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Ecologists & Environmental Services

Storm Water Management Plan for proposed sand mining operations for sand mining operations along the banks of the Sand River on the Farm De Klerkskraal situated near Theunissen, Free State Province.

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DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

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1. INTRODUCTION

The purpose of the assessment is to develop a **SWMP** (Storm Water Management Plan) to inform the **WULA** (Water Use License Application) that is required for the proposed operation of the sand mine for which a mining authorization is in the process of being obtained in terms of the **MPRDA** (Mineral and Petroleum Resources Development Act).

1.1 Mining processes

The sand mining operations will mostly affect the banks and floodplain of the Sand River, though a sand pump in the river will also affect the main channel. The mining operations will consist of a mining right application which is situated on the farm De Klerkskraal which is situated approximately 30 km to the north of the small town of Theunissen (Appendix A: Map 1). The proposed mining operations will entail the excavation of sand from the floodplain and banks of the river while a sand pump within the main channel will be used to extract sand from the riverbed. This will also require the construction of a stockpiling area, sand screen, settling ponds and attenuation areas. The study area consists of a length of approximately 5 km section of the Sand River extending approximately 200 meters to either side of the river. The study area includes both the northern and southern banks of the river as well as large portions of the riparian zone and has an approximate extent of 230 hectares.

The mining processes entails the following:

- Clearance of vegetation.
- Site establishment, including establishment of mining equipment, e.g. floating pump, excavators, dump trucks and infrastructure.
- Mining of sand will be undertaken in a structured manner:
  - Although the proposed project footprint extends over a large area, the larger mining right area will be divided into smaller mining areas of ±2.5 ha each.
  - The maximum area to be disturbed at a time will be limited to 6.5 hectares. This will consist of two smaller mining areas of 2.5 hectares each and an additional stockpiling area (1.5 ha) where the mined material will be screened, washed and stockpiled.

  - Once a 2.5 ha area is mined-out the area will be rehabilitated prior to the opening of a third minor area.
  - The mining method to be used will resemble small scale opencast mining, where the sand will be mined from the earmarked area (±2.5 ha) along benches. An excavator will load the sand onto trucks that will transport it to the screening- and washing plant, after which it will be stockpiled until sold and transported to clients.
  - Pumping of sand from the riverbed via a floating pump to a stockpile area on the riverbank will also take place. It is proposed that the sand will be pumped with agitating sand pumps from the riverbed into an adjacent sand pit (in the riparian area), where the water will either syphon through the floor of the pit or be pumped to the settling ponds (same as those used in the riparian area). Once in the sand pit, the sand will be mined as prescribed earlier.
- Excavators and dump trucks will be utilised in the excavation and moving of mined sand.
- Loading and hauling of product by excavators and dump trucks.
- Screening and washing of the sand.
- Stockpiling of the sand until it is sold.
- Continuous environmental management throughout all the phases of the operation.
- Replacing the topsoil and reinstatement of the mined-out block (minor area) prior to moving to a new minor area. Rehabilitation of disturbed areas on a continuous basis, giving consideration to the planned end land use at the time of closure.

The following structures, infrastructure and operations will be situated within the processing/stockpiling areas (1.5 hectares) and will be implemented to aid in sand excavation and processing:

- Ablution facilities
- Buildings for administration, storage and workshop purposes
- Diesel depot (<23 m³)
- Generators

- Internal roads
- Screening- and washing plants
- Settling pond
- Topsoil stockpile
- Washbay and parking area

In the smaller mining areas (2.5 hectares) the following infrastructure will occur:

- Internal roads
- Sand pumps
- Settling ponds

1.2 Scope of Work

The mining operations will consist of a mining right application which is situated on the farm De Klerkskraal which is situated approximately 30 km to the north of the small town of Theunissen (Appendix A: Map 1). The extent and nature of the mining operations are anticipated to have several significant impacts on the river and its associated floodplain and wetland areas mainly, associated with sedimentation and loss of aquatic and riparian habitat. The study area consists of a length of approximately 5 km section of the Sand River extending approximately 200 meters to either side of the river. The study area includes both the northern and southern banks of the river as well as large portions of the riparian zone and has an approximate extent of 230 hectares. Several lateral stream systems flowing into the river and a few backwater floodplain wetlands were also included within the assessment. The banks of the Sand River are, for the most part, still intact and largely natural with few noticeable impacts.

The purpose is to develop a SWMP for the sand mining operations in support of the water use application in terms of the National Water Act (NWA)], 1996. The main objectives of the SWMP are to ensure:

- Protection of life and property from flood hazards
- Prevention of erosion and consequent sedimentation of watercourses
- Protection of water resources from pollution
- Ensure continuous operation through different hydrological cycles

- Maintaining downstream water quality and quantity requirements
- Protection of the natural environment with the emphasis on the watercourses and their ecosystems

1.3 Methodology

- Desktop assessment of all available hydrological and rainfall data, topographic information, contours and aerial images.
- The mining operations and any associated activities, structures or infrastructure will be obtained from the following approved management reports:
    - Final Scoping Report conducted by Greenmined Environmental and dated February 2022.
- On site assessment of surface water features, and potential sources of contamination.
- Interpretation of surface water flow patterns calculated from available survey data.

1.4 Principles that were considered during the development of the SWMP

- Prevent the contamination of clean runoff.
- Erosion is a consequence of surface water runoff and causes significant degradation of watercourses in terms of sedimentation.
- Dirty water must be contained and disposed or treated in an environmentally responsible manner.
- The SWMP must be sustainable for the life circle of the mine and relevant for all different hydrological cycles.
- The statutory requirements of the various regulatory authorities and stakeholders must be considered and incorporated.

2. OVERVIEW OF THE HYDROLOGICAL CYCLE AND PROCESSES THAT AFFECTS THE GENERATION AND MANAGEMENT OF STORM WATER

2.1 Background

The mine area falls within the quaternary catchment C42L, (Figure 1) which forms part of the Middle Vaal Catchment in the Free State Province. The sand mining area is situated adjacent to the Sand River. The mining area will include the main channel of the river and will extent approximately 200 meters from the channel both on the northern and southern banks. Extensive sand depositions occur along the banks of the river which will be the main focus of sand mining operations. The river flows from east to west past the site. The area has an overall gradual slope from the surrounding terrestrial areas towards the river. However, the banks themselves has exceedingly steep slopes which will also be relevant for storm water management. A multitude of lateral drainage lines and seasonal streams also drain into the river, these also form prominent storm water channels and will therefore be of high importance to the development. The floodplain or riparian zone of the river also contains several backwater wetland areas. These are of moderate size but draining inwards. Sand will be extracted from the main channel by means of a pump as well as excavation of sand from the riverbanks. The mining area itself and surrounding area consists of natural vegetation. The site is situated within the Grassland Biome although vegetation on the site is also dominated by riparian thicket. Surrounding land use is mainly concerned with natural grazing for domestic stock. Dryland crop cultivation is extensive in the region but does not occur near the site. Extensive gold mining activities occurs approximately 5 km south east of the site. The river flows into the Vet River approximately 25 km west of the site.

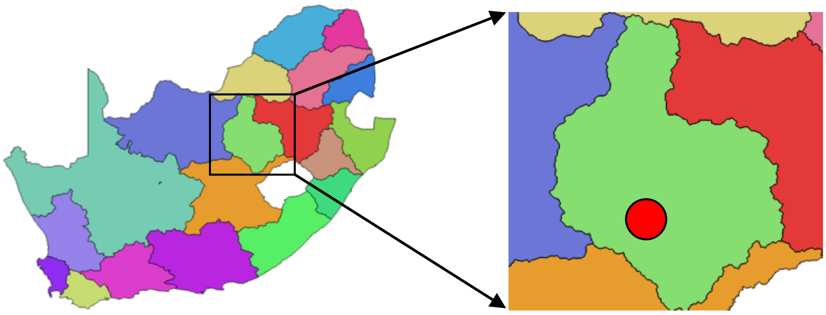


Figure 1: Location of the site within the Middle Vaal WMA.

The vegetation structure along the banks of the river varies considerably, mostly as a result of the variety of habitats and diverse geomorphology along the riverbanks. The surrounding riparian zone is dominated by a fairly dense riparian thicket with interspersed herblands and grassland. Along the upper zone or bank of the river, a dense riparian thicket dominated by tall trees are prominent. Vegetation along the lower and marginal zones of the river bank is subjected to annual flooding and is therefore dominated by a variety of hygrophilous grasses, herbaceous plants, sedges and reeds. Exotic weeds are also abundant along these portions of the river bank. This vegetation structure will also influence storm water management. Currently the vegetation aids in retarding runoff volumes and velocity and where riparian vegetation is removed for mining purposes this will increase storm water runoff.

As indicated, the mining area and affected Sand River consist of different elements which will influence the storm water generation in the area and can be summarised in the following paragraphs.

Sand River main channel and banks

River systems can be divided into different riparian zones within the lateral section of the system. These riparian zones represent the banks of a river and can be distinguished in terms of their geomorphology and vegetation structure. The same applies to the affected section of the Sand River in the study area. These zones are as follows:

The marginal zone is situated from the water level at low flow, up to the features that are hydrologically activated for the most of the year (Figure 2 & 3). The marginal zone within the

Sand River as it occurs within the study area is well defined and easily identifiable. It is relatively narrow in most areas, varying between 1 to 5 meters and is inundated annually during flooding. The majority of this zone seems to be largely natural on both the southern and northern banks.

The lower zone is characterised by seasonal features and extends from the marginal zone up to an area of marked elevation. The lower zone consists of geomorphic features that are activated on a seasonal basis (Figure 2 & 3). The lower zone along the Sand River can also be clearly defined and is easily visible as a definite and steep increase in slope over a short distance whereafter it levels off into the upper zone. The lower zone is inundated less frequently and only during larger flooding events as has recently occurred at the site. In small sections of the river, especially where lateral streams flow into the river and an alluvial fan occurs and the marginal zone is broader the lower zone extends over a larger distance. The lower zone is largely natural within the study area but is affected by the current sand mining area.

The upper zone is characterised by ephemeral features as well as the presence of both riparian and terrestrial species. The zone extends from the lower zone to the riparian corridor. The upper zone contains geomorphic features that are hydrologically activated on an ephemeral basis (Figure 2 & 3). The upper zone along the Sand River is clearly visible as a decrease in slope and an increase in the woodland component. The majority of the upper zone, and the riparian thicket it supports, is still intact.

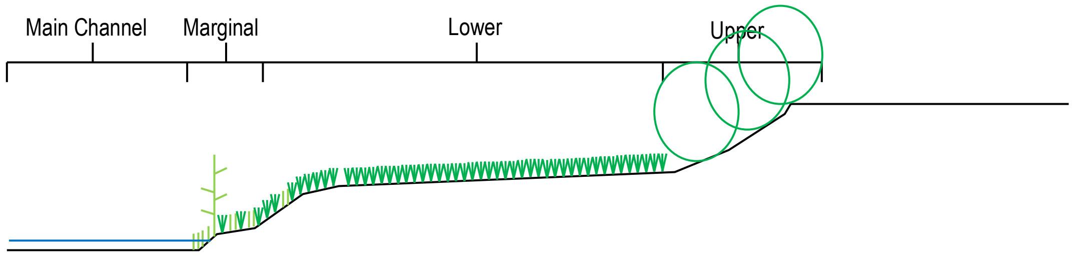


Figure 2: Illustration showing the different riparian zones of the Sand River in the study area. This illustrates the broadening of the zones in areas where alluvial fans occur. These are also the portions most likely to be targeted for sand excavation.

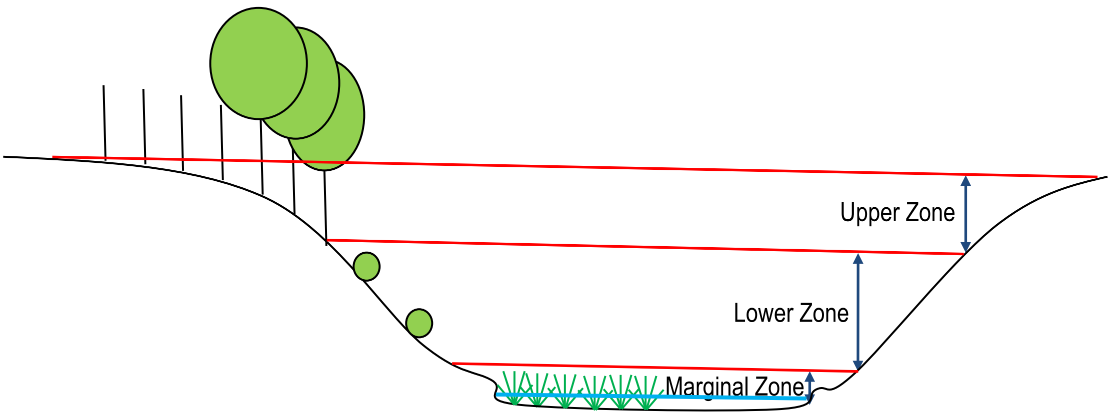


Figure 3: Illustration showing the different riparian zones of the of Sand River in the study area. This illustrates the steep banks occurring in some portions of the river, especially along the northern banks. Note the narrow marginal zone and steep lower zone.

Floodplain or riparian zone of the Sand River

The floodplain or riparian zone of the Sand River along the section in the study area is extensive. It is very broad in most areas and covers the entire extent of the proposed mining areas, i.e. 200 meters in width on both the northern and southern banks. Topography of the floodplain or riparian zone is dominated by a relatively flat, alluvial plain which extends over a larger area and is readily distinguished from the surrounding terrestrial areas which is visible as a slight elevation.

Backwater areas forming floodplain wetlands

As indicated the floodplain or riparian zone of the Sand River is largely devoid of wetland conditions. However, a few backwater wetland areas has formed and here wetland conditions are clearly present. These floodplain wetlands are fairly easily distinguishable from the surrounding riparian thicket. All of these areas form a very shallow depression where, consequently, surface water now accumulates and saturated soil conditions form. The topography of these wetland areas, a shallow depression, does allow for quite easy delineation of these wetland areas. Furthermore, soil samples contained quite clear indication of seasonal wetland conditions and also further aided in the identification and delineation of these floodplain wetlands.

Lateral streams and drainage lines flowing into the Sand River

As previously indicated, there are numerous small drainage lines and seasonal streams that drain from the terrestrial surroundings, across the floodplain and into the Sand River on the site. All of these, irrespective of their size, will transport surface water after rainfall events and they should therefore also be taken into consideration in storm water management of the area.

Soil samples taken within these small watercourses indicated that they all contain significant wetland conditions, at least in those portions of the watercourses that occur within the proposed mining area. They form clearly defined channel wetland systems, the same as the Sand River. Vegetation along these lateral watercourses also confirmed riparian conditions along all of them, while the main channel also contained at least some obligate wetland vegetation.

2.2 Precipitation

The mining area is situated in a region experiencing moderate rainfall, with cold, dry winters and moderate summers. Climate for the site can be extrapolated from rainfall and evaporation data from the weather station C4E009 (Zeebrugge@Sand-Vet). The site is located in an area with a rainfall of between 500 mm and 600 mm per annum with an average of 508.7 mm per year. Precipitation occurs mainly during summer, with most rainfall received during November (69.6 mm), December (71.6 mm), January (63.5 mm), February (67.4 mm) and March (83.5

mm). This is considered a moderate rainfall and causes the area to form part of one of the more temperate areas of South Africa. The mean annual evaporation in the area is 2351 mm. Evaporation is highest during summer in the period from September to February when evaporation exceeds 200 mm. The lowest (93.4 mm) evaporation is experienced in June. From the above description of the climate conditions conducive to the formation of wetlands are regarded as moderate. The overall climate is considered temperate with a moderate rainfall. As a result, surface runoff in the area is also moderate, occurs mostly during summer and results in an estimated mean annual runoff for the area between 20 – 50 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016). Though this is a significant amount of runoff it is still considered moderate.

From the above the average storm water runoff volumes is therefore considered to be moderate, with significant runoff, which will therefore require adequate management. This moderate amount of runoff will however be generated by the surrounding catchment and does not take into account flooding events caused by the Sand River which will affect the floodplain of the river and therefore also the site. Storm water management will therefore have to accommodate runoff from the surrounding catchment but also storm water from flooding events.

2.3 Infiltration

Under normal conditions or undisturbed land the rate of infiltration averages 80%. The type of development or land modification has an impact on the rate of infiltration and therefore the amount of storm water generated.

The infiltration of storm water will be altered to some degree by mining activities but is not anticipated to become problematic. Where vegetation is removed for the stockpile area, excavation areas and settling ponds the infiltration rate will be decreased and runoff generated will be increased (Mmachaka 2013, Mavimbela & Van Rensburg 2016). It is also likely that these areas will be affected by compaction by construction vehicles which will also decrease the infiltration rate. The floodplain has a gentle slope and as long as the processing and stockpiling area is kept well away from the steep banks, storm water management and consequent erosion should not be problematic in these areas. However, the exceedingly steep banks and lower zone of the river will generate significant runoff and the steep bank itself may be significantly affected by erosion where mining causes removal of the riparian thicket.

2.4 Topography

Runoff is generated whenever the rain reaches the ground faster than it can infiltrate and the energy of the runoff water is a direct function of its potential to cause erosion.

The topography of the site consists predominately of the river bank and floodplain and as a result has a moderate slope from south to north toward the Sand River along the southern banks and also from north to south along the northern banks of the river. The floodplain, situated above the steep banks, have an approximate altitude of 1285 to 1289 m over a distance of approximately 150 meters. This indicates a gradual, gentle slope in the floodplain down to the riverbank. Storm water management in these areas will therefore be most manageable. For this reason, it is recommended that the processing and stockpile areas be confined to this floodplain portion in order to make storm water management easier. The riverbank itself, including the upper, lower and marginal zones, is however quite steep and here the altitude decreases over a shorter distance from 1285 m to 1274 m. This is a drop of 11 meters over a distance of approximately 50 meters indicating a significantly steeper slope. Storm water generated and sediment load will therefore drain from south to north on the southern banks and from north to south on the northern banks. It is clear that the gentle slope of the floodplain will have a much lower erosion potential and higher infiltration rate, while the steeper banks will be much more susceptible to erosion with low infiltration rates. The slope of the site, especially the steep banks, should therefore be considered in the stormwater management as it is likely to contribute to erosion and sediment load in the river. As previously discussed, the floodplain will be utilised for the stockpile area, processing plant and settling ponds while the riverbank itself will be affected by sand excavation. As indicated, due to the steep slope of the banks as well as higher likelihood of flood disturbance, it will require more comprehensive storm water management. It will also be necessary to implement an access road between the stockpile/processing area and the sand excavation along the banks of the river. This road will therefore traverse the steep banks of the river to the excavation area and will also require measures to prevent and alleviate erosion.

As indicated, several lateral drainage lines and seasonal streams also traverse the mining area and flow into the Sand River. These form important conduits for storm water from the interior areas and into the Sand River. It should therefore be clear that where mining affects these lateral systems, adequate storm water management will not be possible. As a result, these lateral drainage lines and streams should be completely avoided by mining operations.

Stockpile dumps will represent positive topographic areas which will generate a higher runoff and sediment load and will therefore have to be isolated from the natural drainage pattern and storm water retained on the site.

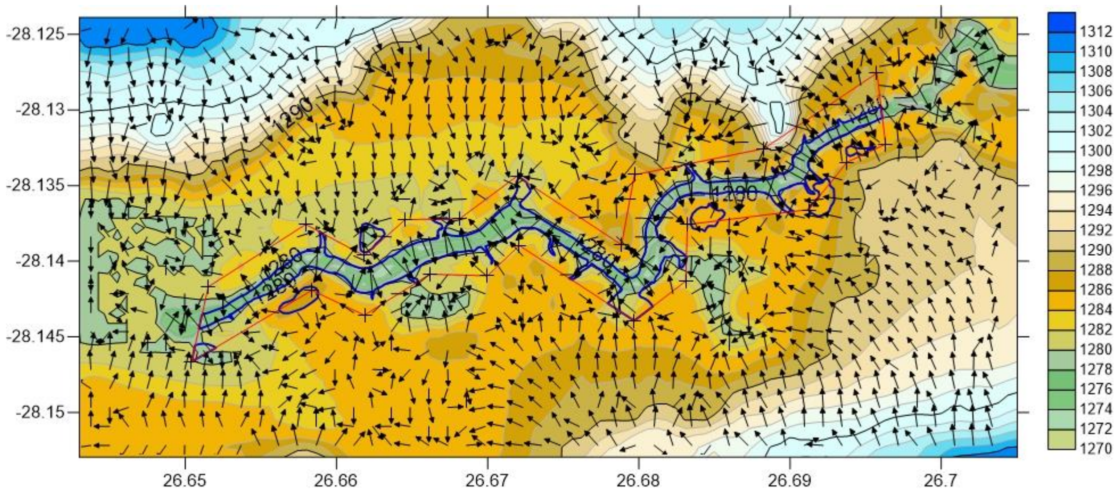
Excavated areas will be primarily inward draining and will infiltrate to some degree as groundwater recharge. Storm water will however have to be diverted around these excavations and into the Sand River.

	View of the floodplain at the site. A more gradual slope is present. This portion will be most affected by the stockpile area, processing and settling ponds.
	View of the upper zone of the riverbank. The upper zone is most easily discerned by dense riparian thicket and a gradual slope but which increases substantially into the lower zone. The riverbank will be affected by sand excavation, access roads and pump infrastructure.

	The riverbank or lower zone contains the steepest slopes. It is clear that this area will have the highest erosion potential and impacts on it should accordingly be kept to a minimum. This zone will however by most likely affected by sand excavation.
	The marginal zone (red) is quite narrow. Note that recent flooding has almost completely removed the riparian vegetation in this zone.
	View of one of the backwater floodplain wetland areas which clearly forms a shallow depression in the landscape. These areas will be inward draining. All backwater floodplain wetland areas should be avoided by mining operations.

The study area contains many large stream systems which clearly flow on a seasonal basis. They form conduits for storm water into the river and should therefore be excluded from mining activities.

The surface water flow patterns are a function of the local topography and indicated in Figure 4 & 5 below. This clearly illustrates the main direction of runoff from the floodplain towards the river.



<u>Figure 4: Surface flow patterns of the De Klerkskraal sand mining area. Uniform drainage across the alluvial plains dominate with concentrated flow occurring along the drainage lines and stream systems. Note also high velocity runoff along the banks of the river. The boundary of the mining area is indicated (red) as well as the border of delineated wetland areas (blue).</u>

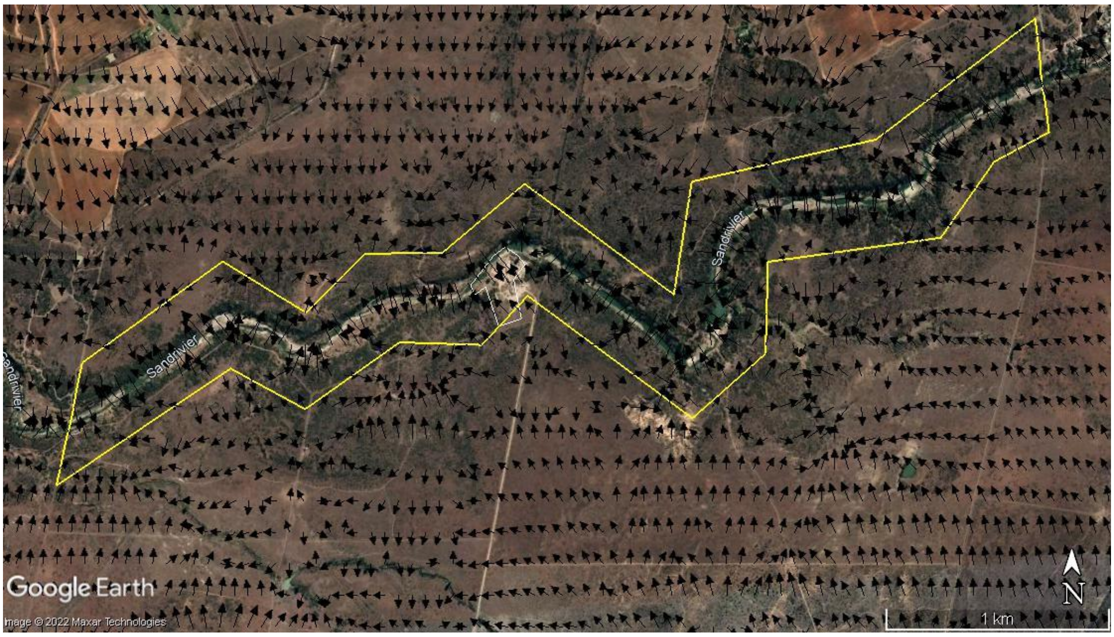


Figure 5: Surface flow patterns of the De Klerkskraal sand mining site overlain on aerial imagery (Google Earth 2021). High velocity flow along the banks is prominent and concentrated flow along streams are also clearly visible.

2.5 Evapotranspiration

Evapotranspiration is the process whereby water is extracted from the soil by plants and respires as vapour through their leaves. Evapotranpiration (ET) for the native thicket and grassland in this region has been estimated at between 450 and 570 mm per annum which is regarded as relatively low. The clearing of vegetation on the site should therefore not have a significant impact on evapotranspiration.

2.6 Recharge

Recharge is the vertical movement of surface water through the unsaturated zone to reach the ground water horizon. The rate of recharge is estimated to be 3 % of the **MAR** (Mean Annual Rainfall).

The rate of recharge and the MAR of the area is considered moderate which will therefore also entail a moderate ground water pollution risk. However, the risk of surface- and ground water contamination is relatively low as a result of the nature of the mining operation, the inert characteristics of the material that is mined and the absence of chemical processes such as leads to high impacts in gold mining for example, etc.

However, the mining activities including access roads, stockpile areas, processing plant, sand excavations and settling ponds will disturb the soil surface, mobilise sediments and may contribute to an increased sediment load in the Sand River. Storm water runoff generated from these areas should therefore be isolated to these areas and prevented from entering the river.

2.7 Streamflow

The mining area is situated on the banks and within the floodplain of the Sand River and is likely to be flooded during large flooding events. The required storm water management measures should therefore be implemented to prevent the site from becoming flooded.

2.8 Ground water flow

The site contains a relatively shallow ground water table, slopes toward the river and therefore recharge of the river will in small part occur from ground water. The geology and topography is however not conducive to the formation of fountains.

3. ASSESSMENT OF CLEAN AND DIRTY AREAS

Areas producing dirty storm water consists of two clearly defined areas, namely the stockpiling area and the sand extraction or excavation along the banks of the river. The stockpiling area especially, should be managed holistically to prevent dirty storm water from exiting these areas. The sand excavations should also be isolated from surrounding clean storm water and dirty storm water contained within excavations. The sand extraction via pumps will occur directly from the main channel and here storm water management will not be possible. The liberation of sediments should be kept to a minimum and erosion along the access roads should be monitored and remedied.

3.1 Stockpiling areas

The stockpiling area is likely to contain the majority of dirty water sources. There is no mine waste or waste product generated as a result of the mining process that could contaminate storm water. However, the stockpiling or processing area will also contain sources such as a diesel depot (approximately 23 m^3), generators, workshop and washbay and these will also form prominent sources of dirty storm water. Furthermore, mobilised sediments in conjunction with storm water will also form a prominent source of erosion and sedimentation. Flooding of the stockpile and processing area remains likely but should be very infrequent, especially if a 38 meter buffer is retained from the banks of the river. Flood protection structures such as berms should still be implemented and maintained.

The following structures and infrastructure associated with the mining operations may contaminate storm water:

Ablution facilities – Improper management or servicing may result in sewage spillage and contamination of storm water runoff. This is an easily managed source of contamination and should not be problematic. Due to the freely draining sandy soils the use of french drains are not recommended since these are highly likely to cause direct contamination of the Sand River.

Fuel storage facility – petrochemicals are known as common pollutants of storm water runoff. A limited volume of diesel (approximately 27 m^3) will be stored in the stockpile area and will be a likely source of contaminants. The fuel storage tank on the site should contain a bundwall and be lined with concrete.

Waste disposal site – Wastes, especially hazardous wastes, may contaminate storm water runoff if not stored correctly. As long as adequate bund walls and concrete lining is implemented this should be easily managed. Storing of hazardous wastes outside the 1:100 year floodline may further decrease pollution risks but will entail a separate area requiring management.

Workshop and wash bay – This is a common source of contaminants as it is not contained within a bunded area. The workshop and washbay areas should be lined with concrete and an oil separator should be installed at the washbay.

Electrical generator – A generator on the site will utilise diesel fuel and oil which may form a source of contamination for storm water. It should be placed within a bund constructed from steel or concrete in order to prevent any significant contamination.

Access roads – The access road from the main road to the site will make use of an existing gravel road and should not form a significant source of dirty storm water. The haul roads between the stockpile area and the riverbanks transect the steep banks of the river and it is clear that this will result in erosion which will require constant monitoring and remedial action. This should include adequate design and construction including storm water management measures such as v-drains, culverts, storm water berms and erosion control measures such as gabions where erosion is problematic.

The above described sources of dirty storm water or contaminants should not become problematic as long as dirty storm water is contained within the operational area. The main concern regarding the mining area is erosion of sediments from the mining site and mobilised as suspended solids in storm water which then enters the river and increases the sediment load. Another significant concern is the flooding of the plant area situated in the floodplain of the river. Therefore, in addition to the above measures such as bund walls, lining, etc. it is recommended that the clean storm water be diverted around the stockpile area by means of berms and that dirty storm water be contained within the plant area by constructing cut-off trenches and berms around the area. Furthermore, the berm facing the riverbank should be of such design as to prevent flooding of the site and plant during flooding events in the river. Retaining a 38 buffer between the stockpile area and the riverbank will further improve storm water management and prevent contamination of surface water within the Sand River.

In addition to the above, areas where the vegetation has been cleared will also experience increased erosion and should be included in the footprint of the stockpiles as described above.

Furthermore, the rehabilitated environment will itself also form a source of erosion and sediment as it will be devoid of vegetation and will contain mobile sediments. Care should therefore be taken to establish an indigenous vegetation layer as quickly as possible and to implement continuous erosion monitoring and remediation.

Berms, cut-off trenches and other storm water management measures should be maintained on a continuous basis and monitoring should include the occurrence of erosion and areas where dirty storm water bypasses this system.

The pollution prevention measures included within the Final Scoping Report dated February 2022 as well as the SWMP should be strictly implemented and should be sufficient to contain sources of dirty storm water.

As long as adequate storm water measures are implemented to contain dirty water within the stockpile area and measures are implemented to prevent flooding of the site the risk of contamination of storm water around the site or the main channel of the river will remain low.

3.2 Sand excavations

The extraction, pumping and excavation of sand will occur separately from the stockpile area and will take place within the main channel and banks of the Sand River and will then form a separate source of dirty storm water. The pumping and excavation of sand will disturb and mobilise these sediments which in turn will increase the suspended solids and sedimentation of the main channel.

The extraction of sand by means of sand pumps will be situated within the main channel where it will not be possible to contain sediments in the immediate area. The infrastructure associated with it will be situated on the banks of the river and any disturbance of the banks, alluvial sandbanks and main channel should be kept to a minimum.

The excavation of sand from the banks of the river will result in significant disturbance of the banks which will contribute to sedimentation of the river. The excavation of sand will form a void, pit or trench which will be largely inward draining and will therefore not contribute to dirty storm water runoff. Excavations will however act as a water trap for clean storm water runoff and as a result it is recommended that berms be erected around excavations to divert clean storm water around them and into the natural drainage pattern. The sand excavated will be taken to the cleared stockpile areas and resultant storm water will be managed as described for these stockpile areas. However, topsoil and overburden will most likely be stored adjacent to the excavation or trench and will have the same impacts on storm water runoff and erosion as described for the stockpile areas. As a result a berm should also be constructed around these smaller stockpiles around excavations and the slope angle of stockpiles should also be kept to a minimum. Any associated areas having been cleared of vegetation should be included in this footprint as it will also be a source of erosion and sediment.

4. STORM WATER MANAGEMENT PLAN - SWMP

The recommendations included within the SWMP should be used as a guideline but, due to the unpredictability of water and its movement they may prove to be ineffective in some instances. This will only become apparent after implementing these recommendations and the SWMP should be amended where storm water measures are found to be inadequate or ineffective in managing storm water runoff. Input in the design of storm water structures from an engineering perspective should also be considered.

Implementation of adequate storm water management measures as discussed should ensure separation of clean and dirty storm water and the containment of dirty storm water in operational areas. This will however be pointless without continuous maintenance and monitoring of these measures. This should also include monitoring of erosion and remedying this where it occurs, monitoring and repair of damaged berms and where cut-off trenches become filled with sediment cleaning of these should be undertaken.

One of the main aims of the SWMP is to retain dirty storm water and therefore sediments and suspended solids within the operational area, i.e. the plant, stockpile area, excavations, etc. These sediments and suspended solids, as well as contaminants such as hydrocarbons, will therefore accumulate within these operational areas. This should also be taken into consideration during rehabilitation of operational areas. In other words, this contaminated material should be disposed of responsibly during rehabilitation. Such contaminated areas may include the areas around diesel storage, washbay, workshop and generators. Contaminated material and soil should be removed and disposed of at a registered disposal facility.

The isolation of dirty storm water will however only be possible within the stockpiling area as well as sand excavations along the banks of the river. It will not be possible to contain disturbed sediments and pollutants caused by the pumping, extraction and excavation of sand within the main channel to the immediate area. The necessary precautions will therefore have to be taken to keep disturbance of sediments to a minimum and to implement adequate management to prevent any pollutants from entering the main channel.

Stockpile areas

As discussed, the stockpile areas will be one of the most prominent sources of dirty storm water. It is therefore recommended that dirty storm water be contained within these areas by means of a berm around the perimeter. This should also allow clean storm water to be diverted around this area and into the natural drainage pattern. These berms should also be of such design as to prevent flooding of the site during flooding events. Settling ponds will be erected on the site for the sand washing as well as to capture storm water from the site. Sediments within the storm water will then be allowed to settle and water will seep into the ground water and into the river whilst containing sediments and pollutants on the site. These settling ponds should also be included within the footprint of the stockpile area otherwise flooding will simply mobilise any settled sediments, increasing the sediment load within the river. The site should be rehabilitated after cessation of operations and an indigenous vegetation established which will bind sediments more adequately and decrease the mobilisation of these sediments.

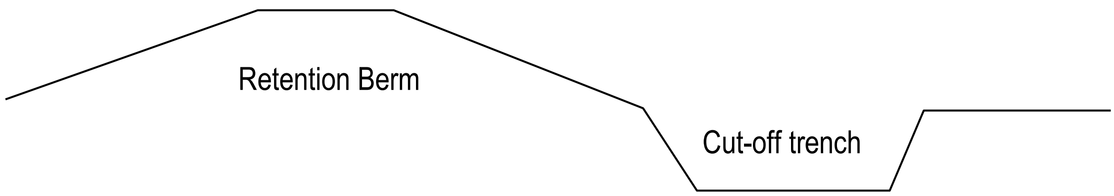


Figure 6: Approximate representation of the recommended berm and cut-off trench system. The approximate dimensions of both the berm and trench should be 1 m deep/high and 2 m in width and should retain an aspect ration of 1:2 height/depth to width.

The stockpile storage area associated with the plant will be especially susceptible to generate dirty storm water in terms of increased runoff rate, erosion, sediment load and suspended solids. It will therefore be important to contain storm water generated on these stockpiles to the immediate area by including stockpiles within the perimeter of the berm as discussed above and keeping the stockpile slope angles to a minimum.

In addition to the above storm water management measures the following measures should also be implemented for specific dirty storm water and sources of likely contamination.

Ablution facilities – Ablution facilities will consist of a built facility which should preferably make use of a septic tank system which is a closed system and should prevent contamination of surface and ground water. This facility should be placed further than 38 meters from the edge of the riverbank and should be included inside the flood protection berms as described above. Due to the freely draining sandy soils the use of french drains are not recommended since these are highly likely to cause direct contamination of the Sand River.

Fuel storage facility – Petrochemicals are known as common pollutants of storm water runoff. A limited volume of diesel (approximately 27 m^3) will be stored in the stockpile area and will be likely source of contaminants. Erect bund walls around diesel storage tanks with a capacity 1.5 times the volume of the tanks. The soil surface should also be lined with concrete both under the tanks as well as where vehicles will be re-fuelled. Adequate maintenance and servicing of diesel tanks are also important.

Washbay/Workshop – This is a common source of contaminants as it is not contained within a bunded area. The workshop and washbay areas should be lined with concrete and an oil separator should be installed at the washbay.

Electrical generator – A generator on the site will utilise diesel fuel and oil which may form a source of contamination for storm water. It should be placed within a bund constructed from steel or concrete in order to prevent any significant contamination.

Waste disposal site – Wastes, especially hazardous wastes, may contaminate storm water runoff if not stored correctly. As long as adequate bund walls and concrete lining is implemented this should be easily managed. Storing of hazardous wastes outside the 1:100 year floodline is also recommended. General waste should be placed in disposal bins and removed periodically to the local landfill site.

Access roads – The access road from the main road to the site will make use of an existing gravel road and should not form a significant source of dirty storm water. The access road to the river will transect the steep banks and may however entail significant erosion which will require constant monitoring and remedial action. This should include adequate design and construction including storm water management measures such as v-drains, culverts, berms and erosion control measures such as gabions where erosion is problematic.

Sand excavations

The extraction, pumping and excavation of sand will occur separately from the stockpile area and will then form a separate source of dirty storm water. The pumping and excavation of sand will disturb and mobilise these sediments which in turn will increase the suspended solids and sedimentation of the main channel.

Where sand pumping and excavation takes place within the main channel it will not be possible to contain sediments in the immediate area. The infrastructure associated with it will be situated on the banks of the river and any disturbance of the banks, alluvial sandbanks and main channel should be kept to a minimum.

Sand excavation from the banks of the river will be done by means of trenches and excavation pits. Clean storm water runoff should be diverted around these excavations and into the natural drainage pattern. Where topsoil and overburden is stockpiled adjacent to excavations the same storm water measures should be implemented as for stockpiles at the plant, i.e. berms should also be constructed around these smaller stockpiles at the excavations and the slope angle of stockpiles should also be kept to a minimum. Any associated areas having been cleared of vegetation should be included in this footprint as it will also be a source of erosion and sediment.

As indicated, access haul roads between stockpile areas and the river should be limited to a single access road for each of the smaller mining areas. Any disturbance of the riverbank should be adequately rehabilitated which must include re-instatement of the natural topography, replacement of topsoil, prevention of erosion and monitoring and eradication of problematic weeds and invasives establishing. Where disturbance of the banks or floodplain takes place the removal of vegetation must be kept to a minimum. In order to limit the risk of surface water contamination the excavation of should be restricted to above the groundwater level which should not exceed a depth down to 300 mm above the groundwater table.

Operation in close proximity to and within the main channel of the Sand River

The Sand River forms part of the proposed mining area and the main channel will be affected by sand pumping while the banks will be affected by sand excavation. The river also serves as a natural storm water conduit and plays a vital role in transporting storm water runoff and attenuating floods. The ecological function of the river is to collect storm water (sheet flow) from the surrounding slopes and catchment during rain events and transportation thereof to downstream reaches. As long as storm water management measures as discussed above are implemented, the stockpiling and excavation areas should not result in any significant modification of the functioning of the river.

There is however still a risk of the stockpiling and excavation areas being flooded during flooding events, this is especially relevant for the excavations situated on the bank itself. This should be prevented by erecting a berm around these areas, designed to prevent this. This berm will also contain dirty storm water within the operational area and allow clean storm water to be diverted around it. However, it is unlikely that the berm system around excavations will be able to prevent flooding, this was also evident during recent flooding. As a result, in addition to berms and measures as indicated, the excavation areas should also be kept free of any materials which may result in contamination of surface water during flooding. This should include any machinery which should be removed prior to flooding and generators should also not be located in the excavations areas. All materials, structures and infrastructure should be contained within the stockpiling/processing area situated further than 38 meter from the edge of the riverbank.

Where sand excavations are being made in the riverbank this causes voids which will become filled during flooding and will then form artificial wetland areas and impoundments which will also cause the formation of wetland conditions. This should be prevented as far as possible by levelling bench cuts and excavation pits and completing and rehabilitating excavation areas before undertaking the following excavation area. The following simplified illustration should also give a representation of the way in which sand excavation is undertaken and how levelling should blend into the surrounding riverbank shape.

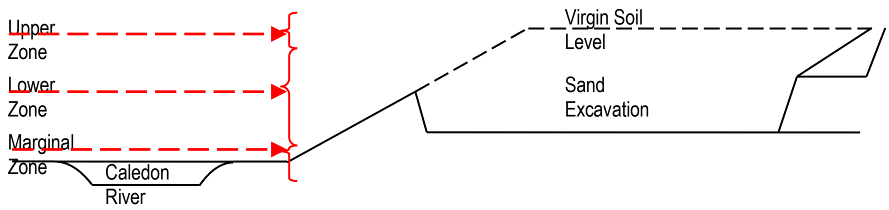


Figure 7: Simplified representation of the excavation of sand from bench cuts and levelling of resultant excavation. An irregular surface topography should be avoided as far as possible.

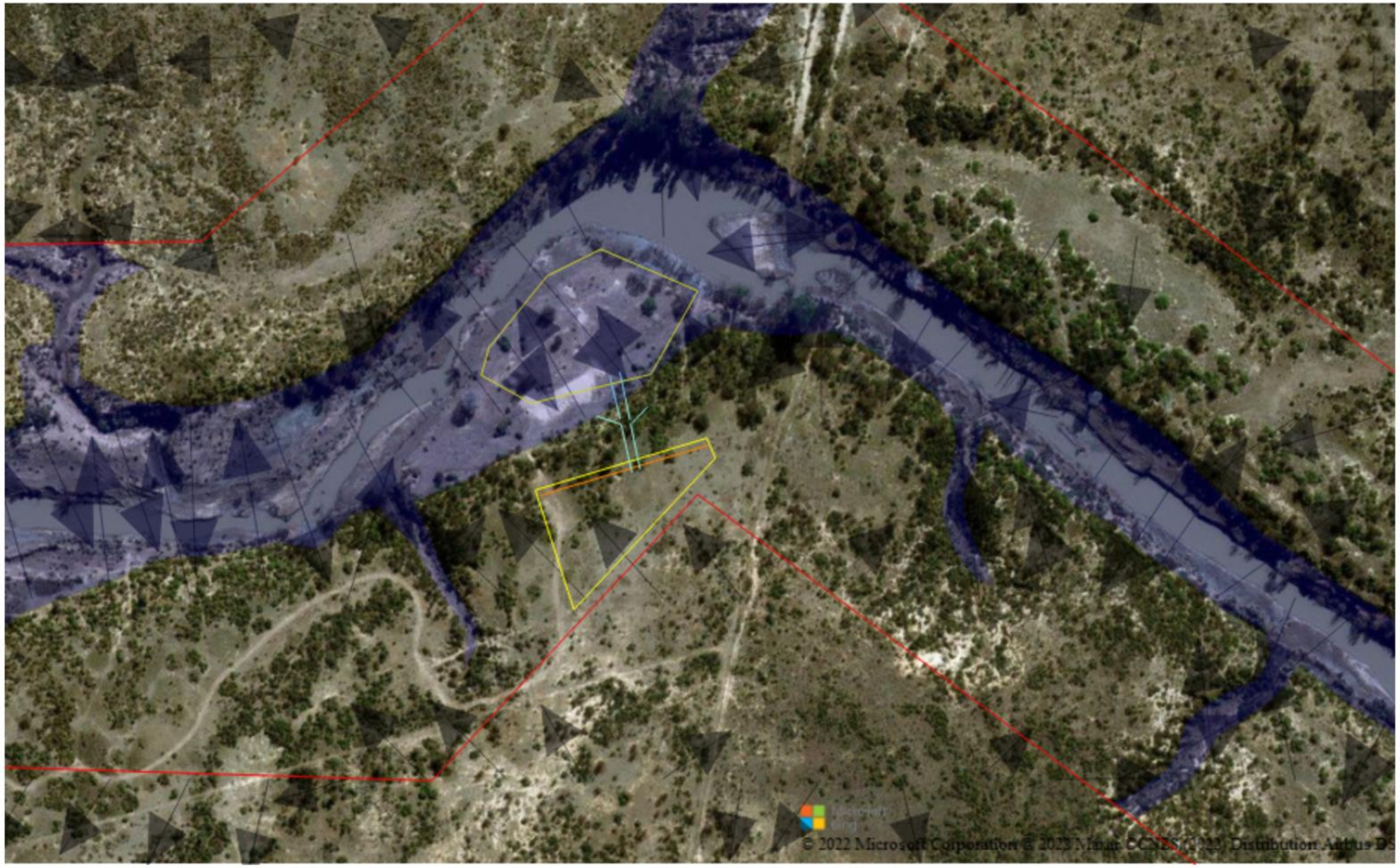
The pumping and excavation of sand from the main channel of the river will most likely impact on the sediment load of the river. As a result, authorisation should be submitted in terms of the NWA in order to operate in and adjacent to the Sand River. Clear management procedures should be developed to ensure that the river is protected and impacts on it are minimised.

Lateral drainage lines and stream systems in the mining area also function as storm water conduits. As a result they should be protected and preserved to perform this function with regard to storm water. In addition, they also form the main conduits by which storm water exits the mining area.

Refer to the layout of the SWMP (Appendix A: Map 1) for a visual representation of the storm water measures as recommended. This should however still be utilised as a guideline and adjusted where necessary and should also incorporate specific designs for structures such as the cut-off trenches, berms and settling ponds.

Annexure A: SWMP Map

Storm Water Management map for the proposed sand mining operations along the banks of the Sand River on the Farm De Klerkskraal situated near Theunissen, Free State Province.



Map 1: Storm Water Management map of the proposed sand mining operations along the Sand River on the Farm De Klerkskraal near Theunissen. The mining area is indicated and the mining operations should be confined to this area. A berm should be erected around the excavation area located on the banks of the river. A single access road should be constructed from the excavation to the stockpile/plant area in the floodplain. This access road should also contain adequate erosion measures such as V-drains, side-drains and berms. The stockpile/plant/processing area should be located outside the delineated banks and a 38 meter buffer retained from the banks. A flood protection berm should also be erected around the stockpile area which should also divert clean storm water around the site while retaining dirty storm water within this area. A cut-off trench should also be used to collect dirty storm water on the site. Note also that adjacent lateral drainage lines and streams should be avoided by mining operations. Surface flow vectors also indicate high velocity runoff from the banks of both the southern but especially the northern banks in this area.

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Legend:

- Application area
- Wetland areas (main channel, riverbanks and lateral streams)
- Surface flow vector
- Berms (Plant/Excavations)
- Cut-off trench
- V-Drains/Side drains/Berms

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

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