annual rainfall at the Mine is about 50% lower than the regional annual average. Total fog precipitation during autumn and winter is on average slightly more than 30 mm. The site receives no other precipitation.

The likelihood and severity (i.e. risk) of extreme rainfall events is informed by *design rainfall* for the catchment (the amount of rainfall that can be anticipated in a catchment over various return intervals). The *design rainfall* indicates, for example, that about 69mm and 78 mm of rainfall is likely over a 24-hour period approximately once every 50 and 100 years respectively; and that less frequent storms (e.g. those with a return interval of between one and 49 years) would be associated with less rainfall - see Section 4.1.6 in Appendix D2 (Epoch Resources, 2019).

A 78 mm rainfall event in a 24-hour period would be a significant event in this arid region, leading to surface water flow in ephemeral watercourses and localised erosion, though is still considered to be a storm event of relatively moderate intensity.



srk consulting	TRONOX EOFS DISPOSAL PROJECT Average monthly rainfall at NS Mine 1995 – 2019	Project No. 548215

Figure 4-5: Average monthly rainfall at Namakwa Sands Mine 1995 to 2019

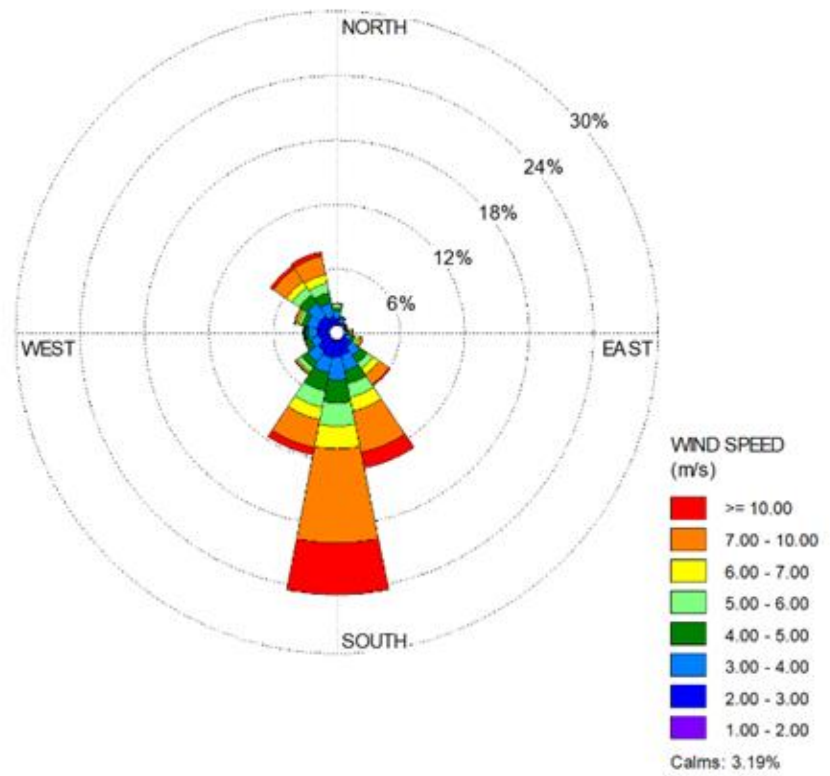
4.1.4.2 Ambient Temperature

The annual average temperatures recorded at Namakwa Sands from 1995 to 2011 range from 15.4˚C (in 1998) to 17.0˚C (in 2009). The maximum temperature at Namakwa Sands was recorded on 28 February 2011 at 49.5˚C, and the minimum temperature on 16 July 1996 at -0.9˚C.

4.1.4.3 Wind

Prevailing winds over a 3-year period from 2015 – 2017 were relatively consistent throughout and across the years. Prevailing winds are from the south and northwest, with a lower occurrence of winds from the northwest than the south (see Figure 4-6). The average wind speed at the Namakwa Sands Mine for all hours is between 4.5 – 4.6 m/s (16.2 km/h). The maximum wind speeds are greater than 11.1 m/s (39.9 km/h).

Winds are predominantly south-south easterly during summer, spring and autumn, with a dominant northerly and north-north westerly component during winter. Average wind speeds are higher during the period from September to February. From March to August, the winds are calmer with exceptions of short periods when high speed winds are observed. Wind patterns observed during the day and at night are similar, with the winds from the east and east-southeast being more prominent at night.



srk consulting	**TRONOX EOFS DISPOSAL PROJECT** All-hours wind rose at NS mine 2015 - 2017	Project No. 548215

Figure 4-6: All-hours wind rose at NS mine 2015 – 2017

Source: (Airshed, 2019)

4.1.5 Air Quality

The Namakwa Sands Mine is located in a very remote part of the Western Cape, with no formal villages or settlements near the Mine. The surrounding area is characterised by strong coastal winds and an arid climate. Background regional air quality is largely unaffected by man-made influence (aside from the Mine) with the main sources of particulates including dust from agriculture activities (livestock), traffic on dirt roads, infrequent vegetation burning and, as one moves inland and closer to centres of urbanisation, from the burning of biomass for fuel purposes (SRK, 2014b).

Potentially sensitive receptors in the vicinity of the Mine include:

- Recreational users of Brand se Baai camp site, which is located immediately west of the Mine;
- The Cawood Saltworks located ~4 km northwest of the Mine and the proposed new RSF on the Sout River estuary;
- The Joetsies Guesthouse located ~3 km east of the East Mine; and
- The surrounding natural environment (SRK, 2014b).

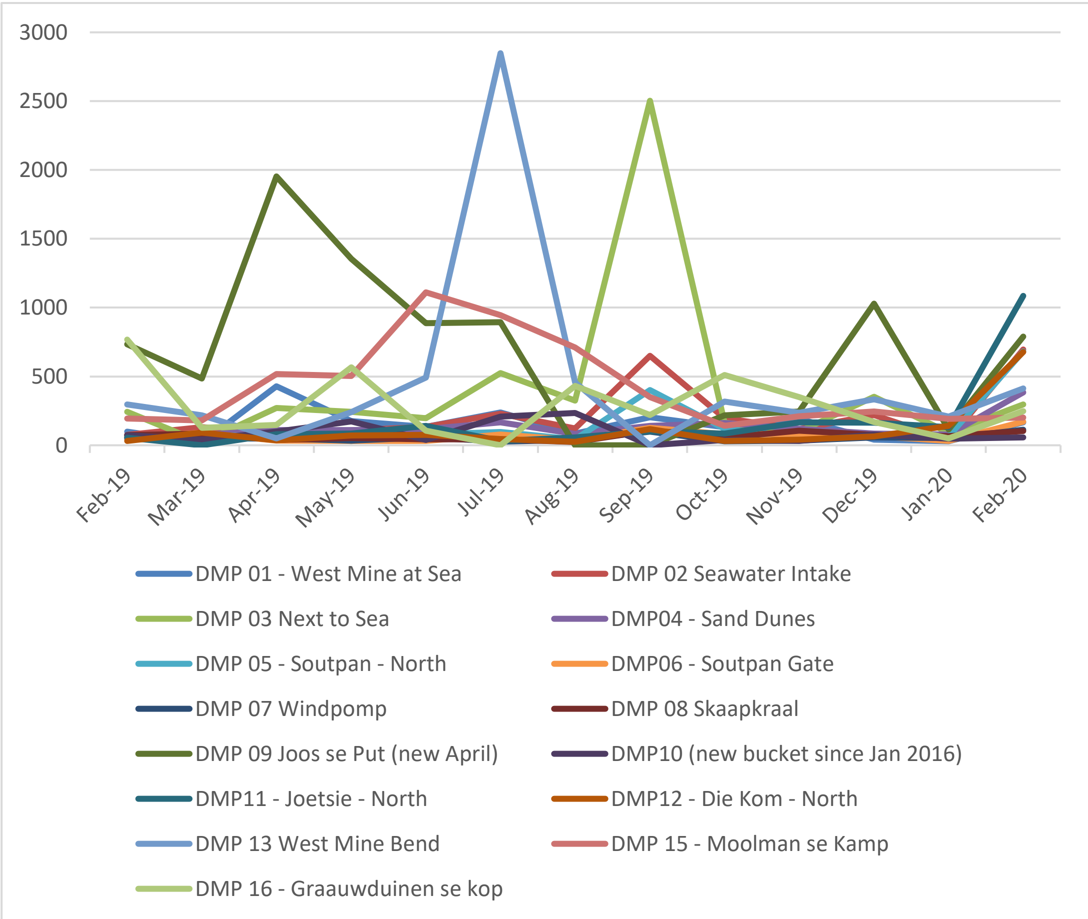
The closest towns to the Mine are too distant to be considered receptors.

Cawood Saltworks is a particularly sensitive receptor because of the potential negative impact that dust can have on the formation of salt crystals.

Opencast mining activities contribute to localised elevated levels of respirable dust. Airborne dust levels in the immediate vicinity of the Mine are directly dependent on the intensity of construction and mining activities i.e. an increase in dust level occurs when the intensity and frequency of construction and mining activities increase, as well as the proximity of activities (SRK, 2014b). In terms of GN R1210 of 2009, Tronox are allowed four exceedances of National Air Quality Standards for particulate matter (PM_{10} – 750 mg/m^3/day) at each specific monitoring location.

Namakwa Sands have a dust monitoring network in place on the boundary of the Mine (see Figure 3-24), and dust fallout is measured and, according to Tronox, reported to the local authority regularly (including explanations for infrequent exceedances). Fence-line exceedances of fallout limits are rare and are responded to timeously (see Figure 4-7 – according to Tronox, only one specific monitoring location, DMP9, recorded more than four exceedances in a one year period – this monitoring site is more than 8 km from active mining activities, and therefore these exceedances are attributed to agricultural activities underway here and not mining).

Dust fallout concentrations are generally lower from April to August and gradually increase from September to March. These trends coincide with lower winds speeds and higher rainfall during autumn and winter and high wind speeds and lower rainfall during spring and summer (SRK, 2014b).



srk consulting	TRONOX EOFS DISPOSAL PROJECT Dust monitoring results February 2019 - February 2020 (mg/m^3/day)	Project No. 548215

Figure 4-7: Dust monitoring results at Namakwa Sands February 2019 – February 2020 (mg/m^3/day)

Source: Tronox

4.1.6 Noise

The site is surrounded by farmland with typical, low noise levels, dominated by the natural sounds of rustling vegetation, wildlife, and anthropogenic sources such as farming activities. The closest receptors are located at Joetsies Guesthouse and the houses at the Cawood Saltworks.

Mining, processing and the operation and movement of vehicles are sources of noise and vibration locally at the Namakwa Sands Mine site. Namakwa Sands has not received any complaints regarding noise from operational activities and it is therefore inferred that operational activities do not materially affect noise receptors.

4.1.7 Hydrology and Surface Water

The study area falls within the Olifants / Doorn Water Management Area (WMA) and the Knersvlakte Sub-Water Management Area (subWMA). The existing Mine area is situated in the quaternary catchments F60D and F60E.

4.1.7.1 Drainage

The ephemeral Groot Goeraap and Sout Rivers are the main surface drainage features in the area (see Figure 1-2). The Sout River originates in hills to the east and drains in a westerly direction towards the Atlantic Ocean. The Klein-Goeraap and Groot Goeraap rivers are tributaries of the Sout River system.

These rivers have low gradients (i.e. are flat), are sandy and characterised by broad channels (~20 m at their narrowest, and frequently wider than 150 m). The mean annual runoff (MAR) of the Sout River Catchment is 0.6 Mm^3 (Golder, 2008) which is very low. Surface flow is extremely rare due to the low MAR – this explains the absence of well-defined drainage lines in the area (Figure 4-8).

srk consulting	TRONOX EOFS DISPOSAL PROJECT Groot Goeraap River with mine in the background	Project No. 548215

Figure 4-8: Groot Goeraap River with mine in the background (to the south)

Source: (Helme N. , 2014)

Alterations to topography from mining have altered surface water flow at the Mine, and no natural watercourses remain within the site boundary. During very high (and therefore rare) rainfall events sub-catchments in the Mine (may) channel surface flows in a stream-like manner as follows (see Figure 4-9):

- RC1, RC3, RC4 and RC5 sub-catchments discharge into the Groot Goeraap River;

- RC2 sub-catchment discharges into the Sout River;
- OC1 sub-catchment discharges towards the coast;
- "De Kom" sub-catchment discharges into the Kom ephemeral pan; and

NDC1, NDC2 and NDC3 sub-catchments are non-draining[25].The Groot Goeraap River passes along the northern boundary of the present study area, and would be fed by surface runoff from sub-catchments RC1, RC3, RC4 and RC5.

4.1.7.2 Wetlands and Pans

A number of features classified as wetlands occur in the Groot Goeraap River, and two ephemeral pans (identified during previous specialist assessment at the Mine) occur in the study area: one east of the RSF and the other in the Kom.

As well as documented surface water features, topographical analysis has identified three depressions within the non-draining sub-catchments in the study area: the Northern Depression, Central Depression and Southern Depression (see Figure 4-9). The Central and Southern Depressions are within mined-out areas.

The ecological significance of these features is described in Section 4.1.10.3.

4.1.7.3 Surface Water Use

There is no surface water use in the area other than infrequently for livestock at times when rivers flow (Golder, 2011a).

A privately owned saltworks (Cawood Saltworks) is located on the Sout River estuary north of the mining authorisation area. Cawood Saltworks does not draw on normal saline estuarine water (Golder, 2011a). Rather, saline water is pumped into the evaporation ponds from a crystalline salt deposit that lies some distance below the bed of the estuary. Local surface water resources are not used by the Namakwa Sands Mine.

Local surface water resources are not used by the Mine.

[25] A non-draining catchment is topographically isolated from other surface water systems, and rainwater falling in the catchment does not discharge to another catchment or to the ocean. Excessive rainwater in these systems is channelled towards a central pan-like depression, or depressions, where it would (depending on the nature of the catchment) evaporate, infiltrate or, in large events, spill into another catchment. At the Mine these depressions are difficult to detect because of the flatness of the terrain and their large size.

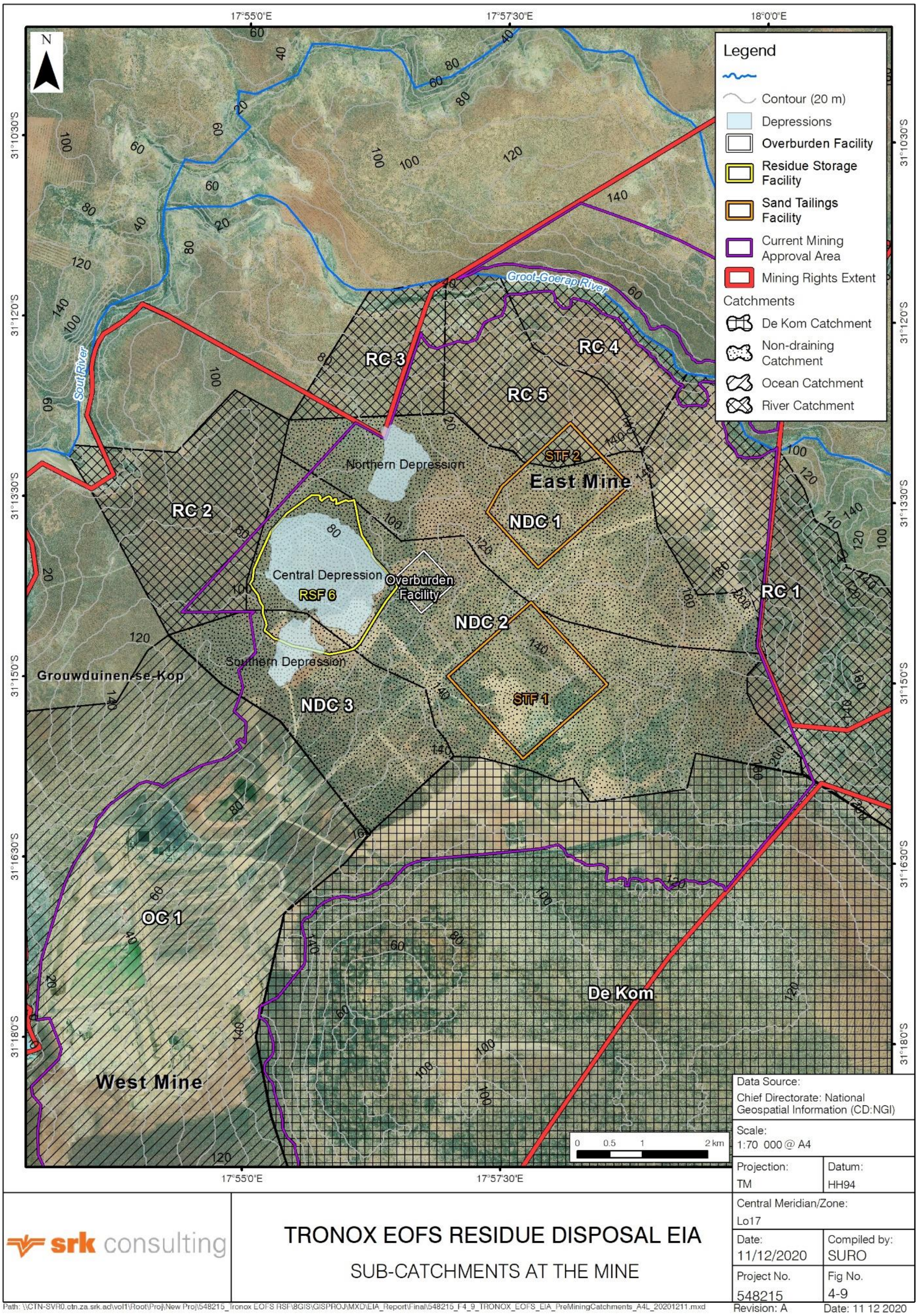


Figure 4-9: Sub-catchments at the Mine

4.1.8 Hydrogeology

4.1.8.1 Aquifers

Two main aquifers are located in the area.

Quaternary sediments form the *Primary Aquifer* at the East Mine. This aquifer has medium to high hydraulic conductivity (K), except at pedocrete (dorbank) lenses. In terms of hydraulic conductivity in the Primary Aquifer, the following observations are noted:

- Vertical recharge to groundwater is relatively rapid (usually <1 month);
- Local horizontal flows and temporary perched water tables are evident above the dorbank;
- Water levels are raised/mounded at the Groot Goeraap River[26] and greater dissipation of potential groundwater mounding is anticipated below leachate sources (i.e. the RSF, STFs and Overburden stockpile; and
- Relatively rapid contaminant transport is anticipated via advection.

The Primary Aquifer has relatively low yields for potential groundwater users in the area, with private borehole yields of <0.5 L/s, noted during a previous hydrocensus. The groundwater levels are deep (> 40 mbgl over most of the East Mine) (SRK, 2019).

Poor water quality, low yields and deeper water levels result in limited saturation thickness and saline water quality, as such, private groundwater users are less reliant on the Primary Aquifer as a source of water.

Suspected preferential flow paths and/or similar subsurface conduits in the area likely form preferential groundwater flow pathways. It is suspected that these conduits direct flow towards the Groot Goeraap and Sout Rivers in the north and west, a that southern conduits direct groundwater flow towards the coastline. The location of these preferential pathways is the subject of continued studies.

The Vanrhynsdorp Group and NMC bedrock form the *Secondary (fractured) Aquifer* at the East Mine. Test results indicate that the secondary fractured aquifer has relatively low effective K. Low hydraulic conductivity in the Secondary Aquifer results in:

- Slow (~0.1 m/d) horizontal and vertical groundwater flow, except where there is preferential flow along structures such as unconformities, faults, fractures and dyke intrusions;
- Limited groundwater storage;
- Potential for groundwater mounding below leachate sources if there is a high seepage rate; and
- Slow contaminant transport via advection (except along structures).

An unconformity separates the Vanrhynsdorp Group and NMC. The contact zone in the vicinity of the unconformity may form a preferential pathway of leachate towards the Sout River, due to the likelihood for fractures and associated higher local hydraulic conductivity values.

The Secondary Aquifer may have low to medium yields for potential groundwater users since borehole yields range from 0.1 – 0.5 L/s (DWAF, 2005) and Fractured aquifers comprising of NMC metasediments typically have yields ranging from 0.5 – 2.0 L/s (DWAF, 2005).

[26] This conclusion is based on groundwater monitoring and decant observations when RAS tailings backfill took place in close proximity (~1 km) of the river.

4.1.8.2 Groundwater Levels and Flow Direction

Regionally, the water table contours mimic topography (i.e. higher lying terrain has elevated groundwater levels and *vice versa*). Groundwater levels vary between 1 and 414 mamsl between the coastline and hills in the east respectively (see Figure 4-10). Groundwater levels tend to be deep (>40 mbgl) for most of the East Mine, within the saturated Primary (sand) Aquifer overlying the bedrock. Low-lying areas (near the coast) have a lower (flatter) hydraulic gradient, thus groundwater movement will be slower than further inland.

A groundwater divide exists between quaternary catchments F60D and F60E, which runs through the middle of the East Mine. Groundwater north of the divide flows inland towards the Sout River and Groot Goeraap River, whereas groundwater south of the divide flows towards the coast and the Sout River.

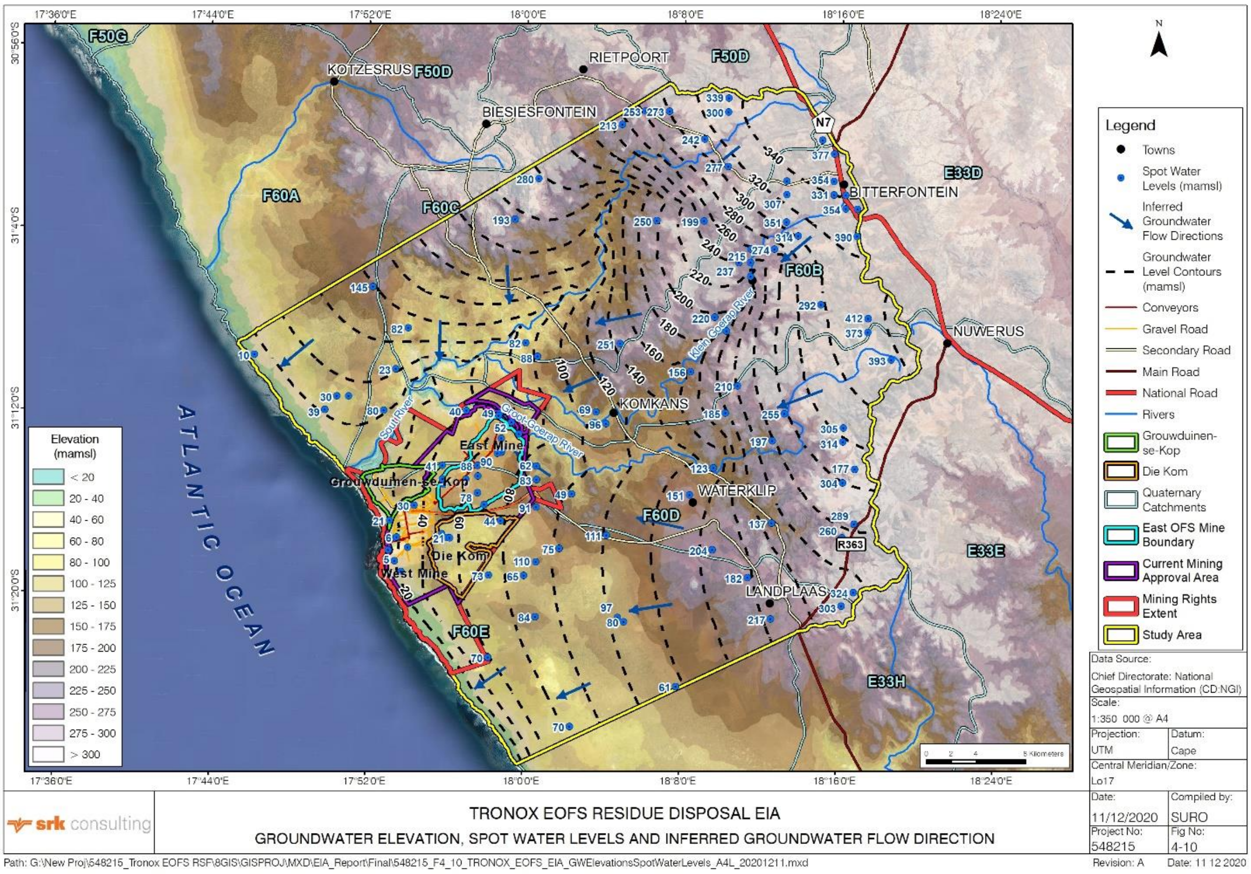


Figure 4-10: Groundwater elevation, spot water levels and inferred groundwater flow direction

Shallow groundwater levels are present near the coastline and river channels; however, it is reliably assumed that the direct groundwater baseflow contribution to flow in the rivers is minimal and only during flooding (as they do not flow under normal conditions). This is common in semi-arid regions with low rainfall and high evaporation.

4.1.8.3 Recharge to Groundwater Table

The region has a low groundwater recharge from rainfall. Recharge ranges from 2.2 to 2.5 mm/a in the north, 0.4 to 0.6 mm/a in the centre, and 0.8 to 1.2 mm/a along the coastline (DWAF, 2005). Lowest recharge occurs along the ridgeline between the Groot and Klein Goeraap Rivers and the higher escarpment in the northeast, with estimated values of 0.2 to 0.4 mm/a.

Existing operations at Namakwa Sands (West Mine, East Mine, processing plants, satellite sites etc.) contribute to recharge: process water (primarily seawater in tailings) from these facilities infiltrates through the geological horizons and enters the water table (recharge).

The site has generally low recharge rates with deeper groundwater levels due to low volumes of water percolating to the water table. This results in a reduced speed of natural attenuation by dilution, which may reduce the contaminant plume footprint.

In terms of the potential for contaminant transport in groundwater, low rainfall recharge rates reduce the speed of natural attenuation from dilution.

4.1.8.4 Groundwater Quality

Based on the 1:500 000 Hydrogeological Map sheet (using Electrical Conductivity [EC] as an indicator) the groundwater quality in the study area ranges from 600 – 1 500 mS/m with a mean of ~1000 mS/m. Spatially, EC within the study area displays high concentrations that decrease towards the higher lying terrain further east (see Figure 4-11). The central study area is characterised by intermediate concentrations, ranging from 840 to 1500 mS/m. This may be a result of both evapotranspiration, naturally high salt content in the local geology and previous backfill of saline material at the Mine. This area also correlates to the lower hydraulic gradients where groundwater movement will be slower than further inland and towards the coast.

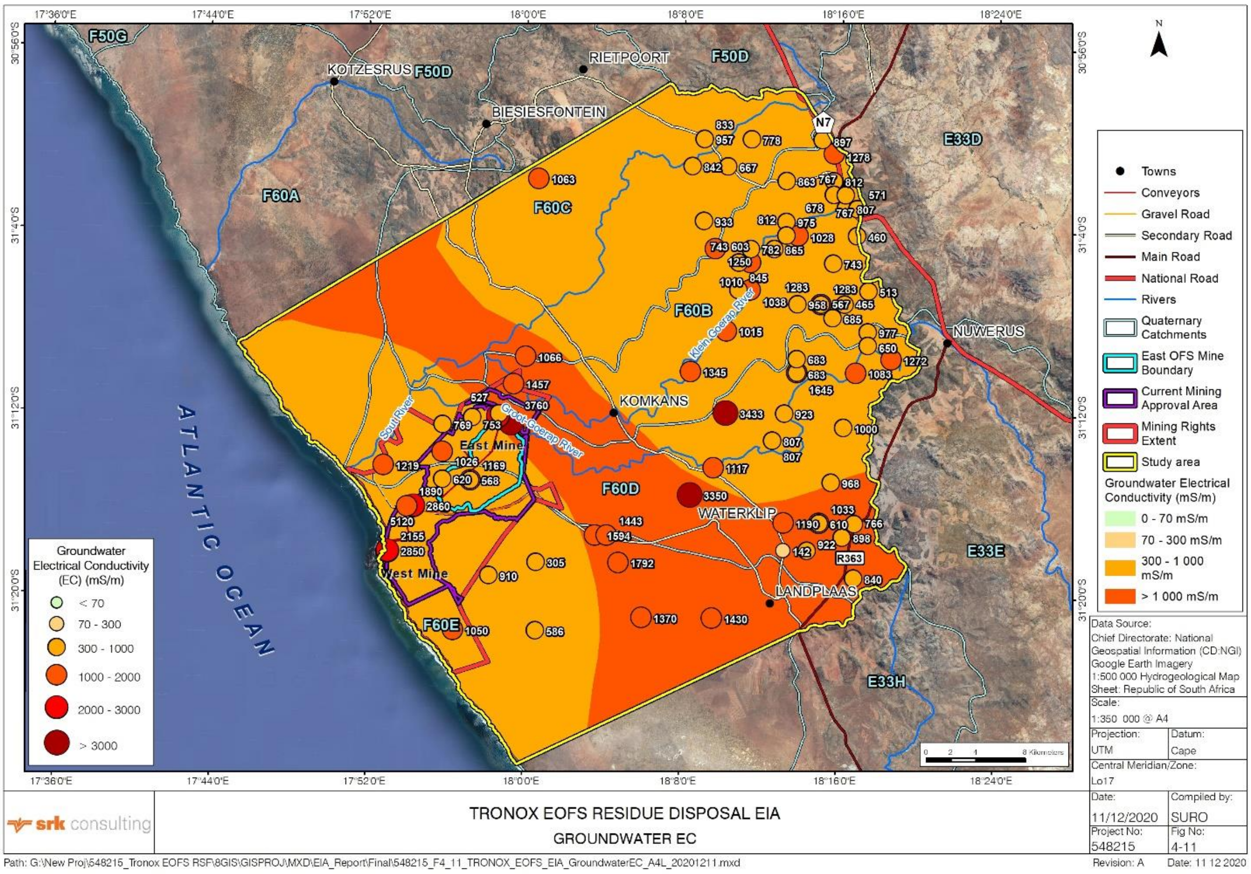


Figure 4-11: Groundwater quality

Baseline groundwater quality exceeds the South African National Standard (SANS) 241:2005 Class II drinking water limit of 170 mS/m by a considerable margin (SRK, 2014c) and is not suitable for human consumption.

Studies by (Golder, 2007) indicate that the pH of the groundwater varies from 4.7 to 8.0.

There is a net increase in the EC and chloride concentrations of the groundwater from east to west down-gradient towards the site and coastline (see Figure 4-11), with baseline EC concentrations exceeding 1 000 mS/m in this area (SRK, 2016a).

The Mine only uses seawater (and flocculants) in the processing and concentration plants, and therefore no contaminants (other than saline water) enter groundwater from operations. Process water infiltration from operations has led to a rise in EC values of groundwater in a 9 km^2 plume at the Mine.

Data from groundwater samples west of the site indicate that levels of Dissolved Inorganic Nitrogen (NO_2 + NO_3) are variable but are highly elevated at times (>200 mg/L). It is possible that these nutrients are concentrated in the slimes and are exposed to groundwater receptors.

4.1.8.5 Groundwater Users

The most recent hydrocensus was conducted by SRK in May 2019, when 35 boreholes within ~5 km of the mine site were surveyed. Of these, seven are no longer in existence. The following observations were made

- The Mine is bordered by five farms, namely Voorspoed Farm, Graauw Duinen 152, Rietfontein EXT 151, Kalkvlei and Hartebeeste Kom. These farms have 16 boreholes in total, the majority of which were in bad condition (i.e. they had collapsed or were damaged) and only one was accessible, open and in good condition to sample during the hydrocensus (‘Grauww Duinen BH1’); however, the borehole was dry.
- Groundwater is not suitable for human consumption; however, relatively low volumes of groundwater are used for agricultural purposes (stock watering) from six boreholes near the Mine. These boreholes are all situated upstream of the site, and previous studies (e.g. SRK, 2019) have demonstrated that they will not be affected by the project.
- The Cawood Saltworks (located to the northwest of the East Mine) in the Sout River Estuary, was identified as a groundwater user and receptor. This facility abstracts groundwater (and possibly surface water) and pumps it to the salt pans/evaporation ponds as part of their salt production process. The evaporation process may concentrate the salts and contribute to salinization locally.

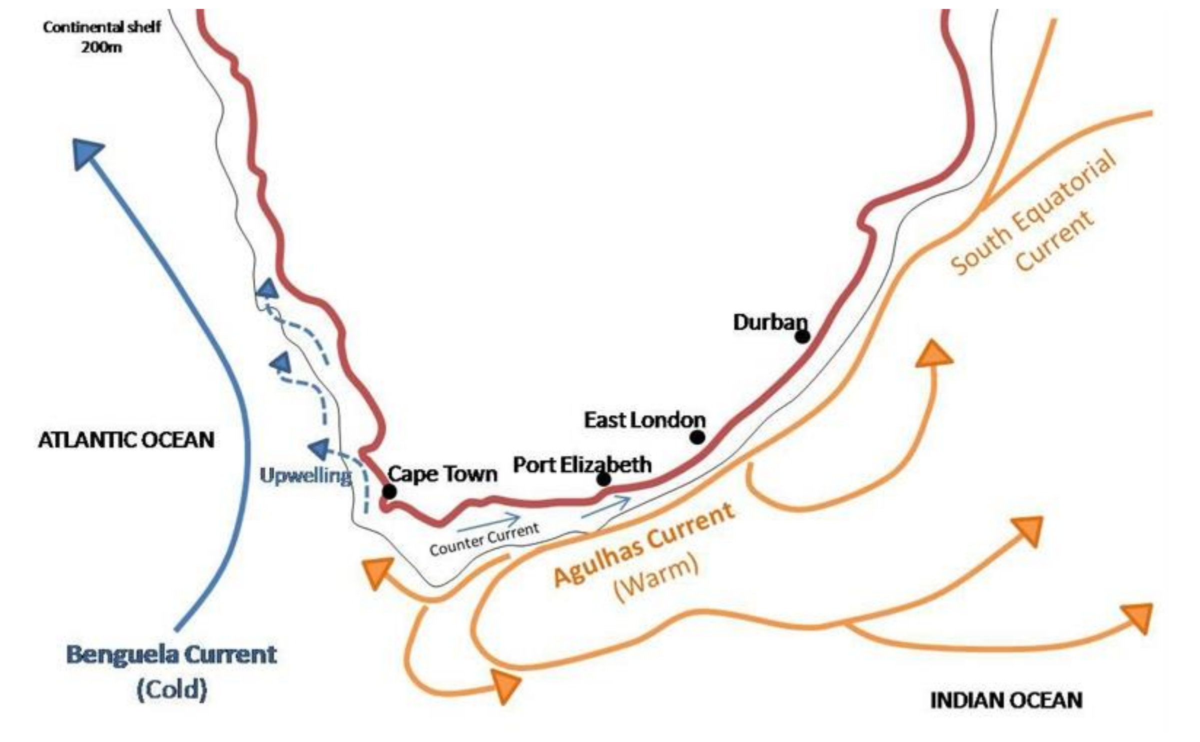
4.1.9 Marine Ecology

4.1.9.1 Regional Oceanography

The physical oceanography of an area, particularly water temperature, nutrient and oxygen levels, and wave exposure, are the principal driving forces that shape marine communities (Anchor, 2020). The broader oceanography of the region is influenced by the cold Benguela upwelling system of the West Coast (Figure 4-12). The Benguela Current originates from the South Atlantic Circulation, which circles just north of the Arctic Circumpolar Current (Anchor, 2020).

The naturally cool temperature of the Benguela Current (average temperature of 10-14°C) is enhanced by the upwelling of colder nutrient-rich deep water (Anchor, 2020). The area experiences strong southerly and south-easterly winds. These prevailing conditions deflect the surface waters offshore and draw cold, nutrient rich water upwards to replace it (see Figure 4-13).

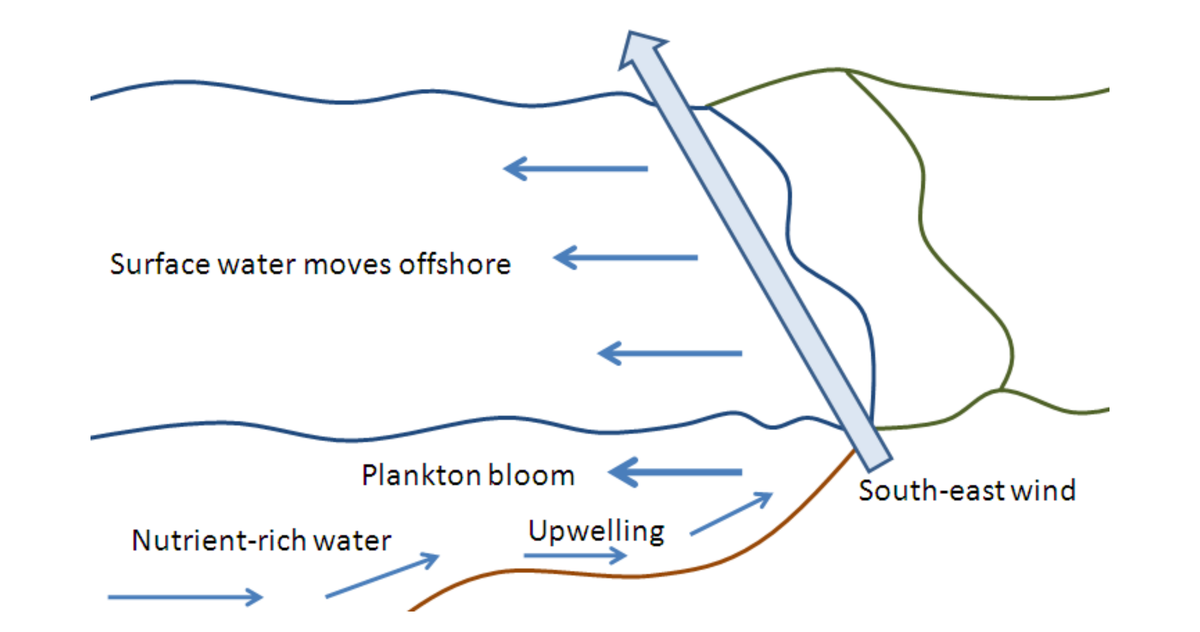
Phytoplankton blooms when the nutrients reach the surface waters where plenty of light is available for photosynthesis. The phytoplankton is then preyed upon by zooplankton, which is in turn eaten by filter feeding fish such as anchovy or sardine. This makes the West Coast one of the richest fishing grounds in the world and also attracts large colonies of birds and seals (Anchor, 2020). The areas that experience the most intense upwelling activity in the southern Benguela are situated off Cape Columbine, approximately 80 km south of Lamberts Bay, and the Cape Peninsula. The water temperature and nutrient levels are strongly influenced by wind with minimum temperatures and maximum nutrient levels occurring in conjunction with upwelling events (Anchor, 2020).



srk consulting	**TRONOX EOFS DISPOSAL PROJECT** Major currents around South Africa	Project No. 548215

Figure 4-12: Major currents around South Africa

Source: (Anchor, 2020)



srk consulting	**TRONOX EOFS DISPOSAL PROJECT** Wind-driven upwelling on the West Coast	Project No. 548215

Figure 4-13: Wind-driven upwelling on the West Coast

Source: (Anchor, 2020)

4.1.9.2 Local Oceanography

The study area is subject to semi-diurnal tides, with each successive high (and low) tide separated by ~12 hours (Anchor, 2020). Each high tide occurs approximately 25 minutes later every day, which is due to the 28-day rotational cycle of the moon around the earth. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and has an influence on when people visit the coastline to partake in various activities (e.g. for recreation or harvesting of marine resources). The tidal variation in the vicinity of Brand se Baai usually ranges between 0.28 m (relative to chart datum) at mean low water springs to 1.91 m at mean high water springs with the highest and lowest astronomical tide being 2.25 m and 0.056 m respectively.

Another factor which greatly influences marine ecology and human activities along the coastline is wave energy. Wave size is determined by wind strength and fetch (distance over which it blows) and determines the degree to which breaking waves at the shore will shift sand and erode rock. The West Coast of South Africa typically experiences high wave energy and is dominated by south-westerly swells with a long fetch and a period of 10-15+ seconds (Anchor, 2020). Southerly and south westerly waves off Brand se Baai frequently exceed 2 m (Anchor, 2020).

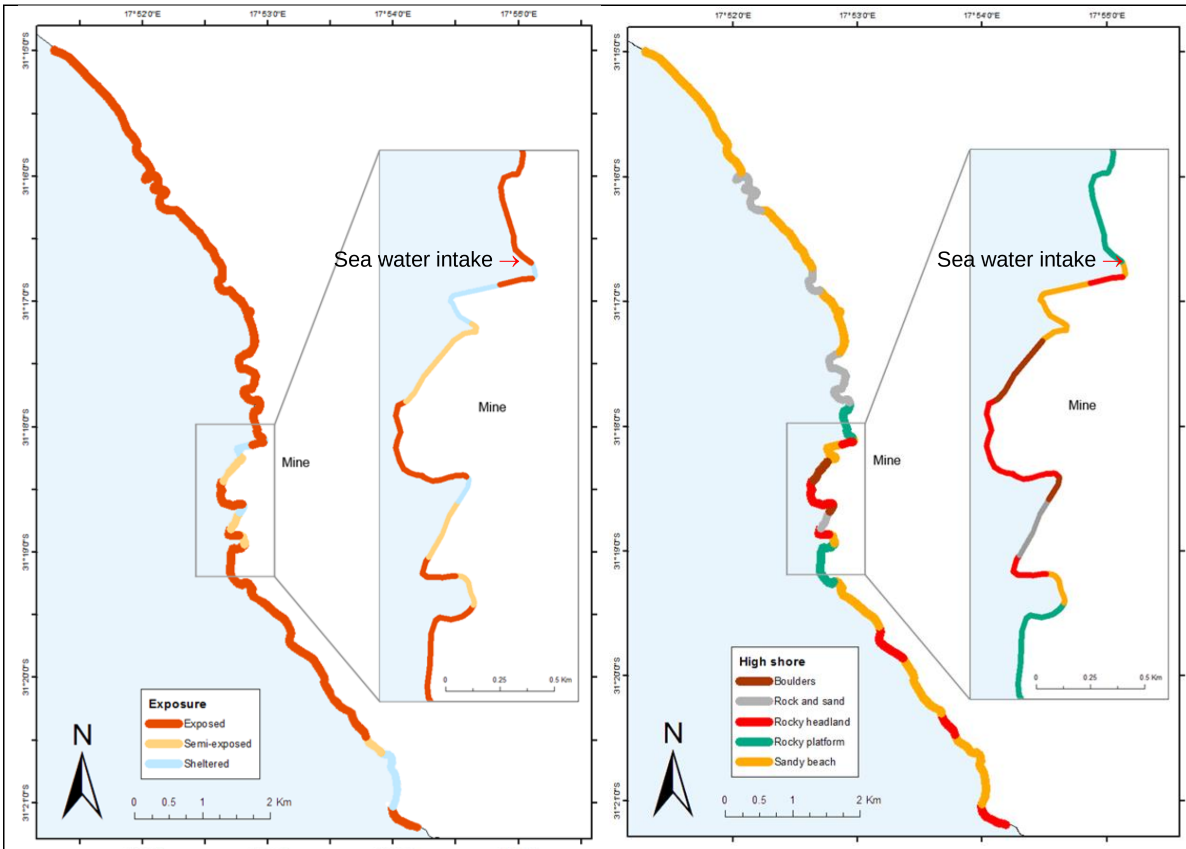
Based on exposure to wave action, the Brand se Baai shoreline is categorised into three groups: exposed, semi-exposed and sheltered (see Figure 4-14). The prevailing swell moving towards the shore from the south-west reaches the headlands first, causing waves to lose energy as they crash onto the headland and then wrap around into the bay. Therefore, the bays in this area are semi-exposed and sheltered, while headlands and rocky platforms are exposed. Bays tend to be retentive, with complex surf zone circulation, while headlands are characterised by deep water close inshore and strong shore parallel currents.

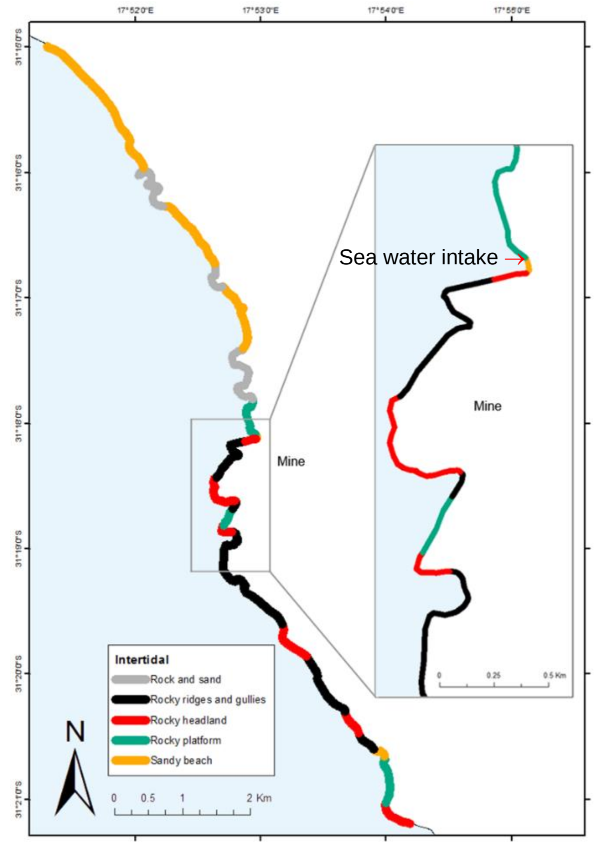
The coastline to the immediate west of the Mine is semi-exposed and sheltered (see Figure 4-14).

4.1.9.3 Coastal and Marine Habitats

The shoreline in the vicinity of Brand se Baai consists of a number of habitat types, while the offshore environment is less diverse (see Figure 4-14) (Anchor, 2014):

- *High shore habitat* is defined as the area of the shore from the top of the HWM at spring tide to the vegetation line. The high shore habitat to the west of the Mine is complex with short stretches of a number of high shore habitat types: rocky platforms, rocky headlands, sandy beaches, boulders and rock and sand;
- *Intertidal habitat* is defined as the area between the water level at spring low tide and the HWM at spring high tide. The intertidal habitat west of the Mine is characterised by rocky ridges and gullies alternating with rocky headlands with occasional rocky platforms; and
- *Subtidal habitat* is defined as the section of coast from the water level at spring low tide to approximately 300 m offshore. The offshore area to the west of the Mine consists of reef with associated kelp bed habitats.





Top left: Wave exposure at coastline near Brand se Baai

Top right: High shore habitat types along the coastline at Brand se Baai

Bottom left: Intertidal habitat types along the coastline at Brand se Baai

srk consulting	**TRONOX EOFS DISPOSAL PROJECT** Shoreline habitats near Brand se Baai	Project No. 548215

Figure 4-14: Shoreline habitat types near Brand se Baai

Source: (Anchor, 2014)

4.1.9.4 Marine Biodiversity

A total of 64 invertebrate species have been identified in the intertidal zone at Brand se Baai, including 28 algal species, 10 filter feeding species, 17 grazing species and nine predatory species (Anchor, 2014). Of the 64 intertidal species found during this study, 12 were identified in the high shore, 28 in the intertidal zone and 40 in the subtidal zone, thus biodiversity increased down the shore as predicted. Species found at the three different shore heights did differ significantly due to the range in stressors (such as desiccation) experienced at different shore levels (Anchor, 2014).

The species most frequently encountered throughout all the zones was *Sculellastra granularis*. The species assemblages at exposed, semi-exposed and sheltered sites did not differ significantly, and all the taxa recorded in the intertidal zone on the rocky shore are ubiquitous throughout the Namaqua Inshore Ecozone (Anchor, 2020) and are not restricted to this particular area. None of the intertidal rocky shore species observed are classified as rare or endangered.

4.1.9.5 Marine Conservation

The nearest marine protected area (MPA) is the Namaqualand MPA, located ~65 km to the north. Sink *et al*. (2012) (Anchor, 2014) assessed the coastal sensitivity of the South African coastline based on the ecosystem threat status of each marine habitat. The marine classification extends a few hundred metres inland to provide a buffer zone for the marine environment. This macro assessment classifies the stretch of the coastline west of the Mine as endangered. As this classification was assessed at a very broad national scale, ground truthing of sensitivity is necessary (Anchor, 2014). Various site assessments to the west of the Mine (e.g. Anchor (2014) and Anchor (2016)) have confirmed that the coastal habitats in this area are well represented, and that the marine fauna and flora are not particularly rare or sensitive.

4.1.10 Biodiversity

4.1.10.1 Vegetation

The project falls within the Succulent Karoo biome exhibiting the highest plant diversity of any arid ecosystem in the world (Namakwa District Biodiversity Sector Plan, 2008). This biodiversity is due to speciation of an arid-adapted biota brought about by unique climatic conditions and high environmental heterogeneity (SANBI, not dated).

The predominant vegetation type of the region is Namaqualand Strandveld of the Succulent Karoo Biome (one of three globally recognised biodiversity hotspots in South Africa). Namaqualand Strandveld is widespread and considered *Least Threatened* on a national basis, typically occurring in a band between 1 to 30 km inland, on deep sands. It is used primarily for small stock grazing, and some areas have been heavily overgrazed. It is under-conserved in formal conservation areas and is vulnerable to future transformation. Plant diversity of this vegetation type is relatively low compared to other Namaqualand Succulent Karoo vegetation types (Mucina and Rutherford, 2006).

Namaqualand Sand Fynbos of the Fynbos Biome occurs on the inland plain. Namaqualand Sand Fynbos is fairly widespread and considered *Least Threatened* on a national basis. It occurs in a narrow, discontinuous band usually about 5 to 10 km inland, on stabilised inland dunes that are composed of neutral to acid sands. It is poorly known from a botanical perspective and various new plant species have recently been identified in this vegetation type. Less than 5% of its original extent is formally conserved and much of it remains vulnerable to loss (Mucina and Rutherford, 2006).

The vegetation of the area consists of low coastal shrub up to 1.5 m high, typical of much of the West Coast. The vegetation is pruned by the salty onshore sea breeze. There are very few trees throughout the landscape. Many of the trees that have been planted to provide shade or wind protection are not indigenous to the area. Isolated stands of alien trees (e.g. *Eucalyptus)* occur around windmills and farmsteads. Windrow hedges have been planted to protect agricultural fields (mostly dryland wheat) from the wind.

Vegetation has been cleared for mining, although an extensive rehabilitation programme is underway (see Figure 4-15). Rehabilitation has been relatively successful, although the poor soils, low rainfall and the sheer size of the affected areas are complex challenges.

srk consulting	**TRONOX EOFS DISPOSAL PROJECT** Areas under rehabilitation near the Goeraap River	Project No. 548215

Figure 4-15: Areas under rehabilitation near the Groot Goeraap River

Source: S Reuther, 5 November 2019

A comprehensive Fine Scale Plan (FSP) - not yet accepted by the Minister - has been developed for the WCDM (Skowno, Desmet and Holness, 2010)[27]. According to the FSP, the entire Groot Goeraap River Valley is designated as an ecological corridor and an Ecological Support Area (ESA). Various Critical Biodiversity Areas (CBAs) are identified in the area, including “Die Kom” pan to the south of the East Mine, the coastal zone. Current mining operations have significantly interrupted north - south ecological linkages in the region, although it is possible that areas affected by mining can be restored to a certain extent through rehabilitation.

4.1.10.2 Fauna

While avifaunal and other faunal species do enter rehabilitated areas in the East Mine, active mining which is ongoing in the East Mine (and which is approved for the East OFS project) presents an inhospitable environment, and most faunal species have evacuated this area into the more natural surrounding environment.

[27] This FSP was developed as part of the South African National Biodiversity Assessment led by the South African National Biodiversity Institute. The FSP is considered to be a “systematic biodiversity plan” and will form the basis of the development of a Bioregional Plan as contemplated in the Biodiversity Act 10 of 2004. While the FSP provides a good indication of the sensitivity of ecological features and is therefore considered in this report and has informed detailed site assessment, the plan has not been subjected to stakeholder review, does not take into account other land use imperatives, and is not recognised as a definitive approved (bioregional) plan in terms of the Biodiversity Act 10 of 2004. Bioregional Plans must be subjected to both focussed (initial) and broad stakeholder engagement (before finalisation) prior to being accepted by the Minister, and adopted as definitive land use decision support tools.

The Groot Goeraap River, Klein Goeraap River and the coastal dune strip south-west of the Mine are important faunal movement corridors. These movement corridors will not be impacted by changes to the East OFS residue disposal plan.

4.1.10.3 Freshwater Ecology

Groot Goeraap River

The Groot Goeraap River is classified as a Lowland River, in a Plain setting, where hydrological inputs are characterised by (any of) "Overland flow from catchment runoff, concentrated surface flow from upstream channels and tributaries, diffuse surface flow from an unchanneled upstream drainage line (i.e. an unchanneled valley-bottom wetland), seepage from adjacent hillslope or valley head seeps, and/or groundwater (e.g. via in-channel springs)" (Ollis, Snaddon, Job, & Mbona, 2013).

The system is further classified as an ephemeral river, characterised by low frequency, irregular flows and extended periods of dryness. It flows within a defined channel, prone to erosion in places.

High evaporation rates and low flows are evidenced in parts of the river low flow channel, where salt crystallisation has occurred (Day, 2020). Day (2019) attributed this in part to the possible influence of seepage of saline (seawater) water from adjacent rehabilitated areas of the Mine, but salt crystallisation is likely to be a characteristic of rivers such as this, where groundwater is naturally saline, with high evapoconcentration rates, and highly infrequent periods of flushing by dilute, flood flows (the last time the river flowed appears to have been 1968 – see Section 3.2 of (Day, 2020)).

The Groot Goeraap River was identified by SAS (2014) as of High Ecological Importance and Sensitivity (EIS). This assessment was corroborated by the botanical specialist, who noted the sensitivity of the environment to impacts such as compaction and even shallow surface disturbance, given the reliance of many species on accessing dew from coastal mists through numerous fine roots that occur close to the surface (Helme N. , 2014). Ecological importance derives primarily from the role of the river as a corridor through the landscape – this role will be increasingly important as mining progresses through the study area.

Generally, the river and its floodplain are dominated by plants adapted to arid conditions with occasional short-lived water availability (see Figure 4-16). Such plants include *Lebeckia* sp, the succulent shrub *Ruschia aff. versicolor*, *Zygophyllum retrofactum* and *Galenia africana* (kraalbosch) (Day, 2019).

The Present Ecological State (PES) of the river has been assessed as Category B (Day, 2020).

Sout River

The Sout River flows within a clearly defined channel, edged on either sides by steep slopes up to the surrounding terrain – see Figure 4-17 (Day, 2020). It is flat-bottomed and gently sloped, and its course meanders gently towards its estuary, typical of a lowland river.

The arid nature of its catchment dictates that the river rarely conveys surface flows. Nevertheless, the channel remains sandy and clear of vegetation, due to low water availability in the landscape, making the proliferation of plants unlikely, and a high salt content in the river substrates (assumed to derive from evapoconcentration of surface waters accumulating in the sands) resulting in an associated dearth of all but the most salt tolerant plant species (see Figure 4-17).