DRAFT

WCR DUST STUDY

This draft copy is issued prior to ability to finalise the levels of dust plume definition in mapping and consequently the detailed plans (Figures 2a, b and c) and the individual hierarchical extents in Table 2 are not yet included. Nor are the paragraphs on Management Conditions for inclusion in the Environmental Authorisation and the Monitoring Requirements included in this draft issue.

Site Plan Consulting

SPC # 2744/DP/R1 Draft

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1. DETAILS OF THE SPECIALIST AUTHOR AND DECLARATION OF INDEPENDENCE

1.1. The specialist author

This report has been prepared by Stephen van der Westhuizen (BSc Geology 1976 and MT&RP cum Laude 1979), Geologist and Environmental Planner, with 35 years' experience as a consultant in assessment of mining and other land uses within coastal systems throughout Southern Africa, and serves Site Plan Consulting as an environmental geologist, as member of the Geological Society of South Africa and as an EAP in terms of the NEMA. For CV refer Annexure A.

1.2. Specific expertise in dust assessment

The author's expertise lies in his understanding of, and experience in dealing with environmental dust related to high wind regimes on the coast-line where primary dune blowouts and headland by-pass dunes have been the focus of many of his commissions in the past, while the assessment and monitoring of mine generated dust has been a component of almost every mining EMP and site assessments for non-mining coastal developments he has undertaken in some 300 commissions over the past 35 years.

Of specific note is his development of the understanding of coastal alluvial diamond mining dust in his compilation of the Alexkor EMPr of 2008 and specifically the dust report of 2014.

1.3. Declaration of Independence of the author

See Annexure B for standard declaration.

2. INTRODUCTION TO THE SPECIALIST REPORT

2.1. General Perspective

In this study, while termed a Dust Assessment, it in fact, given the nature of the dust environment of the West Coast, deals primarily with windblown sand under high wind speeds, which is carried just above the land surface posing a threat to the ecological systems of the site and being a nuisance factor to the built environment as opposed to both the medium fraction "fall-out" dust and the very fine fraction airborne inhalation (gravimetric) dust which when it comes to health considerations, is dealt with in terms of the Mine Health and Safety Act and is fully monitored in terms thereof.

It is furthermore fundamental for the study to emphasize the distinction between:

- natural sand plumes; and
- mining sand plumes

as they have their own origins and sometimes own characteristics but at the same time, they both present as plumes with similar impacts, especially on vegetation and very often overlap to yield cumulative extents and impacts.

Furthermore, it is emphasized that the understanding of the windblown sand plumes and broader dust phenomena at WCR derives not only from the satellite imagery interpretation and mapping and the field assessment of 6-7 July 2016 but also from earlier visits to the greater WCR area when under DBNM ownership and additionally from Site Plan Consulting's (SPC) experience in the assessment of dust (sand plumes) at Alexkor where it was studied in-depth, in developing and in understanding and categorising plumes and sand plume attenuation mechanisms and furthermore from coastal dust assessments of primary dune blowouts at Port Alfred, along the Eastern Cape coast and headland by-pass dunes of Hout Bay/ Llandudno, Port Elizabeth and Cape St. Francis in terms of understanding the phenomenon, their sources and success and failure of control measures of the windblown sand plumes.

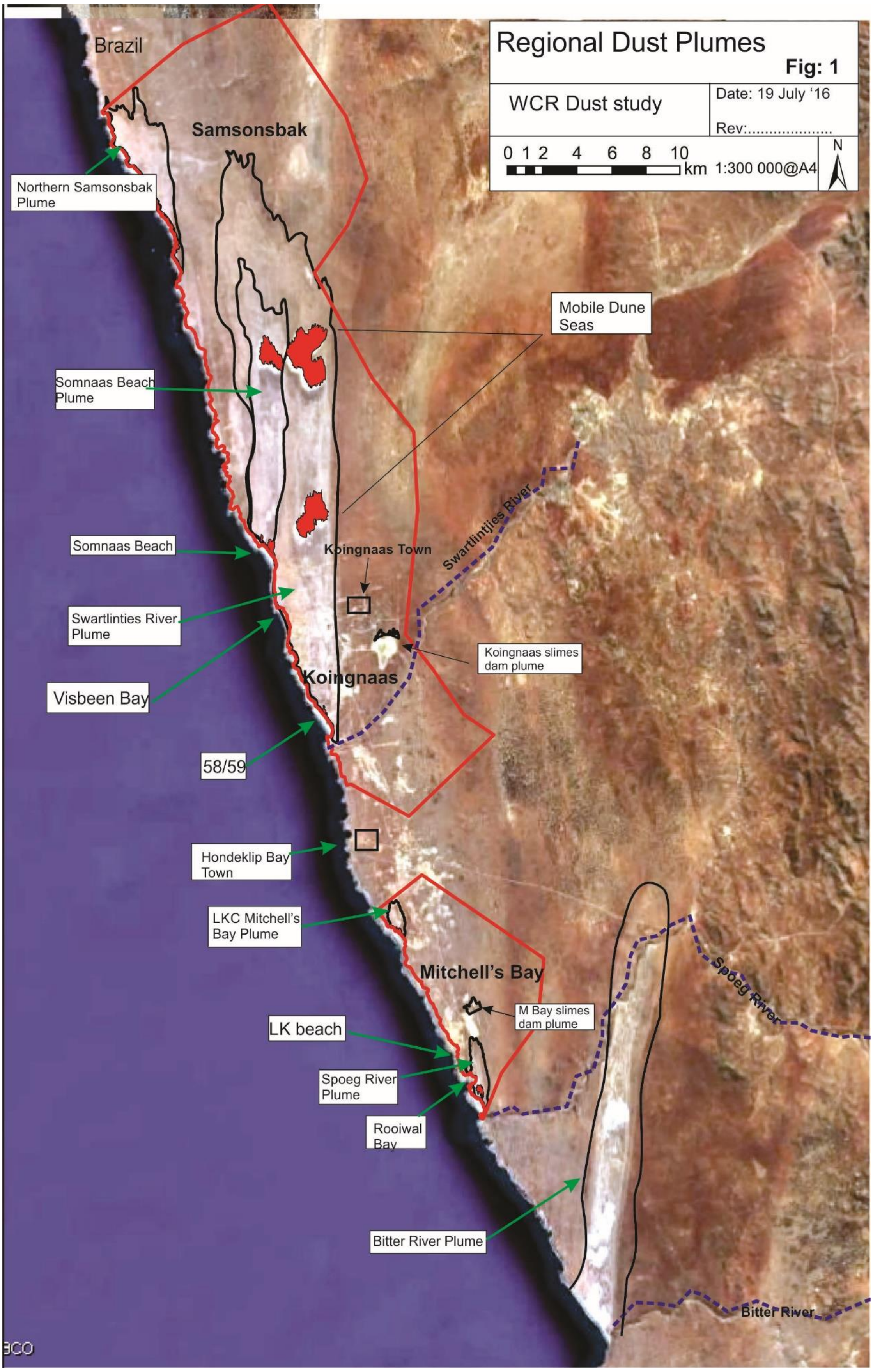


Figure 1: Regional Dust Plumes

As such, this study is not merely an assessment of the impact posed by sand plumes and other dust, but provides a baseline for:

(i) Appreciation of the distinction between natural and mining plumes as a primary underlying consideration for intervention;
(ii) Intervention on a pro-forma basis to deal with existing and future ad-hoc occurrences; and
(iii) Monitoring through periodic re-measurement of the GIS captured and numbered plumes.

Furthermore, the consideration of the dust assessment must be seen within the context of the extensive mining which has occurred within the study area over the past +-70 years by DBNM both as inland terrace mining and beach and back-of-beach mining, all of which present as disturbed areas. Additionally, the purpose of this EMP update is to develop the attenuation measures to apply to the future mining contemplated by WCR as further inland terrace mining as well as further beach, back-of-beach and coffer dam mining (seaward of the low water mark). Hence this dust study will give specific attention to considering the expected future additional dust generation within the context of the current levels of dust plume impact.

2.2. Purpose and scope of the report

This specialist dust report will serve, together with other specialist reports in providing the base-line information, impact assessment and proposed attenuation measures and monitoring to the EIR/ EMP update for the WCR alluvial diamond mining activities.

The study area includes the three Mining Right Areas of:

- Samsonsbak;
- Koingnaas; and
- Mitchell's Bay

as shown in Figure 1.

As discussed in paragraph 2.2. above, this dust assessment focuses on the windblown dust (sand) phenomenon which is characteristic of West Coast diamond mining. Given that such sand movement occurs at very low above-ground level, it does not allow standard methods of dust monitoring/ quantification (by for example DustWatch™ equipment), nor the application of standard dust levels for Atmospheric dust management, which will be dealt with as a specific item in paragraph 4.4. The further element of inhalation (suspended) dust, which is of a health consideration, is not dealt with by this study as it deals specifically with working environment under the Mine Health and Safety Act in terms of which it has specific prescriptions for its monitoring and reporting.

2.3. Assumptions, uncertainties, knowledge gaps and seasonality

As the schedule for the study was set for the month of July and unusually heavy rains fell during June and early July, no evidence of dust coatings of plants nor visibility impact were evident during the site visit of 6-7 July 2016 but the levels that would occur in dry summer months under the prevailing southerly winds are known to the author and photographs of this element will be used from other West Coast assessments which are directly comparable.

Given the fact that the latest Google Earth™ image for February 2016 is patchy, thereby not allowing consistent assessment of the sand plume intensity levels, the consistent images of 2014 were rather used after determining that the date difference did not hold significant implications for the definition of the extent of the plumes as captured as .shp files in the base-line data. This is largely to be expected as the DBMN discontinued active mining over much of the study area in excess of 6 years ago.

2.4. Methodology

The study began with a perusal of similar assessments conducted by SPC and publications on coastline dynamics and coastal dunes as well as the wind regime of the West Coast. In order to place the WCR study in the correct perspective, an initial satellite image assessment of the West Coast natural regional dust plumes was conducted, the relevant portion of which is shown in Figure 1. Fieldwork base-plans with rough outlining of plumes on the photographic base were then prepared also showing access roads for the site visit verification of the plume imagery. Then, in the week of 6 July 2016, a site visit was held during which targeted sites were visited to document the various plume types, intensities and origins and such documentation then served the description of "type-localities" in brief field notes with GPS positions and illustrative photographs. On return to the office:

- The .kml file recording the GPS positions together with photographs of type localities depicting either vegetation impact of plumes or revegetation of earlier disturbed areas and plumes were emailed to Specialist Botanist Dr Dave McDonald in order that during his pending vegetation survey, he could visit the sites as the basis for our joint discussion on the matter of stabilising dust plumes through either assisted, or natural revegetation with hand broadcasting of seed and the impact level categorization, a factor of vegetation status.
- The extents of each plume were captured in .shp file format and transferred to an Excel table reflecting the classification and all other attributes of each plume including; origin (natural, mining or both), categorized level, extent in hectares, impact on vegetation, risk of further impact etc. Against this basis of mapping and tabled recordal, consideration was then given to the choice of appropriate attenuation options. As the attenuation measures are applicable to both existing plumes and possible future plumes associated with similar future disturbances, the attenuation measures are generically designed but illustrated on chosen existing occurrences. Finally, the levels of impact, attenuation measures and latent risks are documented.

3. SENSITIVITY OF THE RECEIVING ENVIRONMENT

In this regard, a distinction is drawn between Samsonsbak Mining Right Area in the north and the Koingnaas and Mitchell's Bay areas in the central and southern area, given that very little mining disturbance has occurred to-date in the Samsonsbak area as opposed to the extensive mining disturbances in the other two Mining Right Areas.

The receiving environment is that of the ex-DBNM alluvial diamond mine which has operated since the 1940's both as inland terrace mining and beach and back-of-beach mining with wide-spread intensive disturbances by excavations, overburden dumps, roads, mining plant and slimes dams (fine tailings ponds). The matter of sensitivity of the receiving environment is therefore closely related to the extent of existing mining disturbances and the distribution of natural plumes, both having a direct bearing on the degree to which impact is further considered. Figures 2a, b and c accordingly show the 2016 mapped plumes with the existing mining disturbances in the background image.

Of greatest significance is the matter of impact on intended beach and coffer dam mining which relate to beach sand plume origins, especially where such disturbed coastlines present as on-shore orientated coastlines and half-heart bays.

3.1. Natural system sensitivities

(i) Natural Vegetation

The veld type is largely uniform over the entire study area Namaqualand Coastal Duneveld as Mucina and Rutherford (2012) with only the following variations:

- Lower density and smaller plant specimen from south to north.
- Lower density and smaller plant specimen within the seaward slopes affected by on-shore/ long-store salt spray as seen in the northern extremity of Samsonsbak where the lower slopes are additionally impacted by the low-level Samsonsbak plume.
- The 2014/ 2015 assessments of natural vegetation at Alexkor showed that the vegetation type is extremely resilient and capable of recovery with limited intervention under the right circumstances. In fact, such recovery was found to be better where it is allowed to occur naturally within the natural West Coast characteristic of combined high levels of windblown sand and seed movement while netting installed to curtail sand movement, totally curtailed seed movement and resultantly areas of high levels of sand transfer without netting revegetated very well by comparison to netted areas which had the purpose of promoting revegetation by curtailing sand movement.

(ii) Areas of high natural sand movement

Given that high levels of windblown sand movement is a characteristic of the West Coast, and accordingly as seen in aerial photography showing repeated periods of sand migration followed by revegetation stabilisation, the extent of natural sand plumes is in itself a system of extensive reduced sensitivity and in this regard the regional sand plumes as shown in Figure 1 are relevant:

- The northern Samsonsbak plume (related to beach orientation)
- The Swartlintjies River-Somnaas Beach plume (natural aggravated by extensive beach mining)
- Mitchell's Bay plume (natural on-shore half-heart bay beach aggravated by intensive mining)
- Spoeg River plume in southern Mitchell's Bay MRA
- The Bitter River plume (natural south of the study area)

As shown in Figure 1 within these large plumes, migrating natural dune seas occur within the Swartlintjies-Somnaas plume and a smaller sea in the Spoeg River plume just south of Rooiwal Bay (refer Photo 1).

Photo 1: Spoeg River plume seen south of Rooiwal Bay

3.2. Built environments and specific land uses

As no farmsteads occur on the properties, the only receiving built environments on this coast are:

- Hondeklip Bay town; and
- Koingnaas town,

both of which to-date have not required specific dust intervention, although the bush line south of Koingnaas town undoubtedly has provided it with protection from the higher dust levels which occurred during the peak operating intensity of earlier mining operations in Koingnaas Mining Right (KMR). Furthermore, the Koingnaas town is directly downwind of the Koingnaas slimes dam, which has dried since decommissioning of the Koingnaas plant and resulted in the windblown plume north of the slimes dam undoubtedly having increased the dust impact on the town, at least to a nuisance level.

3.3. Sensitive areas and buffers

The most sensitive natural areas by virtue of the intensity of plume development are the inland areas immediately north and north-east of half-heart bays such as Somnaas where these areas are subject to focused plume invasion and which beaches will be fed with increased sediment as a result of littoral drift from nearby beach and coffer dam mining. This phenomenon is intensified where there are river mouths south of either such half-heart bays or other on-shore (wind) orientated beaches

Koingnaas town which is directly downwind from the Koingnaas slimes dam plume with insufficient buffer distance.

The privately owned farm of Brazil which is already becoming subjected to the Northern Samsonsbak half-heart bay plume generation already naturally affecting the adjacent private land of Brazil and emphasizing the need for attenuation when any mining of this northern coast line is contemplated.

4. FINDINGS: CLASSIFICATION AND MEASUREMENT

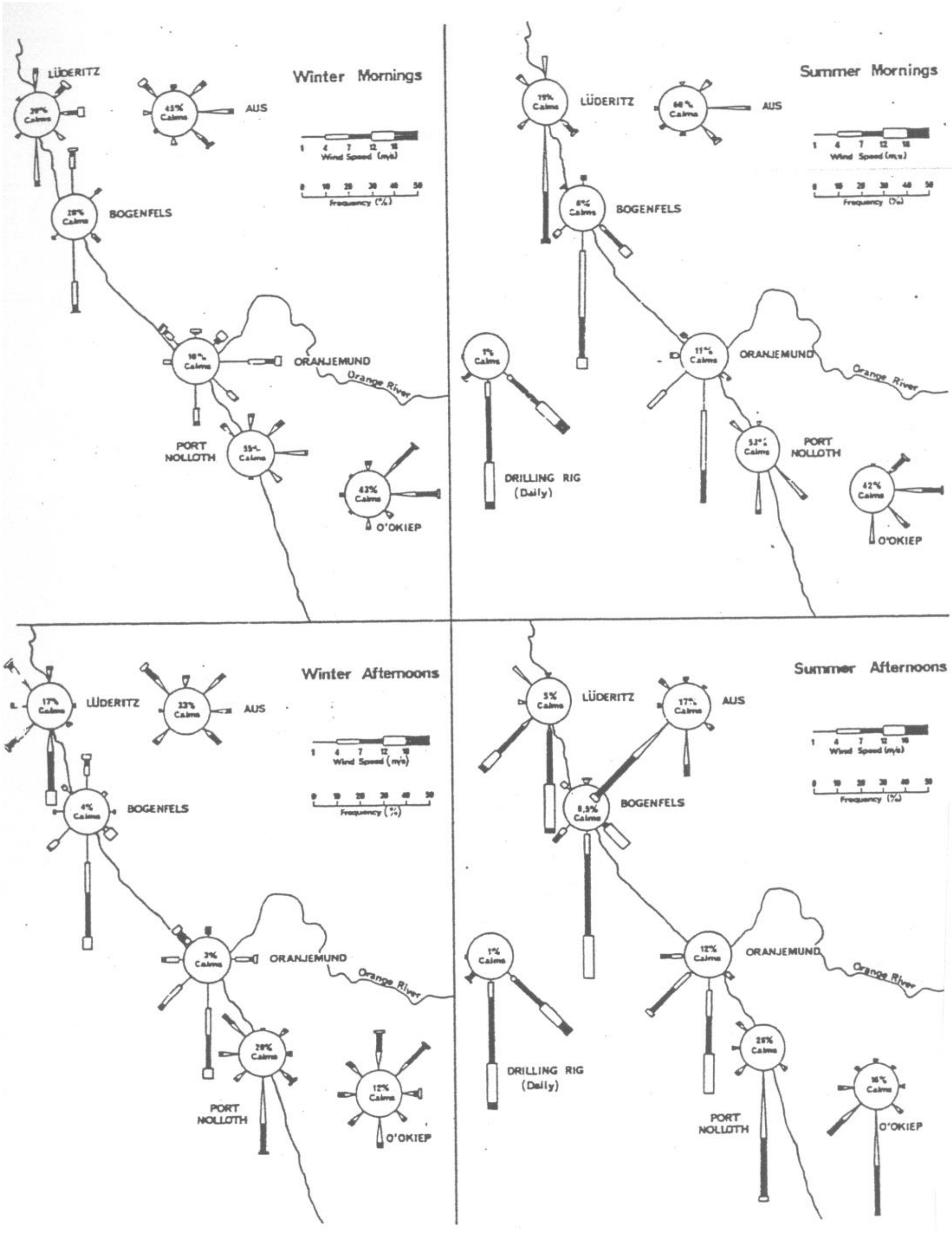
4.1. Origin of dust plumes

The origin of dust plumes on this coastline as part of the West Coast stems from;

- the prevailing winds,
- the sand sources,
- mining disturbance; and
- coastline form and orientation.

4.1.1. Prevailing West Coast winds (applicable to natural and mining dust plume generation)

Prevailing winds are particularly effective in this area given their constant direction and strength through most seasons, as seen in the wind roses below. However, it is noted that the literature sources cited hereafter dealt specifically with the areas of extremely high wind speed and frequency of the Alexander Bay/ Southern Namibian coast and it is acknowledged from personal observations that the wind of the study area is of lower speed and frequency than that further north but non the less, remains best reflected by the technical assessments of Talkenberg and others.



Seasonal wind roses (Talkenberg) FIGURE 2.2 PAGE 23

Diagram 1: Wind rose extracts from the Talkenberg report

This consistency in wind direction results in a very high RDD value (resultant drift direction), representing the net sand distribution after reduction of transport in opposite vectors.

The following photo and extract of plume mapping from the original Alexkor plume quantification of April 2005 indicate that by comparison the WCR enjoys a lower incidence of windblown sand than that at Alexkor.

Extract from the original 2005 Alexkor dust assessment showing the high intensity of Alexkor dust plumes

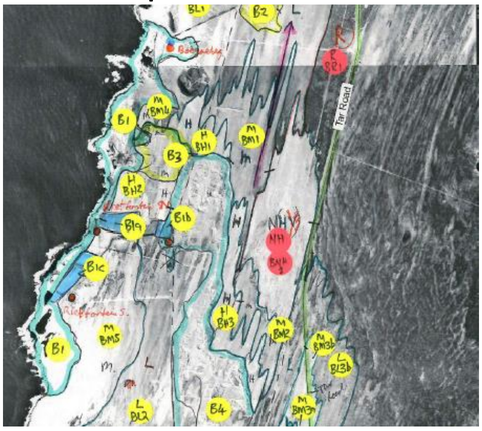
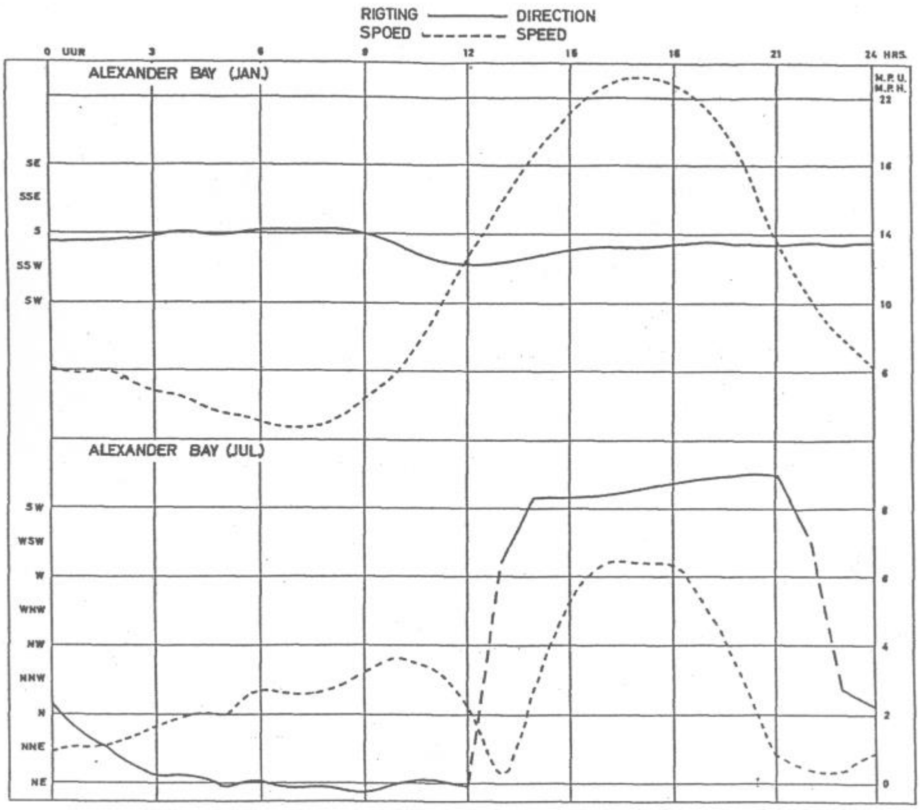


Photo 2: Typical windblown sand levels of the non-mining urban area of Port Nolloth

The strength and consistency is further supported by the constant Diurnal Variation as shown in the graph bellow to reflect the regular afternoon occurrence of high wind speeds at the time of day which coincides with lowest moisture content in the soil and hottest temperatures thereby increasing the effectivity of these high winds in terms of sand transfer.

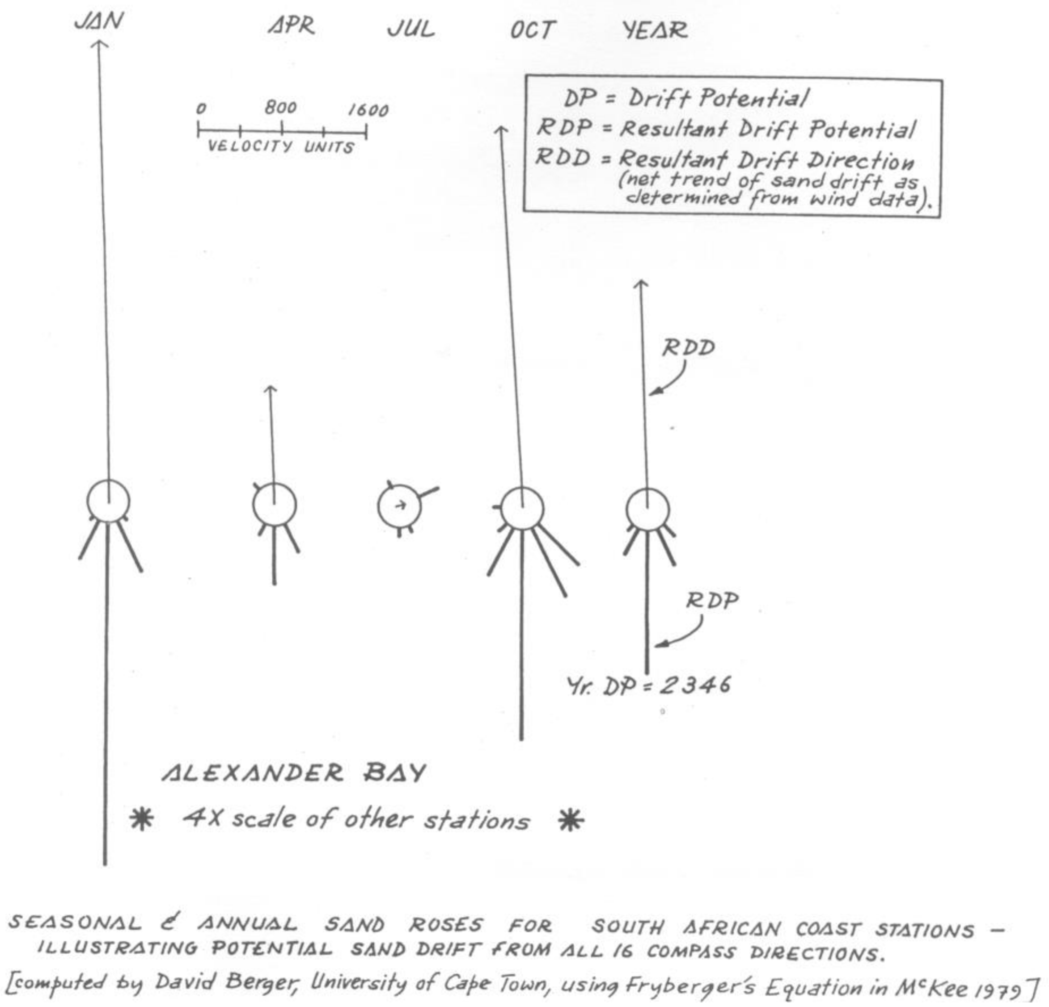


Diurnal variation of Speed and Direction of wind resultants at Alexander Bay (Schultz 1965). Figure 2.3 in DESMET pg 2-72

Diagram 2: Diurnal variation of wind speed and direction from Schultz in Desmet

Given the high wind speed and generally dry conditions with highest wind speeds occurring in the driest part of the day, the threshold wind speed for sand movement is 16km/hour while the average afternoon speeds at Port Nolloth of 26km/hour and Alexander Bay at 22km/hour.

The sand carrying capacity of the mining area winds expressed as a resultant drift potential (RDP) calculations done by David Berger (UCT) and published in Tinley (page 206) shows the sand roses for the four seasons of Alexander Bay as the origin of the wind-blown plumes.



Seasonal and Annual sand roses for Alexander Bay (from Tinley figure 206)

Diagram 3: Seasonal and annual sand roses from Tinley

The magnitude of the sand movement at Alexander Bay is further reflected by the above graph which shows the annual resultant drift potential at Alexander Bay which is almost equal to that of the Bogenfels located in the heart of the Namib Desert Coast characterised by extreme sand excretion.

4.1.2. Sand sources

a. Natural

   The primary source of sand plumes on the West Coast is the combination of river mouth sediment discharge via adjacent beaches to the north of such river mouths and the on-beach sediment which is part of the littoral drift. This relationship of sand plume generation to rivers is clearly illustrated in Figures 1 and 2a, b, and c from which the following inset of the Bitter River natural plume is taken.

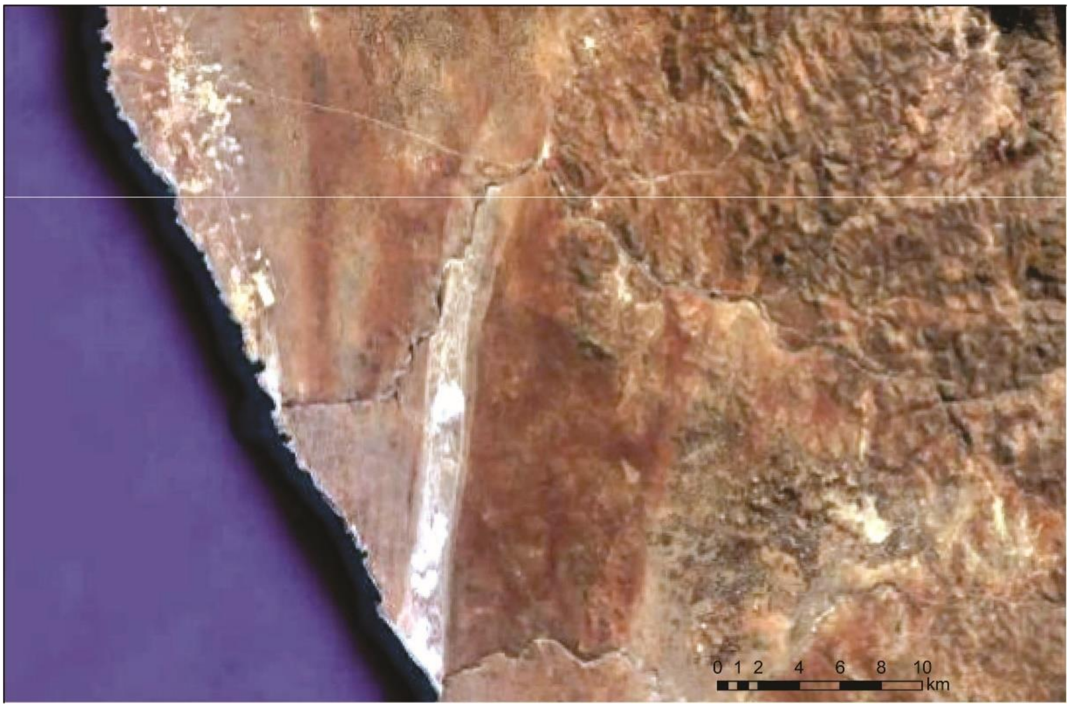


Diagram 4: The natural Bitter River plume south of the study area (Google Earth™ image)

Additionally other sandy beaches serve as sand sources, especially related to coastline form, discussed in para 4.4.

As primary dunes are generally absent on this portion of the West Coast, the phenomenon of dune blowouts associated with plumes is not a general characteristic of this coast and largely limited to the primary and hummock dune systems to the immediate north of half-heart bays.

By further comparison to Alexkor, it is noted that while the beach origin sands (white sands) compare directly between the two areas in terms of their ability to generate plumes, the surface soils of the inland areas differ completely between Alexkor and the WCR in that:

- Within Alexkor, surface sands present as light yellow/ grey loose sands with no clay content and are very susceptible to wind erosion in vegetation disturbed areas and in the formation of deflation pans.
- Within the WCR, as particularly experienced in the revegetation of the earlier Hondeklip Bay mining areas by THG, the surface sands of the WCR, which present as orange coloured sands, have a significant clay fraction content. This forms a surface crust and does not permit ready surface dust generation, especially not off undisturbed areas and also not off re-topsoiled areas where the crust forms readily after placement. Consequently in WCR, by comparison to Alexkor, unshaped and shaped overburden dumps show very limited plume development, if at all. Additionally, this crust, unless broken, does not permit ready germination of in-blown seed.

b. Mining

By comparison to Alexkor, the mining dust generation of this WCR study area is relatively low and does not present the same level of threat to natural eco-systems nor the built environment.

Nonetheless the sand plumes and finer dust impacts derive from the following mining activities in the WCR:

(i) Lines of overburden dumped adjacent to prospecting trenches. At WCR such dust generation occurs on a very limited scale.

(ii) Overburden dumps rounded or unrounded again on a very limited scale.
(iii) Fine tailings ponds (slimes dams). In the case of the WCR, the clay content of the soils of the slimes dam walls, largely inhibits dust generation from the walls and consequently the dust source is primarily the silt content of the dam once dried.
(iv) Heavily trafficked roads if not wetted during mine hauling, again to a lower degree than at Alexkor and with future mining in WCR at a lower level than under DBNM, the significant road-parallel plumes are not expected to occur in future, especially under the current policies for road dust attenuation by water cart wetting in the interest of road safety.
(v) Beach and back-of-beach disturbances by mining (the main mining dust generator in WCR).
(vi) In-field screening plants, if run dry. However as currently witnessed at WCR given the clay content, much of the in-field screening is conducted wet with no dust generation.

4.1.3. Coastline form and orientation: in the generation of natural dust plumes

From on-site and satellite imagery interpretation of coastline form and orientation in relation to dust plumes on the West Coast, the following coastline characteristics are fundamental to coastal dust plume generation:

- The northern curve of half-heart bays where the predominant south wind blows onshore; and
- The occasional changes in coastline indentation from south-north to south-east-north-west directly affects on-shore movement primarily from sandy beaches with such orientation.

4.2. Mapping and classification of WCR plumes

The study mapped the sand plumes from Google Earth™ imagery of 2014 (most consistent image by comparison to 2016) captured at between 1:10 000 and 1:20 000 scale and the site visit of 6 - 7 July 2016 verified the sand plume levels (intensity) within the respective categories of high, medium and low (as generally shown in Figure 1 but depicted in detail in Figures 2a, b and c, in which these polygons are .shp files):

Note: only a three-way categorization of intensity is used and is based on a subjective classification as quantification of the level in terms of coverage depth or mass per square meter is not attempted as the most significant element of the classification is the degree to which the sand plume affects vegetation and this affect differs between vegetation intensities and plant sizes.

Accordingly, the classification herein in based on the following site observations as illustrated in typical photos below:

High (LKC Plume) Photo 3

Readily visible, exposed wind-blown sand patches are evident between plant specimens but the area does not classify as a mobile dune-sea but small hammock dunes are evident in the lee, of especially pioneer species (particularly restioid grasses *Cladoraphis cyperoides*), populating the area.

Medium (Medium portions of the Somnaas plume) Photo 4


Significant sand accumulation between plant specimens but with only a limited impact on specimen spacing.

Low (Northern Samson's Bak natural plume) Photo 5


Clear visual evidence of in-blown sand/ dust seen in the veld and defined by Google Earth™ image but with level of sand/ dust not impacting on plant specimen spacing.

Mobile dune-seas (Typical mobile Barchanoid dunes of a dune-sea within a plume; Bitter River) Photo 6 Google Earth™ image

Such sand seas are evident as natural features along the entire West Coast and occur within the full range of vegetation stability and density with aerial photo interpretation showing them to have moved through successions of revegetation over their long history.

Plume #	Plume name	Intensity (level)	Natural Origin	Mixed Origin	Mining Origin	Incl. mobile sand-seas
SBK1	Northern Samsonsbak	Medium				no
	Swartlintjies River/ Somnaas	Medium-High				yes
SN1	Somnaas Beach	High				yes
KNR1	Swartlintjies River 68/69 beach	High				yes
KNR2	Koingnaas slimes dam	High				borderline
MB1	Mitchell's Bay north	High				yes
MB2	Mitchell's Bay old plant slimes dam	High				borderline
MB3	Rooiwal Bay northern promontory	Medium-High				borderline
MB4	Spoeg River	High				yes

Table 1: 2016 Plume mapping and categorisation as per Figures 2a, b, c

4.3. Quantification of current plumes

The table below captures the extent (in ha) and the intensity (level) of each of the dust plumes as captured as .shp files.

Fid	.shp #	Plume #	Plume name	Total extent in ha	High ha	Med. ha	Low ha	Mobile Dune Seas		
								Fid	Name	ha
7		SBK1	Northern Samsonsbak	1598						
6			Swartlintjies River/ Somnaas	15977				6	east	571
								5	west	169
								4	south	300
5		SN1	Somnaas Beach	3362				3		39
		KNR1	Swartlintjies River 68/69 beach					2	68/69 beach	6
4		KNR2	Koingnaas slimes dam	28						
3		MB1	Mitchell’s Bay north	155						
1		MB2	Mitchell’s Bay old plant slimes dam	50				1		9
2		MB3	Rooiwal Bay northern promontory	2						
0		MB4	Spoeg River	322				0		22

Table 2: 2016 Quantification of current plumes (refer dust plumes .shp)

4.4. Non-plume fall-out dust

This paragraph deals with dust associated with normal mining conditions excluding the West Coast wind-blown sand phenomenon. This dust fraction is therefore held in semi suspension generally for up to 600m and as it is not at ground level, can be monitored by normal fall-out dust monitoring systems such as DustWatch™ and measured against the current NEMA standards, which have derived from the “Dust Fall Standards SANS 1929 of 2004” which have been applied in the mining industry for many years and within which we have developed a good understanding of the attenuation required to be applied at the various sources in order to achieve the set standards.

4.4.1. Industry standards

Accordingly, this report will make reference to the extracts from the SANS report and deal with well-established control measures.

Given the nature of mining dust the Dust Fall Standards recognise that certain enterprises including mining need to operation within “Band 3” by virtue of “the practical operation of the enterprise............provided that the best available control technology is applied for the duration”.

“***DUST FALL STANDARDS SANS 1929:2004***

4.8 Dust Deposition

4.8.1 General

The four-band scale to be used in the evaluation of dust deposition is given in 4.8.2 and target, alert and action levels indicated in 4.8.3. Permissible margins of tolerance are outlines in 4.8.4 and exceptions noted in 4.8.5

4.8.2 Evaluation Criteria for Dust Deposition

Dust deposition rates shall be expressed in units of mg m² day-1 over a 30-day averaging period. Dust deposition shall be evaluated against a four-band scale as presented in Table 9.

Table 9 – Four-band scale evaluation criteria for dust deposition

Band number	*Band description label*	*DUSTFALL RATE (D) (mg /m² /day ¹ 30-day average)*	*Comment*
1	*Residential*	*D < 600*	*Permissible for residential and light commercial.*
2	*Industrial*	*600< D < 1 200*	*Permissible for heavy commercial and industrial.*
3	*Action*	*1 200 < D < 2 400*	*Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.*
4	*Alert*	*2 400 < D*	*Immediate action and remediation required following the first exceedance. Incident report to be submitted to relevant authority.*

4.8.3 Target, Action and Alert Thresholds are given in Table 10

Table 10 – Target, action and alert thresholds for dust deposition

Level	*DUSTFALL RATE (D) (mg/ m² /day ¹ 30-day average)*	*Averaging period*	*Permitted frequency of exceedances*
Target	*300*	*Annual*	
Action residential	*500*	*30 days*	*Three within any year, no two sequential months*
Action industrial	*1 200*	*30 days*	*Three within any year, no two sequential months.*
Alert threshold	*2 400*	*30 days*	*None. First exceedance requires remediation and compulsory report to authorities.*

4.8.4 Margin of Tolerance

An enterprise may submit a request to the authorities to operate within Band 3 (ACTION Band), as specified in Table 9, for a limited period, providing that this is essential in terms of the practical operation of the enterprise (for example the final removal of a tailings deposit) and provided that the best available control technology is applied for the duration.

No margin of tolerance will be granted for operations that result in dust fall rates which fall within Band 4 (ALERT Band) as specified in Table 9.

4.8.5 Exceptions

Dust falls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such event might typically result in excessive dust fall rates across an entire metropolitan region, and not be localised to a particular operation. Natural seasonal variations, such as dry windy period during the Highveld spring will not be considered extreme events for this definition"

4.4.2. Established dust sources and their attenuation

At alluvial diamond mines, fall-out dust is generated by the following activities and the respective attenuation measures are generally considered and/ or applied to limit resultant dust.

Dust generation activities/areas/points	Related attenuation measures when necessary
Site preparation, including dozing of topsoil to berms, road construction and construction of the primary plant ramps.	Pre-wetting of areas prior to earthmoving.
Drilling (Not generally but on an ad-hoc basis).	As international standard, all rigs are equipped with dust extraction equipment.
Blasting (Not generally but on an ad-hoc basis).	As ad-hoc events in alluvial mining, blast dust is not excessive and requires no attenuation given its isolation and periodicity.
Loading of especially overburden to overburden dump sites or backfill and the loading of dry ore horizon gravels.	When mining occurs up-wind of dust sensitive receiving environments such as sensitive vegetation and built environment, the overburden can be wet by fire hose spraying from water cart prior to loading but is generally not advocated unless the material being loaded has characteristics of unusually high dust generation as wetting can interfere with dry screening and introduce additional salt into the system.
Hauling overburden to dumps or back-fill and hauling of ore to processing plants.	Water cart wetting of haul roads to reduce vehicle generated dust impact on traffic safety and reduce roadside dust plume impact on vegetation. Levelling of the load to reduce wind-swept dust off the load during transport.
In-field screening.	Site visits have noted that by comparison to many other alluvial diamond mining areas, the ore at WCR is often moist with lower dust generation than witnessed elsewhere at dry in-field screening plants. Furthermore, the higher clay content occurring in the ores of WCR seen to-date also requires wet screening which totally eliminates dust. In planning of mobile in-field screening plants, which will receive dry ore feed and be run as dry screening plants, the production planning team shall give consideration to the plant locality in insuring it is not upwind of sensitive receiving environments and preferably be replaced in the up-wind end of large previously mined areas, which can receive the down-wind dust generated by such dry screening plants. Where further dust control on the plants is required, the well-established methods of mist sprays on the screens and conveyor transfer points should be applied.

Stockpiles, overburden dumps and back-filled mine blocks	The control of dust on such stockpiles and over such areas shall be dealt with through the same attenuation measures of promoting revegetation and through the use of temporary sand-trap cut-off netting systems as advocated for dust plume control hereafter.

4.4.3. Monitoring of fall-out dust

The industry can fortunately rely on established methods, contractors and commercially available, affordable equipment for this purpose and given the proximity of WCR to the Western Cape DustWatch™ supplier/ service provider, the use of the DustWatch™ system is advocated. It is designed for ease of operation by the mine personnel and provides results which reflect both ambient and mine generated dust through the combination of two or more installations on-site. (Refer para 8 for further requirements of monitoring)

5. CURRENT AND EXPECTED LEVELS OF DUST PLUME IMPACT

Table 1 in para 4.2. read with Figures 2a, b and c against the sources of dust plumes in para 4.1. identifies the following areas of high risk of dust plume generation as follows:

5.1. Risk of beach and back-of-beach plumes.

On-shore orientated beaches, half-heart bays and low lying back-of-beach areas fed with either river mouth sand or littoral sand, with such existing plumes including the following:

(i) Rooiwal Bay coffer dam development and the Rooiwal-Spoeg River paleo channel of mine blocks 102, 89 and 90, both of which will continue contributing to the existing Spoeg River natural plume and dune-sea advance and will require attenuation.

(ii) Langklip (LK) Beach Zone and coffer dam (see photo 7), on the LK beach, opposite the Mitchell's Bay seawater intake and already revealing half-heart bay type plume generation. Further beach sand and littoral zone disturbance by the coffer dams will increase the risk posed by the half-heart plume and require attenuation.

Photo 7: The LK beach bay where proposed further beach mining and coffer dams can intensify the plume

(iii) LKC Beach Zone and Grysduine area of northern Mitchell's Bay photo 8. Further mining of this low lying beach and back-of-beach area, which has already generated the dune sea and plume in photo 9 require intervention now and in future through the proposed methodology adopted in the study in para 6, which shows the application of the methods of attenuation to the LKC/

Grysduine plume. This requirement for intervention will be exacerbated through the further disturbance by the intended coffer dam mining.

Photo 8: Current beach mining on LKC beach

Photo 9: The high level LKC plume with dune-sea

(iv) 68/69 beach mining to-date has, together with the high level of Swartlintjies River sediment supply resulted in the extensive moderate-to-high Swartlintjies River plume (photo 10). The further contemplated 68/69 beach and coffer dam mining will increase the sand movement in the littoral zone and increase the need for intervention in the mining generated component of the Swartlintjies River plume (it must be emphasized that a large component of this, the largest plume system in the WCR, is river-mouth generated and will remain active, irrespective of mining).

Photo 10: Existing 68/69 beach mining with half-heart plume in the distant right of photo

(v) Koingnaas (KN) Beach Zone. Given the cliffed nature of the Koingnaas coastline, the KN beach and coffer dam mining presents a low risk for plume development but the actions on the beach will increase littoral drift thereby increasing the source material at Visbeen and 68/69.

(vi) Visbeen (VB) Beach Zone. Given the general cliffed nature of this coastline, plume management must focus on the half-heart beach plume generation (as per photo 11), which under greater littoral drift sand supply from the extended VB beach and coffer dam mining, will require increased attenuation of this source within the greater Swartlintjies River plume.

Photo 11: Nothern end of the Visbeen beach mining with half-heart bay Visbeen plume right

(vii) Somnaas Bay (SN) and associated planned inland channel mining (blocks 94, 99). These activities have already resulted in a very typical on-shore beach and half-heart bay plume as in photo 11a.

Photo 11a: Extensive Somnaas high level half-heart plume in distance

Generation of the high level Somnaas plume and associated dune-sea with planned beach, coffer dam and channel mining in the SN Beach Zone, the sand source will increase and attenuation measures for the Somnaas plume must be introduced with significant sand traps to stem the advance of the early stage dune-seas and avoid them reaching the tar road as per photo 12.

Photo 12: Somnaas plume ridge parallel dune as seen from the tar road.

5.2. Risk of slimes dam plumes

(i) Within the WCR the two slimes dams of Koingnaas and the old Mitchell's Bay Plant have developed the highest dust risk of all inland mining activities but even so, the resultant plumes following their abandonment are limited in extent by comparison to the plumes generated by Alexkor's abandoned slimes dams. The difference is ascribed to the slight clay content of the

WCR material used in the slimes dam walls and generally occurs in the slimes whereby upon drying or even during production, the walls do not generate wind-blown sand/ dust, while those at Alexander Bay do, in the absence of any clay fraction.

While, as seen in Photos 13 and 14 of the Koingnaas and Mitchell's Bay slimes dam plumes, which are partially, fairly successfully revegetating, with and without netting, further attenuation of especially the Koingnaas slimes dam plume must be applied as it presents a significant dust nuisance impact on Koingnaas town. It is advocated from a dust perspective that this slimes dam should be fully rehabilitated and not reused as it is located directly upwind of Koingnaas town and the extent of its surface presents a shallow dam development with high-lying wind exposure, which is not preferable for new slimes dam development. Furthermore, in the long term it is not advisable to develop further silt generation activities in the catchment of the Swartlintjies River estuary.

Photo 13: Koingnaas slimes dam plume revegetation

Photo 14: Mitchell's Bay slimes dam plume

In terms of method of attenuation, it is advocated that a single dust plume cut-off system (dust trap) be provided along the northern perimeter roads of the slimes dams, together with periodic hand-broadcast seeding to infill the groundcover between the existing shrubs.

(ii) As numerous slimes dams are currently being planned, it is important that the locality and design/ selected site topography takes cognisance of the following dust generation considerations in new slimes dam development, which include:

- Limiting the surface area of the dams (within the considerations of slimes dam design) and plan them as deep as possible to reduce their surface area and especially any area which, during operation will periodically or seasonally dry presenting as a major dust source.
- Giving preference to locating in existing excavations or deep valleys between dumps to avoid or minimise walls which can present as dust sources and to also restrict the lateral extent of the dams. Such location will also ensure proximity of overburden cover material in the post drying rehabilitation of the surface.
- Ensuring that if walls are required, material with the highest possible clay content is used in such walls to limit dust generation by the walls during and after operation.
- Ensuring that, under no circumstances, natural, low depressions nor deflation pans be used as slimes dams (as has occurred elsewhere) as their shallow perimeters, broad lateral extents and exposure to high winds result in significant plume generation both during low water levels in operation and following drying on abandonment.
- Slimes dams should never be located upwind of sensitive built or natural receiving environments, given the high dust risks associated with them.

6. MITIGATION (ATTENUATION) MEASURES

6.1. Mitigation of non-plume fall-out dust

These mitigation measures are discussed fully in paragraph 4.4.2.

6.2. Mitigation/ attenuation of sand plumes

6.2.1. Lessons from Alexkor

At Alexkor, under extreme dust plume development conditions which posed the greatest single threat to the natural and built environment of the mine and surrounding area, the study and trials of dust intervention methods were conducted in the period 2004-2013 with documentation of the methods initially done in the EMP update of 2008. Then, during 2013/2014 a comprehensive reassessment of dust plume attenuation was conducted and documented in the Alexkor Dust Plume Study SPC #2714/DP/R1 February 2014.

Such reassessment culminated in the framing of a 3-pronged holistic approach to dust plume attenuation to consist of:

" · stabilization of sources
· cut-off system for dust removal from the mobile dust columns; and
· stabilization of dust impacted areas to facilitate recuperation of remnant vegetation".

While general netting had previously served West Coast mining as the appropriate method to restrict sand movement and promote revegetation, the Alexkor review of 2014 by Site Plan Consulting's Stephen van der Westhuizen and Bergwind's Dr Dave McDonald, showed categorically that extensive netting as had been undertaken in the 2005 – 2013 period, had impacted negatively on revegetation by comparison to un-netted areas where the uninterrupted wind transfer of both high levels of sand but also seed occurred with success.

6.2.2. The role of netting in sand plume attenuation

It was concluded that netting had a crucial role when applied and maintained as narrow sand traps from which excess sand accumulations are removed to stem the perpetuation of the plume but that such netting systems be non-continuous and temporary in order that seed could pass relatively freely through the system to germinate and stabilize the remainder of the plume. Unfortunately the sand-trap projects also showed that the introduction of these systems are only as successful as their maintenance (periodic removal of excess sand from the netting trap).

Photo 15: Shows the failure of unmaintained cut-off netting systems at Alexkor at the time

6.2.3. Stabilization of the source

The studies and pilot projects further confirmed the success and affordability of attenuating sand plume sources by armouring source areas such as dried slimes heaps/ slimes dams with coarse tailings. The coarse tailings cover mimics the natural desert geomorphological phenomenon of "pebble deflation deserts (surfaces)" and was very successfully undertaken in the pebble cover of the Alexkor Rietfontein inland and Noordsif slimes dumps which were sources of the massive plumes invading the sensitive Boegoeberg and Alexander Bay town. In the wetter WCR climate such pebble cover of surfaces will very readily promote revegetation through their accumulation of in-blown sand and seed to germinate within the cool germination environment presented by the pebble horizon.

Photo 16: Armouring by coarse tailings of sandy slimes dam wall dust source at Alexkor

6.2.4. Promotion of revegetation

As the Alexkor 2014 review of revegetation trial areas in previously disturbed back-fills and plume areas proved less successful than natural revegetating areas or areas where only hand-broadcasting of seed occurred, this WCR dust plume study promotes revegetation by hand-broadcasting of seed, with limited direct transplant of chosen mature plant specimens immediately following rain episodes with repeated follow-up seeding during a later episode. Preferably such seeding should be accompanied by light hand-raking of the soil, which is especially important in the WCR wherein the inland orange sand areas form a crust which inhibits seed germination unless the crust is broken as was shown in trials conducted by Transhex in their Hondeklip Bay mining area rehabilitation. In the case of the white coastal sand plumes of WCR, such sand has no clay content and readily accepts hand-broadcasted seed and also promotes the rapid landward spread of restioid grass pioneer, *Cladoraphis cyperoides*. Photo 17 below, taken in an area with no netting to hinder sand or seed movement, shows the establishment of pioneer grass which then develops a small hummock dune in its lee and the subsequent germination of a variety of species in such hummock dune to achieve sought after species diversity.

Photo 17: Showing natural revegetation in an intense plume where seed movement is not hindered.

6.3. Proposed method of dust plume attenuation for WCR

The generic plan for the proposed WCR plume attenuation is depicted below as would be applied to the back-of-beach blow-out at Langklip LKC, Grysduine in the northern Mitchell's Bay Mining Right Area for illustration purposes to consist of:

- Stabilization of the source by armouring with coarse tailings as immediate stabilization, which will later promote revegetation of a back-of-beach hummock dune zone.
- Plume cut-off netting systems at both the root of the plume and the plume toe for periodic removal of the accumulated excess sand from the traps, thereby reducing sand movement in the plume.
- Hand-broadcasted seeding of both the armoured source area and the plume surface as well as the distant landward extent of the plume.

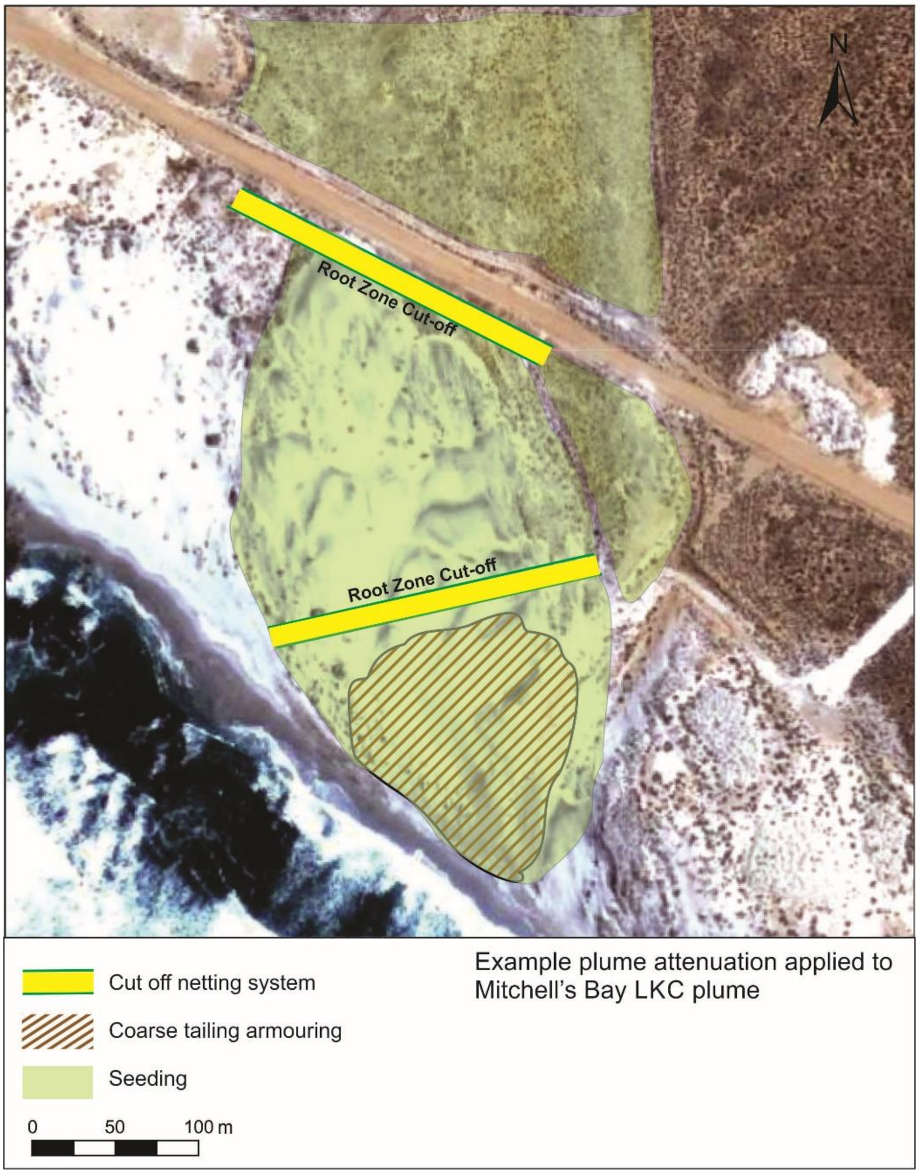


Diagram 5: Example of generic plume attenuation applied to Mitchell's Bay LKC plume

7. MANAGEMENT CONDITIONS FOR INCLUSION IN ENVIRONMENTAL AUTHORISATION

Once the structure of the EMP update has been formulated, the author thereof should draw on the above attenuation methods in the preparation of the EMP, which wording will then serve the wording of the Environmental Authorisation.

The management conditions will be included as soon as the revegetation method assessment is finalised between SPC and Bergwind for definitive wording for inclusion in the Environmental Authorisation.

8. MONITORING REQUIREMENTS

As above

8.1. Monitoring of fall-out dust

8.2. Monitoring of plume extent and intensity by periodic measurement

8.3. Monitoring of intervention successes and failures of methods

9. COSTING OF SAND PLUME CONTROL

Once the mine plan and draft EMP have been prepared, a dust intervention schedule, together with a costing system can be prepared by WCR. In the interim, the following considerations would serve as a basis for preparation of such costing:

(i) Stabilization of dust sources if by coarse tailings cover to include shaping of the source and then the cost of hauling and spreading the coarse tailings.
(ii) Dust trap netting systems to be costed per linear meter of netting as construction cost.
(iii) Provision for the cost of periodically loading, hauling and dumping the accumulated sand.
(iv) Cost of seeding (at this stage seed collection, hand broadcasting with raking) as well as an allocation for mature plant specimen transplant.