Richards Bay Port Expansion Programme

Dredge Disposal Site Selection

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TRANSNET

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EXECUTIVE SUMMARY

Transnet expects significant growth in the volume of cargo imported and exported through the Port of Richards Bay over the next 30 years. As a result, certain improvements and expansions need to be made to the port to cater for the growth. These expansion options will require the dredging and disposal of large volumes of sediment.

BKS (Pty) Ltd (hereafter referred to as BKS) was appointed by Transnet SOC Limited to undertake an assessment for the management of dredge material as a baseline study to determine the integrated environmental authorisation process for the Richards Bay Port Expansion Programme (RBPEP).

Scope of works

This project is limited to a review of existing reports that was done for the RBPEP. Relevant information is extracted to provide key findings, suggest alternatives and motivate for further studies. The following tasks were undertaken:

- *Characterisation of the dredge material*
  - *Contamination levels*
  - *Volume of material dredged*
- *Identification of potential disposal sites*
  - *Criteria for suitable off-shore disposal sites*
  - *Dredge disposal options*
  - *Beneficial uses of dredge spoil*
- *Potential Environmental Impact of Disposal Options*
- *Final Disposal Option to be considered during the EIA process*

Key factors

From all previous studies that were conducted the following key factors were identified:

- *An estimated 13 million m^3 sediment will result from the proposed port expansion and coal terminal.*
- *Of this sediment, 16 % is sand, and 59% is silt and clay and 25% is rock.*
- *A small, but unknown volume is Level 1 and Level 2 copper and chromium contaminated*
- *Available land for deposition is 5 million m^3*

Currently, the sandy portion in dredge material is separated from finer silt and clay particles using a sand trap. Sandy material is discharged to the beach at Alkantstrand by means of pumping through a pipeline. Fine material which is unsuitable for discharge onto the beach is disposed offshore by opening the bottom doors of the hopper above the offshore dump site. Sand separation of the 13 million m^3 will result in 2.1 million m^3 sand, 7.6 million m^3 silt / clay and 3.2 million m^3 rock.

The 2.1 million m^3 sand, can be used as permanent fill material for the port expansion (5 million m^3 available).

The 3.2 million m^3 rock can mostly be accommodated as permanent fill as well. Some additional rock material dredged could be used in other construction related activities depending on the nature of the rock (0.3 million m^3).

The following options, or a combination thereof, can be considered for the 7.6 million m^3 saline silt / clay.

- *Off shore disposal (current periodic maintenance material is disposed of 3.5 km south of the port entrance)*
- *On land disposal (CSIR, 2004, Figure 3-1)*
  - *Site 4: South of the Mhlatuze River with more than 5 million m^3 permanent storage capacity.*
  - *Site 5: Approximately 2km east of the N2 highway and 8-10km from the port, with approximately 29 million m^3 permanent storage capacity.*
  - *Site 6: The Ticor slimes dam is adjacent to the N2 highway and could be considered for disposal in the long term.*

Mitigating measures

Aurecon (2013) identified a number of possible measures to mitigate the impact of dredging on the environment, which includes amongst others the following:

- *Reduction in the size of the sand dredging area;*
- *Limiting the mud disposal rate;*
- *Limiting the overall dredging rate;*
- *Restricting the type and number of dredgers permitted within the main navigation channels;*
- *Decreasing the time frame over which the dredging operation is to take place, to avoid the daily re-suspension of sediments;*
- *Suctioning of sediments that have resettled to curb the impacts of the daily resuspension of sediments;*
- *Avoid dredging during rough seas; and*
- *Should blasting be required, it should be carefully planned.*

It is also suggested that any metal contaminants, e.g. copper and chromium, be separated from the dredge material at the sediment separation plant before disposal.

Conclusion

This assessment indicated various possibilities to manage dredge material that can be considered. This includes the disposal of dredge material on land or off-shore as well as various options for the beneficial use of the materials. The final disposal option may be a single solution or a number of solutions that best manage the environmental impacts. The environmental impact of each option must be investigated during the EIA phase.

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1. Introduction

BKS (Pty) Ltd (hereafter referred to as BKS) was appointed by Transnet SOC Limited (hereafter referred to as Transnet) to undertake an assessment for the management of dredge material as part of a number of baseline studies to determine the integrated environmental authorisation process for the Port of Richards Bay Expansion Programme (RBPEP).

Figure 1-1: Richards Bay Port Expansion Study Area

1.1 Background to the Richards Bay Port Expansion Programme

The following is understood with regards to the Richards Bay Port Expansion Programme:

- Phase 1 consists of two sections, namely the General Freight Bulk expansion (inclusive of rail, road and harbour bound industries) and the development of a new Coal Terminal.
- Phase 2 is the future expansion for the long-term development of the Richards Bay Port Expansion and Industrial Development Zone Environmental Management Framework.
- Options for the General Freight Bulk (GFB or, port) expansion, has been reduced to the following three:
    - Option 1A: Changes to the existing dry bulk terminal, construction of a finger jetty at the 800 series, expansion of railway lines and associated infrastructure, expansion of the ferrochrome slab, 2 additional berths to the east of the proposed discard coal terminal (further detail below).
    - Option 1D: The same as Option 1A with the only difference that the 2 additional berths for the proposed discard coal will be situated opposite the proposed discard coal terminal on the other side of the dock.

- Option 3A: This is the same as Option 1A with the only difference that the proposed bulk terminal will be switched with the proposed discard coal terminal.

- The Options for the GFB also include an area for a container yard, with options to the east, north and south of the 600 series.
- The Options for the new Coal Terminal considers mainly the development of the south dunes and the 500 series. However, , the South Dunes section is no longer considered for expansion by Transnet. In the current port expansion programme but may be developed in the future by TNPA.

1.2 SCOPE OF THE DREDGE DISPOSAL SITE EVALUATION

This assessment is concerned with the management for dredge material that are expected to result from the proposed RBPEP. This requires an assessment of the following:

- Characterisation of the dredge material
  - Contamination levels
  - Volume of material dredged
- Identification of potential disposal sites
  - Criteria for suitable off-shore disposal sites
  - Dredge disposal options
  - Beneficial uses of dredge spoil
- Environmental Impact of Disposal Options
- Final Disposal Option

Onshore disposal of the spoil material is primarily dependent on the volume and hazard rating. The hazard rating will define the type of facility that can be used to stockpile and the end use that would be suitable for the material. The cost for spoil material disposal depends on the volume and thus a large volume of spoil material will have cost implications.

For offshore disposal, the prime concern with the disposal of the dredged material is the impacts on water quality (increased turbidity, decreased dissolved oxygen levels and the release of sediment bound contaminants including metals and persistent organic pollutants) and the physical smothering of adjacent areas with sediment.

This project is limited to a review of readily available existing reports that have been prepared historically for the Port and for the RBPEP. Relevant information is extracted to provide key findings, suggest alternatives and motivate for further studies.

2. TASK 1: CHARACTERISATION OF THE DREDGE MATERIAL

2.1 CONTAMINATION LEVELS

The characterisation of the spoil material is primarily undertaken as part of the assessment on contamination levels. The sediment quality results are used to define the hazard rating of the spoil and the nature of that hazard. Typically the spoil could have high concentrations of lead (from paint), mercury (from industrial processes) iron (from ships) and trace metals. Particle size analysis is also considered, as there may be a need for a settling dam system to remove specific fractions of the spoil for a combination of waste disposal options.

The CSIR (2013) determined the metal contamination of sediment in the Richards Bay portr and the implications for dredging this material. They found that the Inner Basin Complex (for the purposes of the CSIR's study comprising Inner Basin 1, Inner Basin 2 and Inner Basin 3 as indicated in Figure 2-1) contains heavy metals that exceed limits of Warning levels, Level I and Level II of sediment quality guidelines as defined by the Department of Environmental Affairs (un referenced in CSIR, 2013), who defined sediment quality guidelines for the purpose of determining whether sediment identified for dredging in South African ports is of a suitable quality for unconfined openwater disposal.(un referenced in CSIR, 2013)

Concentrations of copper, chromium, nickel, lead and zinc exceeded the Warning Level, at a relatively high proportion of sampling stations in the case of copper and chromium (25 and 19% of stations respectively) (CSIR, 2013). Copper and chromium concentrations exceeded the Level I and Level II. Copper exceeded Level II at one sampling station and chromium exceeded Level II at four sampling stations (**Figure 2-1**) (CSIR, 2013). Table 2.1 sets the hazard classification for copper and chromium, where they can both be classified as having a high hazard risk at enriched concentrations.

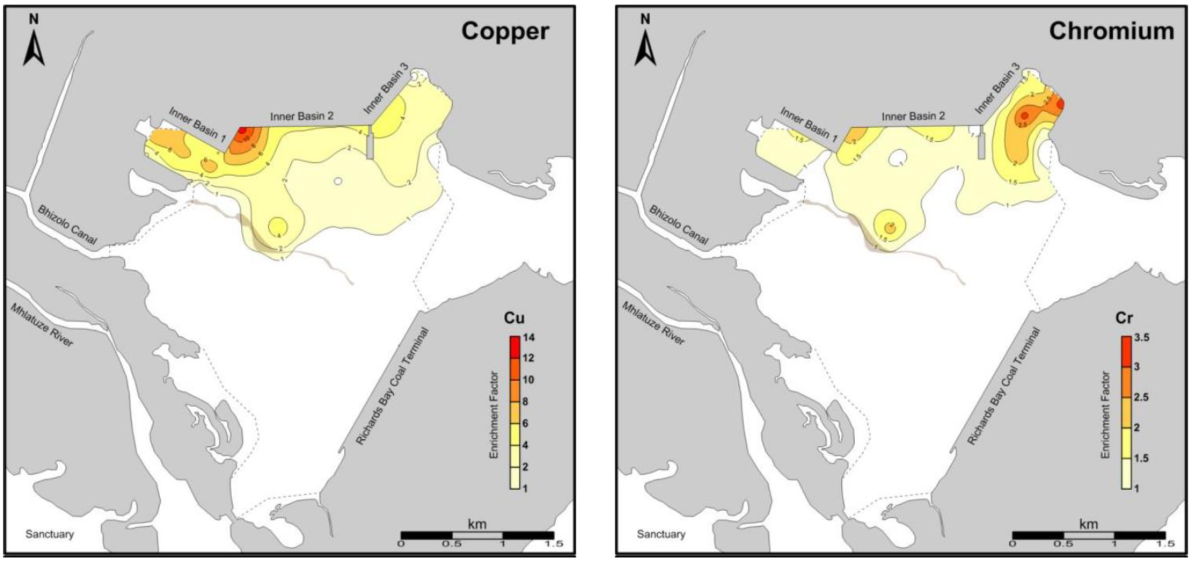

Figure 2-1: Enrichment factors of copper and chromium in the Richards Bay Harbour (CSIR, 2013)

Table 2.1: Hazard Waste Classification of Copper and Chromium (DWAF 1998)

S.I.N.	WASTE STREAM/ CAS NUMBER	EXAMPLE INDUSTRIAL GROUP	SABS 0228 CLASS / DANGER	HAZARD RATING	ACCEPTABLE ENVIRON. RISK ppm	DISPOSAL ALLOWED g/ha/month	PREFERRED TECHNOLOGY	ALLOWED TECHNOLOGY	UNACCEPTABLE TECNOLOGY
	Chromium (III) [7440-47-3]	B2	-	3 (moderate hazard)	4.7	7121	Recovery	Chemical Treatment then landfill codispose residues	Landfilling without treatment (LWT)
1755	Chromium (VI) [7738-94-5]	D4	8(II)	1 (extreme hazard)	0.02	30	Recovery	Reduction then landfill codispose residues	LWT, pH<6
2775	Copper [7440-50-8]	D4	6.1(III)	2 (high hazard)	0.1	151	Recovery/ Immobil-isation then landfill	Encapsulation/ Precipitation then landfill codispose residues	LWT

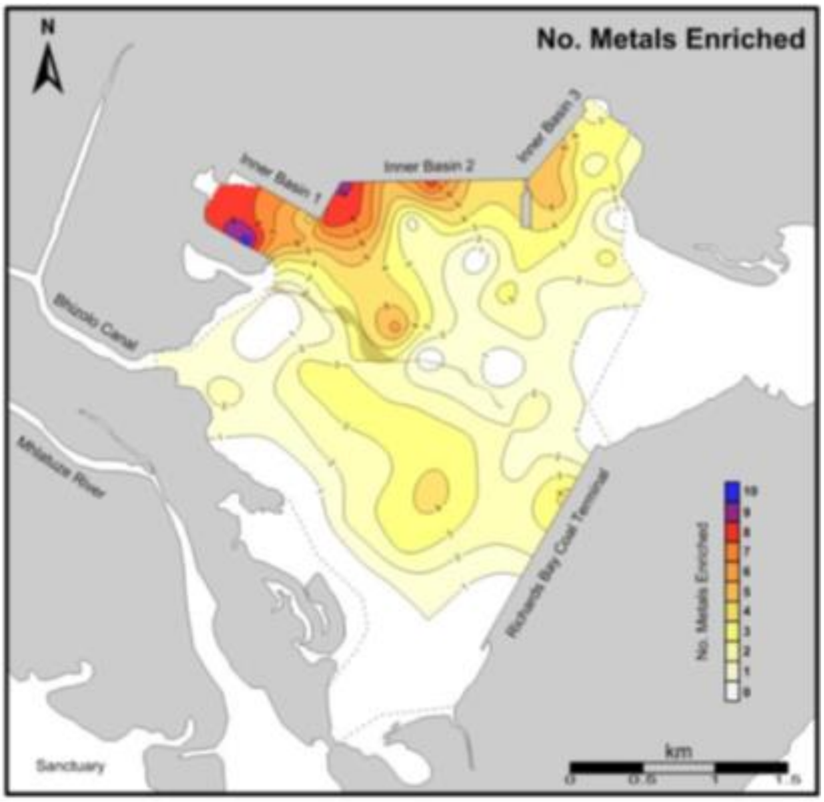

Figure 2-2: Spatial trend for the number of metals enriched in sediment collected from Richards Bay in 2012 (CSIR 2013)

Figure 2.2 indicates that the sediments in the Port are more highly enriched in Inner Basin 1 and the north side of Inner Basin 2.

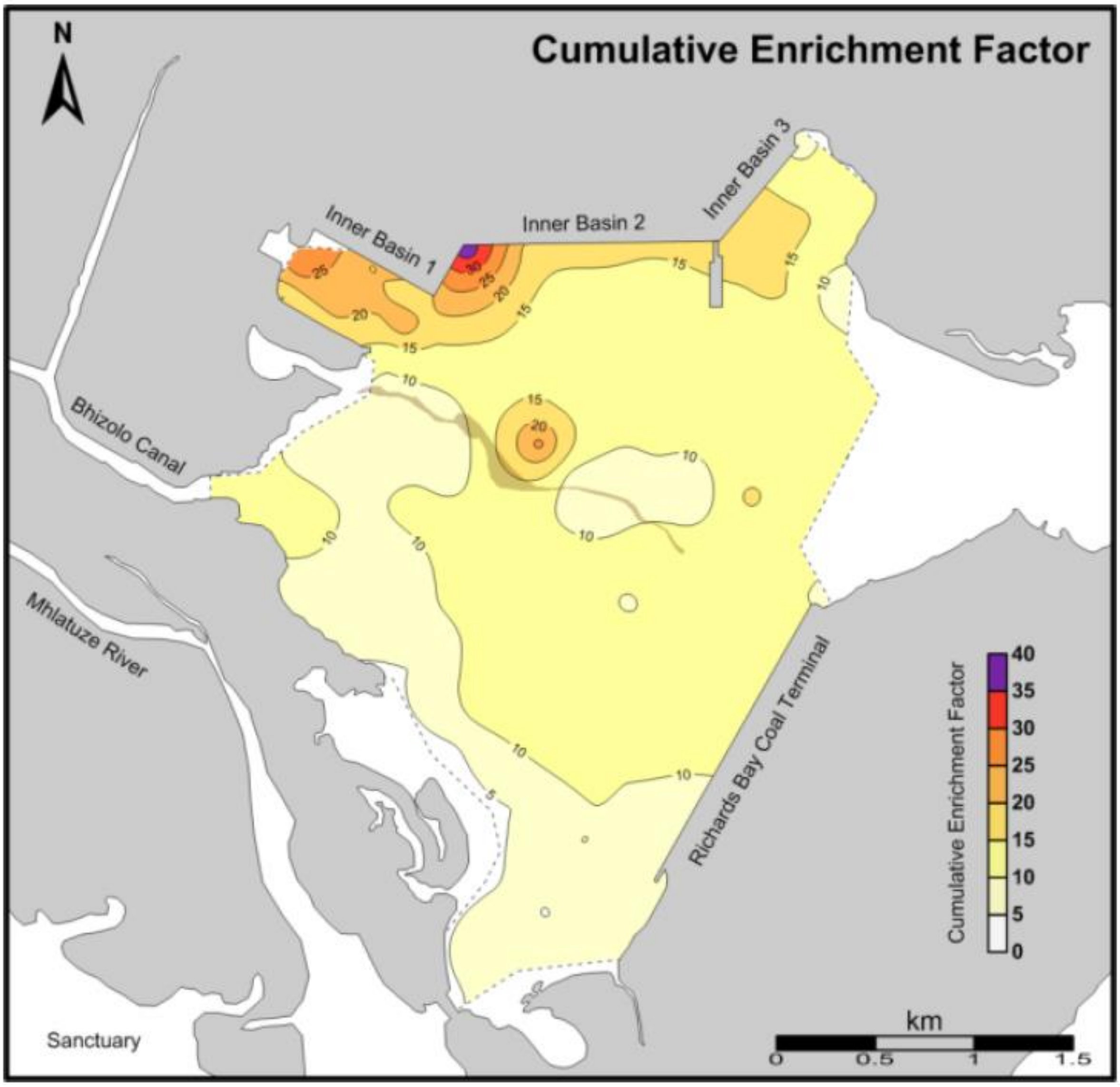

Figure 2-3: Cumulative Enrichment Factor spatial trend for sediment collected from Richards Bay in November 2012 (CSIR, 2013)

Figure 2.3 indicates that cumulative enrichment spatially in the Port is similar to the results observed for the number of metals enriched in the Port, where the factors are highest in the Inner Basins 1 and 2.

Sediment with metals at concentrations equivalent to or lower than the Level I is regarded as posing a low toxicological risk to bottom-dwelling organisms and is of a suitable quality for open water disposal (CSIR, 2013) (Figure 2.4).

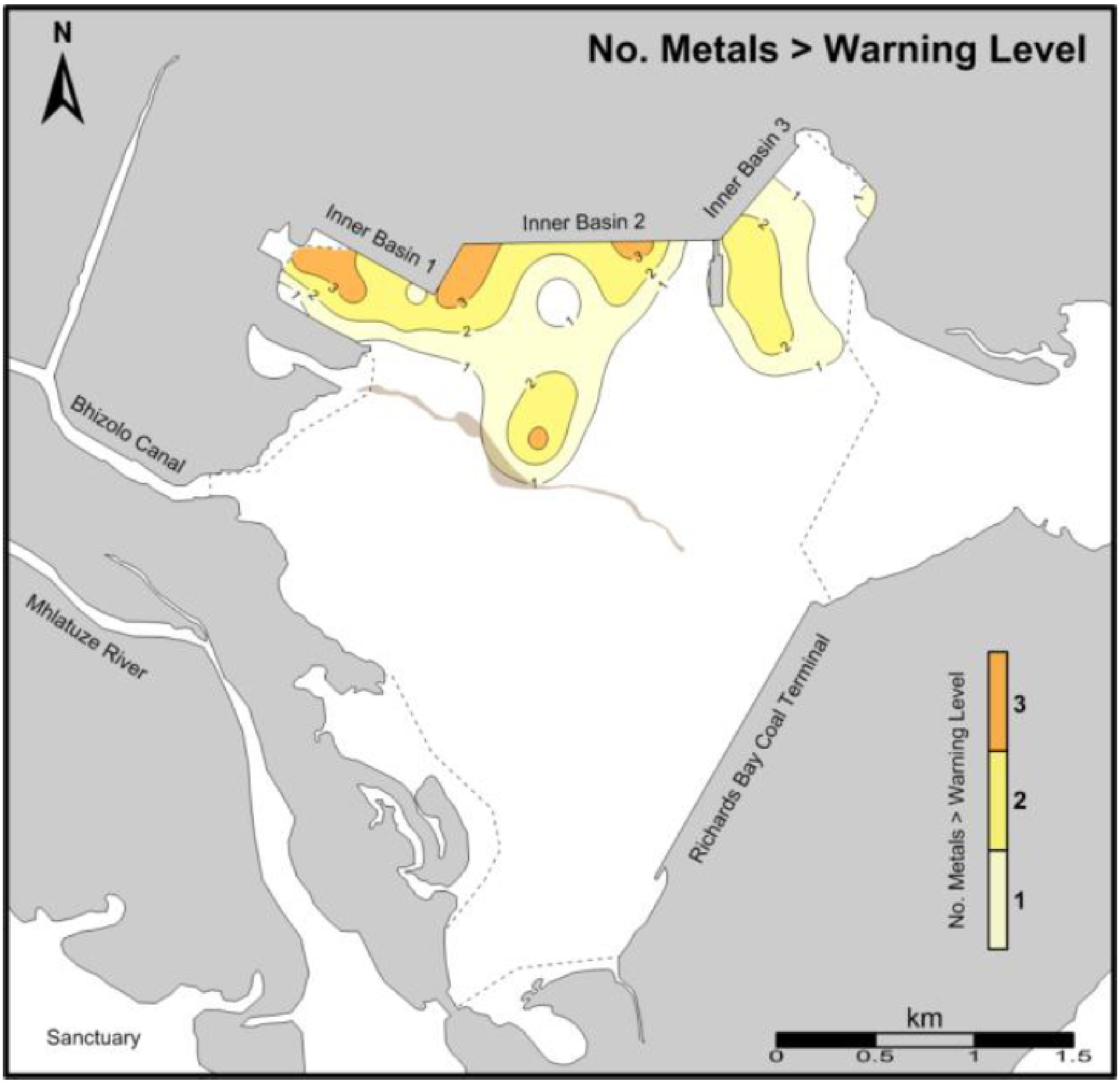

Figure 2-4: Spatial trend for the number of metal concentrations in sediment collected from Richards Bay in 2012 that exceeded the Warning level of the sediment quality guidelines used to determine whether sediment identified for dredging in SA ports is of a suitable quality for unconfined open water disposal (CSIR, 2013)

Sediment with metals at concentrations between the Level I (Figure 2.5) and Level II is regarded as posing a potential toxicological risk to bottom-dwelling organisms, with the degree of risk increasing as the Level II is approached. A decision on whether this sediment is of a suitable quality for open water disposal is made after consideration of the number of metal concentrations that exceed the Level I and the magnitude of exceedance. Additional testing (e.g. chemical analysis and toxicity testing of sediment elutriates) may be requested by the Department of Environmental Affairs to assist decision-making (CSIR, 2013).

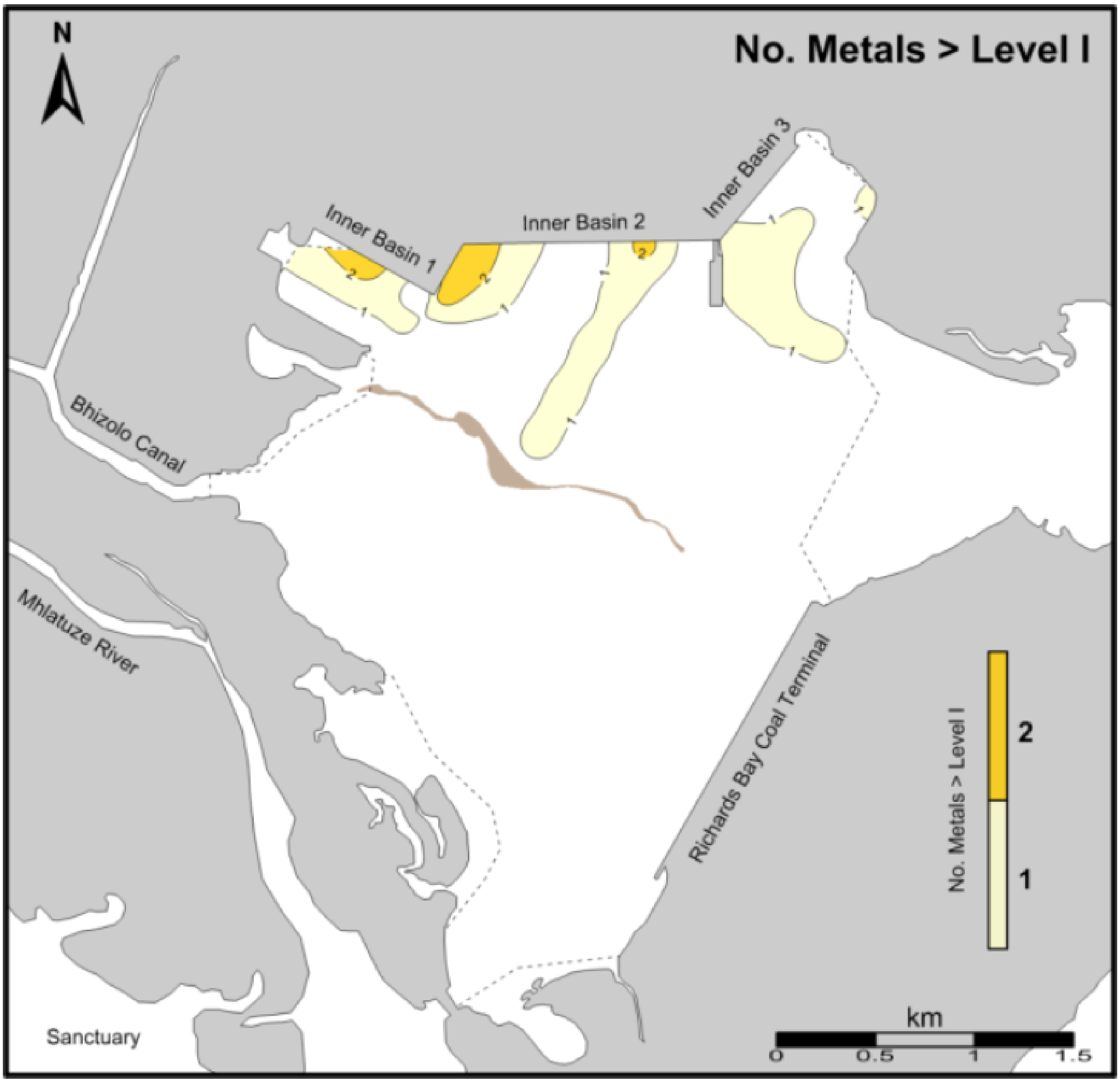

Figure 2-5: Spatial trend for the number of metal concentration in sediment collected from Richards Bay in November 2012 that exceed the Level I of the sediment quality guidelines used to determine whether sediment identified for dredging in SA ports is of a suitable quality for unconfined open water disposal (CSIR, 2013)

Sediment with metals at concentrations equivalent to or higher than the Level II (Figure 2.6) is regarded as posing a high toxicological risk to bottom-dwelling organisms and in the absence of other data to refute this conclusion is generally considered unsuitable for open water disposal (CSIR, 2013).

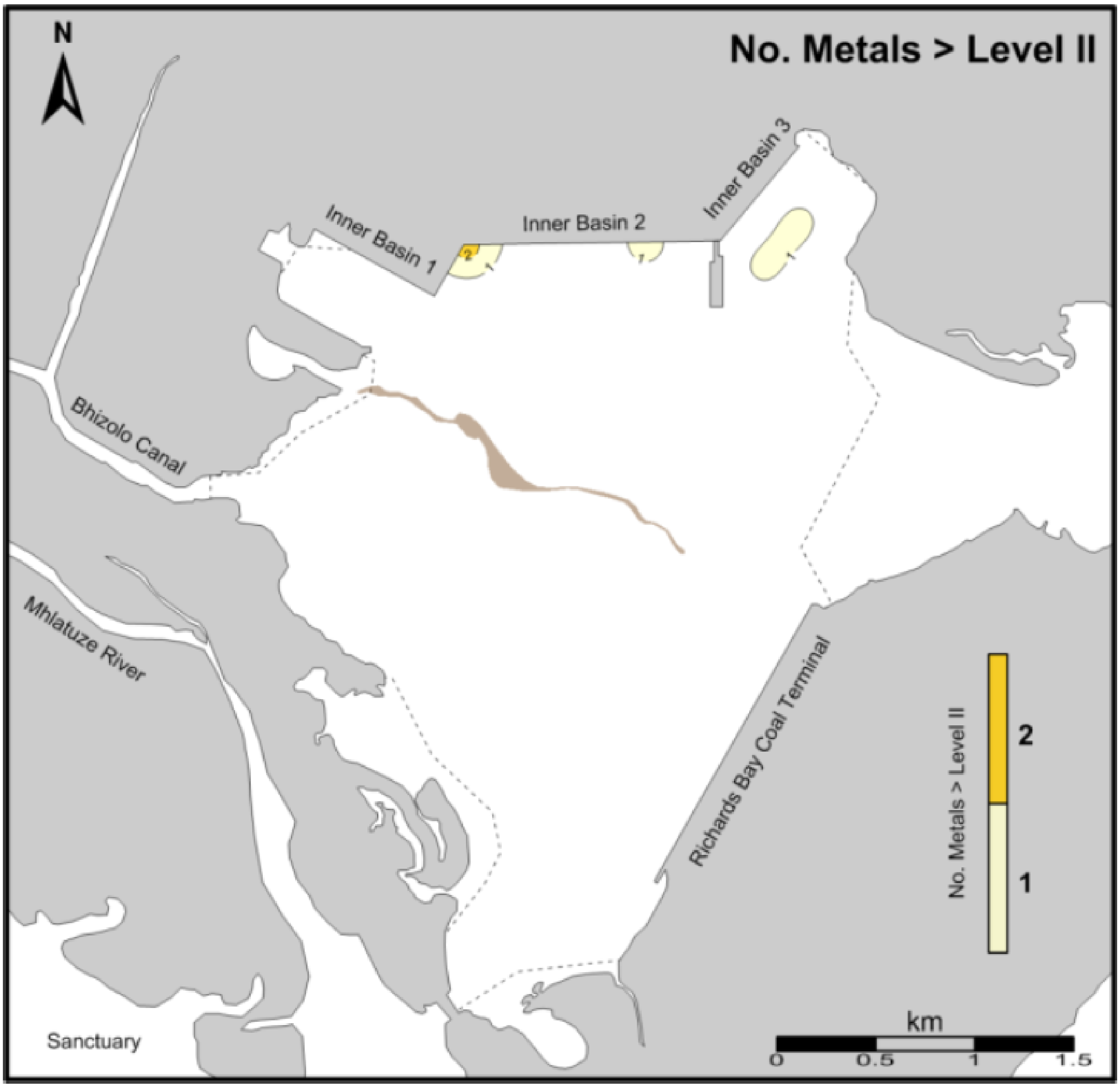

Figure 2-6 Spatial trend for the number of metal concentration in sediment collected from Richards Bay in November 2012 that exceed the Level II of the sediment quality guidelines used to determine whether sediment identified for dredging in SA ports is of a suitable quality for unconfined open water disposal (CSIR, 2013)

2.2 DISPOSAL VOLUMES

The spoil volume estimate is used to define the containment boundaries for a potential disposal site.

According to the Strategic Environmental Assessment (SEA) Sustainability Framework (CSIR, 2005) 137 million m^3 of dredged sediment has been disposed of on Richards Bay beaches and in the near shore region to date (Table 2.2). As roughly 113.4 million m^3 is recorded to have been disposed to the beaches, it is inferred that the remaining 23.6 million m^3 was disposed of at the offshore dump site, approximately 3.5 km south of the port entrance (Figure 3.1)in the near shore environment of Richards Bay (Table 2.3).

Between 2004 and 2060 a further 108 million m^3 will need to be disposed of (28 million m^3 from capital dredging (for the Port expansion) and 80 million m^3 from maintenance dredging based on the average annual maintenance dredging of 1.4 million m^3/year from available data (Table 2.2). Based on existing data on disposal to the north beach (average 639 000 m^3/year from 1989 to 2003) (Table 2.4), roughly 36 million m^3 of the maintenance dredging total will be supplied to the beaches. If the current policy of disposal of maintenance spoil to the offshore dump is continued, **about 44 million m^3 would need to be disposed of at this site** (based on past dredging volumes, about 5 million m^3 of this material would constitute sand, the remainder being fine sand)**. An appropriate disposal site for the remaining 28 million m^3 was assessed** in the Sustainability Framework Report (CSIR, 2005).

Table 2.2: Dredge disposal volumes (CSIR, 2005)

Period	Capital (million m^3)	Maintenance (million m^3)	Total	Comments
1973 to 2003	98.4	38.6	137	75 million m^3 of capital was from port construction
2004 to 2060	28	80	108	80 million m^3 maintenance based on figures from 1989 to 2003.

Table 2.3: Total dredge disposal volumes from port inception to end 2003 (CSIR, 2005)

Type	Dredged (million m^3)	Disposed at (million m^3):			
		North Beach	Central Beach	South Beach	Offshore
Capital	98.4	15.4	81	2	0
Maintenance	38.6	15	0	0	23.6
Total	137	30.4	81	2	23.6

Table 2.4: Maintenance dredging volumes (CSIR, 2005)

Year	Dredged				Disposed of	
	Sandtrap (m^3)	Channels (m^3)	Basins (m^3)	Sum (m^3)	Northern Beach (m^3)	Remainder (offshore) (m^3)
1977	8 500	5 500	37 200	51 200	0	51 200
1978	413 600	298 300	37 200	749 100	0	749 100
1979	841 030	271 400	37 200	1 149 630	9 000	1 140 630
1980	604 300	591 550	37 200	1 233 050	264 000	969 050
1981	583 017	114 300	37 200	734 517	361 277	373 240
1982	1 117 944	692 387	37 200	1 847 531	679 374	1 168 157
1983	722 609	1 348 763	37 200	2 108 572	808 134	1 300 438
1984	630 257	1 417 197	37 200	2 084 654	649 621	1 435 033

Year	Dredged				Disposed of	
	Sandtrap (m^3)	Channels (m^3)	Basins (m^3)	Sum (m^3)	Northern Beach (m^3)	Remainder (offshore) (m^3)
1985	985 199	1 365 646	37 200	2 388 045	776 198	1 611 847
1986	320 089	1 233 945	37 200	1 591 234	810 569	780 665
1987	5 557	1 609 283	37 200	1 652 040	484 543	1 167 497
1988	346 009	1 128 816	37 200	1 512 025	560 767	951 258
1989	372 206	697 204	34 814	1 104 224	525 541	578 683
1990	531 956	887 361	34 447	1 453 764	574 435	879 329
1991	618 470	720 324	11 789	1 350 583	593 763	756 820
1992	696 688	490 591	11 222	1 198 501	708 209	490 292
1993	648 523	593 351	51 651	1 293 525	624 319	669 206
1994	698 201	499 764	44 596	1 242 561	760 777	481 784
1995	698 248	568 043	18 283	1 284 574	656 277	628 297
1996	167 800	2 210 803	25 750	2 404 353	124 477	2 279 876
1997	338 113	1 294 934	6 985	1 640 032	412 718	1 227 314
1998	371 308	717 277	26 130	1 114 715	826 034	288 681
1999	425 347	1 370 740	45 234	1 841 321	598 715	1 242 606
2000	524 958	638 285	100 443	1 263 686	724 109	539 577
2001	678 410	670 804	37 665	1 386 879	873 380	513 499
2002	796 099	683 644	44 480	1 524 223	824 014	700 209
2003	652 805	681 368	64 505	1 398 678	757 703	640 975
TOTAL	**14 797 243**	**22 801 580**	**1 004 394**	**38 603 217**	**14 987 954**	**23 615 263**

The current developments, the Expansion of the Capacity of the Port and the Coal Terminal, would require less material to be dredged then the estimated total volume for the total development footprint. The Marine Engineering Report of the Coal Terminal Development (Ref 4653710-RPT-0079) estimated some **3,236,024 m^3** of material (Table 2.5)**.** Calculations supplied from Aurecon in support of the Marine Engineering Report for the Port Capacity Expansion (Ref 4653710-RPT-0088) estimate some **9,718,000 m^3** needs to be dredged (Table 2.6).

Table 2.5: Coal Terminal Dredge Volume (m^3)

Sand	1%	14,900
Silt	0%	0
Soft Clay	61%	1,981,367
Stiff Clay	26%	849,157
Rock	12%	390,600
TOTAL	**100%**	**3,236,024**

Table 2.6: Port Capacity Expansion Dredge Volumes (m^3)

Sand	22%	2,121,000
Silt	4%	394,000
Soft Clay	32%	3,093,000
Stiff Clay	14%	1,326,000
Rock	29%	2,784,000
TOTAL	**100%**	**9,718,000**

A total of **12,954,024 m^3** of material dredged from the two developments requires disposal.

3. TASK 2: IDENTIFICATION OF POTENTIAL DISPOSAL SITES

The land use classification and inshore / deep sea bathymetry will be used to identify potential disposal areas, using the spoil characterisation as the main input data.

3.1 CRITERIA FOR SUITABLE OFF-SHORE DISPOSAL SITES

The SEA Sustainability Framework (CSIR, 2005) listed the following criteria for off-shore disposal sites.

- **Economy**
  Impacted on by cost of steaming to and from dumpsite (increases with distance) and need for re-dredging of material that is re-deposited in the harbour (decreases with distance).
- **Changes in bathymetry and effect on shoreline erosion**
  A recent, comprehensive study that tested the response of waves, sand transport and shoreline response to a dredge pit (CSIR, 2002) indicated that bathymetry changes of 1.7 m (over an area of about 3.5 km^2) in a 20 to 40 m depth resulted in predicted shoreline erosion of about 10 m. The results of this study suggest that bathymetric changes in depths of about 20 m should be limited to within about 0.5 m in order to avoid significant wave focussing and shoreline erosion.
- **Smothering of benthic ecosystems**
  Studies (Klages et al, 2004) indicate that disposal reduces biodiversity, but it also recovers fairly quickly. Thresholds where recovery is impaired is uncertain "with appropriate controls, moderate dumping of uncontaminated dredge spoil should not pose any significant ecological threat". Impacts on the Mhlathuze Estuary (mangroves), sandbanks & mudflats are described in the Marine and Estuarine Research baseline study prepared for this project (2013)
- **Turbidity**

Predictions indicate that elevated suspended sediment concentrations (over 100 mg/l) will occur in the immediate region of the offshore discharge site in response to discharges. Visible plumes (concentrations over 25 mg/l) are predicted to be evident over a more extensive offshore area (spanning a few km). Turbidity is generally not an issue within the estuary and port (CSIR 2013)

3.2 Dredge Disposal Options

The SEA Sustainability Framework (CSIR, 2005) considered various dredge spoil disposal options as discussed in **Table 3.1**. Figure 3.1 presents a map showing the location of the various beaches and offshore silt disposal area (5 km south of port entrance). The sand disposal area is approximately 10 km south east of the port entrance

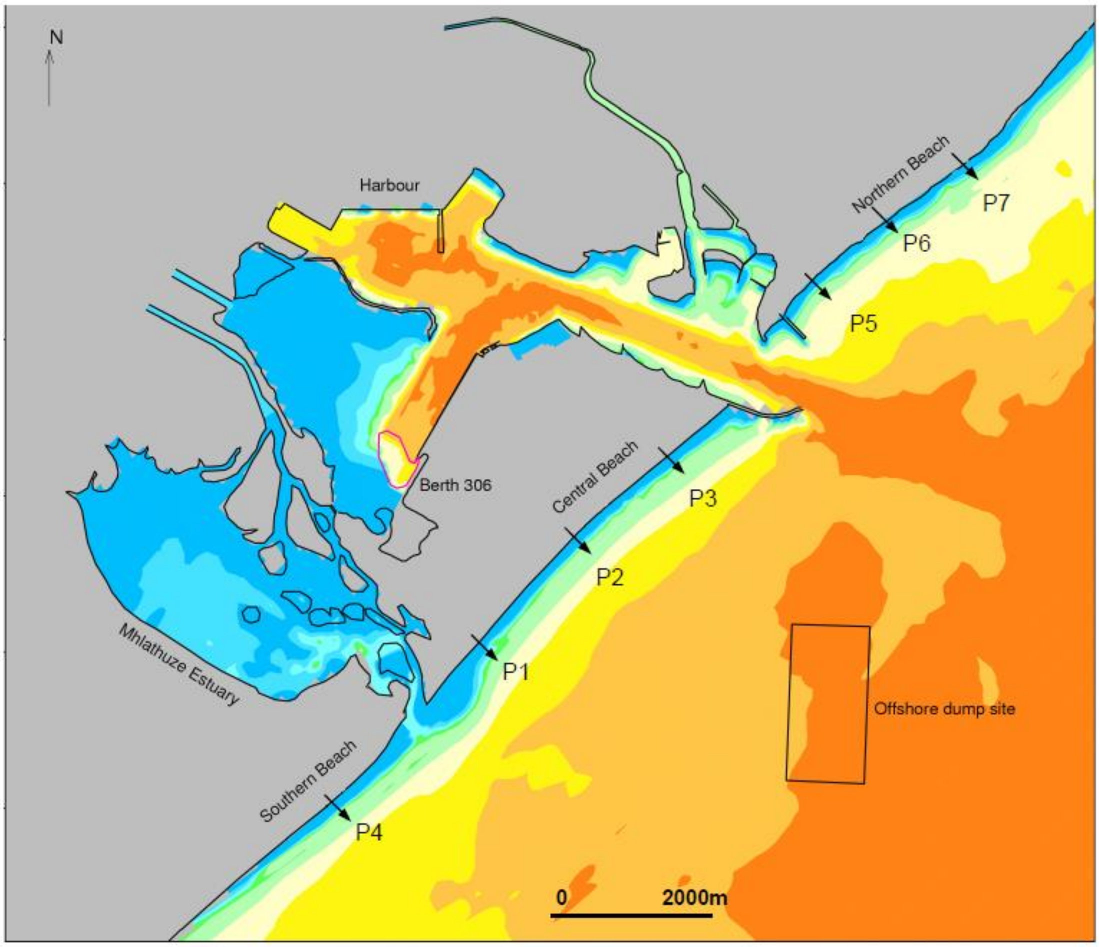

Figure 3.1 Map indicating location of beaches and off-shore silt disposal area (from CSIR, 2004)

Table 3.1: Sustainability Framework Dredge Disposal Options (Appendix D of the SEA Sustainability Framework; CSIR, 2005)

1. Disposal on northern beach

<table>
<tr><th colspan="2">1. Disposal on northern beach</th></tr>
<tr><td>Description</td><td>This may involve disposal at the present location at Alkantstrand. An alternative would be disposal by dredger into a feeder berm (at a depth of some 8 m). This disposal would probably result in less turbidity at the shoreline. Preliminary feasibility studies (e.g. CSIR, 1994) indicate that feeder berms have been employed successfully elsewhere in the world. A combination of disposal on the beach and on a feeder berm is also a possibility. Use could possibly be made of the existing pipeline to Alkantstrand and/or existing available dredgers. Most of the development planned up to 2060 is on the eastern and northern sides of the port, from which a pipeline to the northern beach would be feasible.</td></tr>
<tr><td>Suspended Sediment Concentrations</td><td>Model predictions indicate that a discharge on the northern beach would result in frequent high concentrations of suspended sediment concentrations in the near shore area of the northern beach that could impact on biota. However, predictions indicate that occurrence of high concentrations in the estuary and port would only occur in calm (low flow) regions for a very small percentage of the time of dredge disposal. Elevated suspended sediment concentrations would not be expected offshore.</td></tr>
<tr><td>Visible plumes at Alkantstrand</td><td>Northern beach disposal would result in frequent turbid plumes at Alkantstrand. These plumes could possibly be alleviated by discharging further north and/or by discharging to a near shore feeder berm. Both of these alternatives could be employed according to wave conditions in order to minimise plumes at Alkantstrand.

In assessing impact of visual turbidity from discharged material from capital dredging, it is important to note that:
• This impact should be traded off against the fact that erosion at the beaches could be solved for an extended period through sand supply; and
• At most, the disposal will occur for only about 6% of the time in the period from 2004 to 2060 (This assumes an average cutter-suction dredging rate of 1000 m^3/hour).</td></tr>
<tr><td>Deposition</td><td>Accretion of the beach would be expected in response to the discharge, as has been measured in response to past capital dredge disposal (SOE report: Part II, section 3.1.2). The latter measurements manifested rapid subsequent retreat of the accreted beach, which would probably result in the beach slope and composition being re-instated within a year or so. Modelling studies indicate acceptable levels of deposition of material in the green zone of the port, the estuary and the near shore regions, in response to spoil disposal on the northern beach.</td></tr>
<tr><td>Re-dredging</td><td>Both model predictions of fine sediment behaviour and dredging records suggest that discharge on the north beach would result in considerable deposition in the port channel, which would require “re-dredging” to maintain the channel. While modelling suggests deposition of several hundred cubic metres of fine material (in response to 2.4 million m^3 of sediment being discharged), sand trap and dredging measurements confirm that annual sediment deposition (of both sand and silt material) increases (by as much as 1 million m^3) in response to major capital dredging. Modelling shows that mitigation by moving the discharge from</td></tr>
</table>

1. Disposal on northern beach	
	1.55 to 3 km north of the north breakwater results in relatively minor reduction in deposition of fines in the channel.
Beneficial use of sand	The northern beach disposal option makes beneficial use of all available sand to replenish the severely eroded northern beaches.
Use of existing infrastructure	The northern beach disposal option could make use of the existing pipeline infrastructure.
Suitability for long term	If the issue of visible plumes can be alleviated and/or intermittent periods of frequent plume occurrence can be accepted (with the benefit of beach restoration), then this option of disposal to the northern beach will be suitable in the long term.

2. Disposal on the central beach	
Description	This would involve the establishment of a pipeline from the dredging site to the central beach. While suitable for developments in the north and west of the port, the distance from developments in the east of the port (constituting a large proportion of developments up to 2060) would result in a relatively expensive pumping operation.
Suspended Sediment Concentrations	For this discharge option, frequent high concentrations of suspended sediment in the near shore area of the central beach are predicted, which could impact on biota. Predictions indicate that a high occurrence of elevated concentrations would occur in the estuary. However, high concentrations in the port would only occur in calm (low flow) regions for a very small percentage of the time of dredge disposal. Elevated concentrations would not be expected offshore.
Visible plumes at Alkantstrand	Predictions indicate that this disposal option would not result in frequent turbid plumes at Alkantstrand.
Deposition	Accretion of the beach would be expected in response to the discharge, as has been recorded in response to past capital dredge disposals. The latter recordings manifested rapid subsequent retreat of the artificially accreted beach, which would probably result in the beach slope and composition being re-instated within a year or so. Modelling studies indicate insignificant deposition of material in the green zone of the port, and in the offshore region. However, considerable deposition of fine material would be expected in the estuary (order of tens of thousands of tons would result from deposition of around 2 million m^3 onto the central beach).
Re-dredging	Both model predictions of fine sediment behaviour and dredging records suggest that discharge on the central beach would result in considerable deposition in the port channel. Modelling suggests about 200 000 m^3 of deposition when 2.4 million m^3 of material is discharged, while channel dredging records confirm major increases in channel deposition of both sand and silt (in the order of 1 million m^3) in response to capital dredging. In the case of the central beach, limited opportunity exists to meaningfully reduce channel deposition since moving the discharge position south results in increased estuary deposition.
Beneficial use of sand	The disposal of sand on the central beach would not be beneficial, as this beach is in an accreted state already. In any event, this beach is not accessible to the public. A benefit could occur if sand desperately needed for northern beach nourishment is in the sand trap, as has been the case in the past. However, data on channel dredging quantities suggest that accretion in the trap from central beach deposition would occur at the expense of concurrent undesirable deposition in the channel.
Use of existing infrastructure	No opportunity for use of existing infrastructure is foreseen.

2. Disposal on the central beach	
Suitability for long term	Unless studies of estuary impacts are conducted during and after discharge on the central beaches and unless these studies indicate acceptable impacts of high suspended sediment concentrations and deposition, it is unlikely that this site will represent an environmentally sustainable disposal option.

3. Disposal on the southern beach	
Description	This option would involve establishment of a pipeline from the dredging site to the southern beach. While this pipeline and pumping may be acceptable for developments in the north and west of the port, the distance from developments in the east of the port (constituting a large proportion of developments up to 2060) would result in a relatively expensive pumping operation. High suspended sediment concentrations and deposition in the estuary may require discharging some distance (up to a few km) south of the estuary. This could add significantly to the cost.
Suspended Sediment Concentrations	Frequent high concentrations of suspended sediment concentrations in the near shore area of the southern beach are anticipated which could impact on biota. It is expected that a high occurrence of elevated concentrations would occur in the estuary unless the discharge point is situated far south of the estuary mouth. However, high concentrations in the port would be expected in calm (low flow) regions for a very small percentage of the time of dredge disposal. Elevated suspended sediment concentrations would not be expected offshore.
Visible plumes at Alkantstrand	The southern beach disposal option would not result in frequent turbid plumes at Alkantstrand.
Deposition	Accretion of the beach would be expected in response to the discharge, as has been recorded in response to past capital dredge disposals. The latter recordings manifested rapid subsequent retreat of the artificially accreted beach, which would probably result in the beach slope and composition being re-instated within a year or so. Insignificant deposition of material would be expected in the green zone of the port and also in the offshore region. However, significant deposition of fine material would be expected in the estuary, unless the discharge location was situated approximately 2.4 km to the south (CSIR 2004)
Re-dredging	Although not directly tested, both model predictions of fine sediment behaviour and dredging records suggest that discharge on the southern beach could result in considerable deposition in the port channel. This could be reduced by moving the discharge position even further south. However, the benefit of reduced deposition is unlikely to weigh up against the additional pipe and pumping cost.
Beneficial use of sand	The disposal of sand on the southern beach would not be beneficial, as this beach is already in an accreted state.
Use of existing infrastructure	No opportunity for use of existing infrastructure is foreseen.

Suitability for long term	Unless (1) studies of estuary impacts are conducted during and after discharge on the southern beach and unless these studies indicate acceptable impacts of high suspended sediment concentrations and deposition, and/or (2) mitigation by moving the discharge further south can be economically achieved, it is unlikely that this site will represent an environmentally sustainable disposal option.

4. Disposal via a pipeline to the region offshore of the central beach	
Description	This option involves the permanent installation of a pipeline to a site offshore of the central beach. While suitable for developments in the north and west of the port, the distance from developments in the east of the port (constituting a large proportion of developments up to 2060) would result in long pumping distances and thus an expensive pumping operation (particularly considering that the pipeline would extend some 2 to 4 km offshore). In the above beach disposal option, pipelines/pumps could be temporary (e.g. supplied by contractors). In this case, the pipeline section crossing the beach and surf zone and situated on the sea bed would be permanent, due to the expense of construction.
Suspended Sediment Concentrations	Frequent high concentrations in the offshore area seawards of the central beach are anticipated. These could impact on biota. It is expected that a low occurrence of elevated concentrations would occur in the estuary and at the near-beach region. Elevated concentrations in the port would only occur in calm (low flow) regions for a very small percentage of the time of dredge disposal.
Visible plumes at Alkantstrand	This disposal option would not result in frequent turbid plumes at Alkantstrand.
Deposition	No deposition would be expected in the beach and near-beach region. Judging from model predictions, insignificant deposition of material would be expected in the green zone of the port. In addition, limited deposition of fine material (less than 1% of the annual river sediment load) would be expected in the estuary. However, in the offshore region, deposition (of coarse material) would be expected near the pipeline end.
Re-dredging	Model predictions of fine sediment behaviour indicate that discharge offshore of the central beach would result in limited deposition in the port channel (less than 1% of the discharged sediment is predicted to deposit in the channel). Thus re-dredging of material would be minimal.
Beneficial use of sand	The disposal of sand offshore would not be beneficial.
Use of existing infrastructure	No opportunity for use of existing infrastructure is foreseen.

4. Disposal via a pipeline to the region offshore of the central beach	
Suitability for long term	Considering the assumed composition of dredged material (37% sand), the volumes of material to be discharged would prevent this option being sustainable because: • The volume of sand would accumulate and inundate the pipe end (even if measures are taken to raise the discharge this would be difficult to avoid); and • The volume of material would cause wave focussing effects which may cause undesirable beach erosion. Thus, this option would only be feasible if (1) dredged material is found to be much finer than assumed for this study or (2) a means of first separating out sand is employed. This sand-separation process is discussed in CSIR (2004) and is Appended to this report as Appendix 1).

5. Disposal via the Mhlathuze Water pipeline	
Description	Mhlathuze Water operates two marine outfall pipelines at Richards Bay (A and B pipelines, 4-5 km from shore). They have been operational since December 1985. During their construction, an additional line was constructed (C pipeline, 700 m from shore) (CSIR, 2004). The "C" pipeline is a Class 4 or 5 High Density Poly Ethelene (HDPE) pipeline with an inside diameter of 1000 mm and extends 700 m from the shoreline to an approximate water depth of 11 m. The landward end of the pipeline is at the beach and is not connected to the A or B pipelines. The seaward end is sealed and the pipeline is presently not in use. This third pipeline, termed the C-pipeline, may be suitable for the disposal of dredger spoil. This would require an assessment of whether the pipe can withstand the pressure during pumping of dredge spoil, and whether an arrangement could be made with Mhlathuze Water for pipeline re-use. This option would involve establishment of a pipeline from the dredging site to the northern beach. This disposal option may be economical for developments in the north and east of the port (i.e. the larger portion of developments). However, for developments in the west of the port, a relatively expensive pumping operation would ensue.
Suspended Sediment Concentrations	Although this scenario has not been modelled, references to similar modelling scenarios (CSIR, 2004; CSIR, 2001) provide some insight into likely effects. Modelling of a discharge position beyond the surf zone at a nearby site (at 600 m offshore) indicates limited (less than 10% occurrence during dredge disposal) elevated concentrations within 150 m of the shoreline. Predictions from a northern beach discharge (CSIR, 2001), i.e. close to the Mhlathuze Water pipeline discharge, suggest a low occurrence of elevated suspended sediment concentrations at isolated regions in the estuary and a low occurrence of elevated concentrations in the port green zone. However, frequent high concentrations in the offshore area seawards of Alkantstrand beach would be anticipated.
Visible plumes at Alkantstrand	Modelling of discharge from a similar offshore position at central beach suggests up to 30% occurrence of visible turbid plumes at Alkantstrand.

5. Disposal via the Mhlathuze Water pipeline	
Deposition	No deposition would be expected in the beach and near-beach region. Minor deposition of material would be expected near the green zone of the port. In the offshore region deposition would be expected in the region of the end of the pipeline. Furthermore, limited deposition of fine material would be expected in the estuary (model simulations of similar scenarios indicate moderate annual volumes - in the order of 1-2% of the annual riverine sediment discharge volume - of discharged material to deposit in isolated regions in the estuary).
Re-dredging	Model predictions of fine sediment behaviour for similar discharge scenarios in the northern beach region indicate considerable deposition in the port channel (amounting to at least 7% of the discharged volume and probably much more since the discharge location would only be about 1 km north of the port channel).
Beneficial use of sand	The disposal of sand in a depth of 11 m would probably not be significantly beneficial to the beach, since only a small amount of this sand would be transported to Alkantstrand beach.
Use of existing infrastructure	The option would employ the existing pipeline extending from the upper beach to 11 m depth. It may be possible to also make use of the pipeline installed for nourishment at Alkantstrand beach. However, interruption of regular maintenance beach nourishment may prohibit this.
Suitability for long term	Considering the assumed composition of dredged material (37% sand), the volumes of material to be discharged would prevent this option being sustainable because: • The volume of sand would accumulate and inundate the sand discharge (even if measures are taken to raise the discharge, this would be difficult to avoid). • The volume of material would cause wave focussing effects which may cause undesirable beach erosion on an already vulnerable beach. Thus, this option would only be feasible if (1) dredged material is found to be much finer than assumed or (2) a means of first separating out sand is employed. This separation process is discussed in detail in CSIR (2004).

6. Beneficial uses of dredger spoil	
Description	Beneficial uses of dredger spoil are discussed in some detail in Appendix 2. Two beneficial uses already exist in Richards Bay: beach nourishment and replacement fill. To date these have been conducted without employing sand separation methods. Other possibilities that could be explored further (without sand extraction) include: Land creation; Land improvement; Offshore berm creation; Wetland creation; Brick/ceramic manufacture; and Topsoil. In future, the need to reduce turbidity/deposition from fine material (depending on the location of disposal) may necessitate sand separation. The extraction/separation of sand from fine material could

6. Beneficial uses of dredger spoil	
	open up other possibilities for beneficial use, such as sand for construction materials (e.g. bituminous mixtures and mortar). However, the present sand demand for both beach nourishment and fill is deemed to override any alternative sand use. In addition, the issue of how to dispose of the large percentage of remaining fine material would need to be solved. These options would need to be revisited during the EIA. The beneficial use disposal option would probably involve considerable pumping distances to appropriate sites (e.g. to agricultural lands, proposed parks etc.), with the volumes of material disposed of being limited. Thus it is likely that the pumping cost to benefit gained ratio would be high. This assessment assumes that some land-based beneficial use will be selected. Thus, the option of offshore berm creation is not included here (as this is dealt with under the northern beach disposal option).
Suspended Sediment Concentrations	Employment of land-based options involving both the sand and silt components of the spoil would probably not result in the generation of suspended sediment during disposal.
Visible plumes at Alkantstrand	No visible turbid plumes at Alkantstrand would result.
Deposition	No deposition would occur in the marine environment.
Re-dredging	No re-dredging would be required for this option.
Beneficial use of sand	Some beneficial use of the sand component of the spoil would be obtained, but it is likely that the sand would be better used elsewhere, such as for beach nourishment. Beneficial use of the sand per se could only be achieved by means of sand separation. This unfortunately would not solve the problem of disposal of the large fines portion of the dredged sediment.
Use of existing infrastructure	No benefit from existing infrastructure is foreseen.
Suitability for long term	The land-based beneficial dredge disposal options would only account for a fraction of the total volume which needs to be disposed of up until the year 2060. For example, even if a square kilometre of recreational/agricultural/habitat land (5 m high) were created with dredge spoil, this would account for only about 18% of the total volume of material. Thus, while beneficial uses may provide high environmental profile for the port, such uses would not relieve the need to dispose of massive volumes of spoil on an environmentally sustainable basis.

7. Disposal on land	
Description	The Transnet National Ports Authority (TNPA) in Richards Bay has identified possible sites for land disposal within the existing TNPA port boundary (CSIR, 2004). These would only accommodate a possible 10.6 million m^3 of the estimated total 28 million m^3 volume material to be disposed of by 2060. In addition, 5.6 million m^3 of the 10.6 million m^3 represents temporary land disposal sites, where development is anticipated in future (if the material had a higher sand content then it

7. Disposal on land	
	may be suitable for permanent fill – however this is not the case given the high percentage of fine material; material would therefore need to be removed at a later stage). Pumping distances from dredging sites would range from 2 to 6 km, for the capital dredging expected up to 2010 (CSIR, 2004). The Ticor slimes dam adjacent to the N2 highway may also be an option. This would involve a pumping distance of a land based pipeline over 12 km. An agreement would need to be formed with Ticor to use the facility. Salt water leaching from the material during the drying processes could lead to salt contamination of ground water resources; this issue may need assessment.
Suspended Sediment Concentrations	Disposal on land would involve no generation of suspended sediment during disposal.
Visible plumes at Alkantstrand	No visible turbid plumes at Alkantstrand would result.
Deposition	No deposition would occur in the marine environment.
Re-dredging	No re-dredging of any part of the port would be necessary.
Beneficial use of sand	The beneficial use of sand is foreseen. Assuming that the material is predominantly fine, material deposited on future development sites would not serve as useful fill (e.g. for construction or port activities), since the material would result in poor foundation conditions.
Use of existing infrastructure	No benefit from existing infrastructure is foreseen.
Suitability for long term	Permanent land disposal would only account for only 18% of the 28 million m^3 to be disposed of by 2060. Temporary disposal is not considered to represent an economical long-term solution. Larger volumes of disposal may be possible but would involve expensive pumping over large distances.

8. Barge disposal offshore	
Description	The offshore disposal site, located approximately 3.5 km south of the port entrance is used for disposal of periodic maintenance dredging material. An option is to use barges to dispose of future capital dredging spoil on this dumpsite. This would involve pumping material from the dredger to a barge moored alongside, which would then travel out to the dumpsite and bottom-dump the material before returning for another load. This disposal method is not frequently used in South Africa, and therefore equipment such as barges would need to be mobilised from elsewhere, entailing considerable costs. Such mobilisations would need to be repeated for each future dredging phase. In 2004, barge disposal is likely to be employed for the disposal of material from the dredging of Berth 306. The potential for barge disposal for the 500, 600 and 700 series berths would be the subject of the Environmental Impact Assessment

8. Barge disposal offshore	
	The slurry being pumped into barges would typically only contain 10% to 30% solid material. To avoid inducing high suspended sediment concentrations in the water, limited/no spillage of the lean mixture over the sides of the barge would be permitted. As a result, the total volume of solid material being transported by the barges will be quite low, resulting in an inefficient operation. Assuming a barge volume of 1500 m^3 (typical barge volumes range from 500 to 2000 m^3) and a solids content of 20%, it would take almost 2250 barge trips to dispose of 1 million m^3. This would result in an increase in the shipping traffic through the port. Given the rates of dredging relative to rates of disposal offshore, it is likely that a small fleet of barges will be required. While disposal offshore may be expensive *per se*, if conducted in tandem with sand sourcing it may become more economically viable. This would involve dumping dredge spoil with a dredger, dredging sand required for backfill and returning to the construction site. This *modus operandi* is to be employed at the construction of Berth 306 and may be the same for the 500, 600 and 700 series berths. No metal concentrations in sediment samples collected from the Richards Bay Coal Terminal Basin and Mudflats exceeded sediment quality guidelines, meaning there is no limitation to openwater disposal of sediment dredged from these parts of for maintenance. Sediment at four stations, two in Inner Basin 2 and two in Inner Basin 3 theoretically cannot be disposed offshore because copper and/or chromium concentrations in the sediment exceeded the Level II.
Suspended Sediment Concentrations	Model simulations (CSIR, 2004) indicate that disposal offshore would result in negligible occurrence of elevated concentrations at and near the northern, central and southern beaches, at the green zone of the port and in the estuary. Only at and near the disposal site, elevated concentrations would be expected.
Visible plumes at Alkantstrand	Modelling indicates that visible turbid plumes at Alkantstrand resulting from disposal at the offshore dump would rarely occur (<1% occurrence).
Deposition	Deposition of the coarse fraction of disposed material would occur at the offshore dump site. However, deposition at the beaches, in the estuary (less than 0.5% of the annual river sediment load) and in the green zone of the port would be negligible.
Re-dredging	Negligible re-dredging is predicted. (Deposition in the port channels is predicted to be less than 0.1% of the material discharged offshore).
Beneficial use of sand	No beneficial use of sand is foreseen, unless this is either separated before disposal or is subsequently dredged from the offshore dump site.
Use of existing infrastructure	No benefit from existing infrastructure is foreseen.
Suitability for long term	An estimate of the total amount of sand discharged to the offshore dump indicates that accumulation of sand may cause wave focussing (and shoreline erosion) within the next 5 to 10 years at the present rate of maintenance dredging disposal. Thus, an alternative site would be

8. Barge disposal offshore	
	required at some stage. This may be desirable, in order to allow benthic biota to re-establish at the present dump site. Apart from this requirement to avoid wave focussing, and recognising localised (and possibly temporary) impacts in terms of sediment suspension and deposition, it is likely that this dredge disposal option could be employed indefinitely from a purely green environment perspective. However, this option is clearly inefficient and costly from an engineering perspective.

The different dredge spoil disposal options outlined above can be summarised as follow (CSIR, 2005):

- Disposal on the central or southern beach (assuming a practically close pumping distance for the latter) result in significant deposition and high suspended sediment concentrations in the estuary. Maintaining the estuary in good condition in the long-term is considered to be a high priority;
- Disposal at the northern beach results in acceptable deposition and insignificant occurrence of high suspended sediment concentrations in the estuary;
- Northern beach disposal would result in reasonable pumping distances for most planned expansions and the supply of sand that would allow medium term recovery of the depleted beaches to the north. Therefore, this is an appealing disposal option;
- Pipeline disposal is practically not possible on an on-going basis unless sand is separated, since excessive accumulation of sand at the discharge position would inundate the outlet. However, if sand-separation was carried out, then a pipeline could be employed to discharge fine material. Use of the Mhlathuze Water pipeline is preferable (if permission can be obtained, and if feasible from an engineering perspective) as infrastructure is available and the pumping distance would be reasonably short in most cases. However, this would need to be traded off against the cost of re-dredging material that deposits in the channel and against the occurrence of visible plumes at Alkantstrand.
- Land disposal has a low impact on the environment. Unfortunately, disposal opportunities are limited and only a fraction of spoil material could be economically disposed of. Nevertheless, it is recommended that this option be employed where possible and that investigation of land disposal opportunities be given high priority.
- Land-based beneficial uses are also low in impact. Opportunities appear to be limited and it appears that only a very small fraction of spoil material could be beneficially used. The dredge spoils are primarily sediments unsuitable for fill material because of their high silt content. Nevertheless, it is recommended that beneficial uses be employed where possible and that investigation of beneficial use opportunities be given high priority.
- Barge/vessel disposal offshore will limit impacts to a designated offshore region. However, with the loss of sand offshore and the relatively high expense, this option is not favourable. Yet, it may prove viable if other options prove impractical (or have excessive impact) and/or if conducted in association with a sand winning operation.

The CSIR (2004) identified the following six disposal sites on land (**Figure 3-1**):

- Site 1 (750m x 250m): Between the Richards Bay Coal Terminal loop and the entrance channel with a temporary storage capacity of 1.875 million m^3. This site is now considered unfeasible, because of the high conservation value of the South Dunes.
- Site 2 (1500m x 250m): Mud-flat adjacent to Bayside Aluminium, opposite Berths 606 and 608, on the western portion of the port. The site has a temporary storage capacity of 3.75 million m^3. This site is now considered unfeasible, because of the proposed new Coal Terminal Development programme.
- Site 3: In the Duine inside the Richards Bay Coal Terminal rail loop with approximately 1 million m^3 of temporary storage capacity. This site is now considered unfeasible, because of the high conservation value of the South Dunes.
- Site 4: South of the Mhlatuze River with more than 5 million m^3 of permanent storage capacity.
- Site 5: Approximately 2 km east of the N2 highway and 8-10 km from the port, with approximately 29 million m^3 of permanent storage capacity.
- Site 6: The Ticor slimes dam is adjacent to the N2 highway and 12 km from the port which can be used for disposal in the long term. . The potential volumes that could be disposed of have not been precisely calculated.

Therefore, Sites 4-6 should be considered as options for disposal on land.

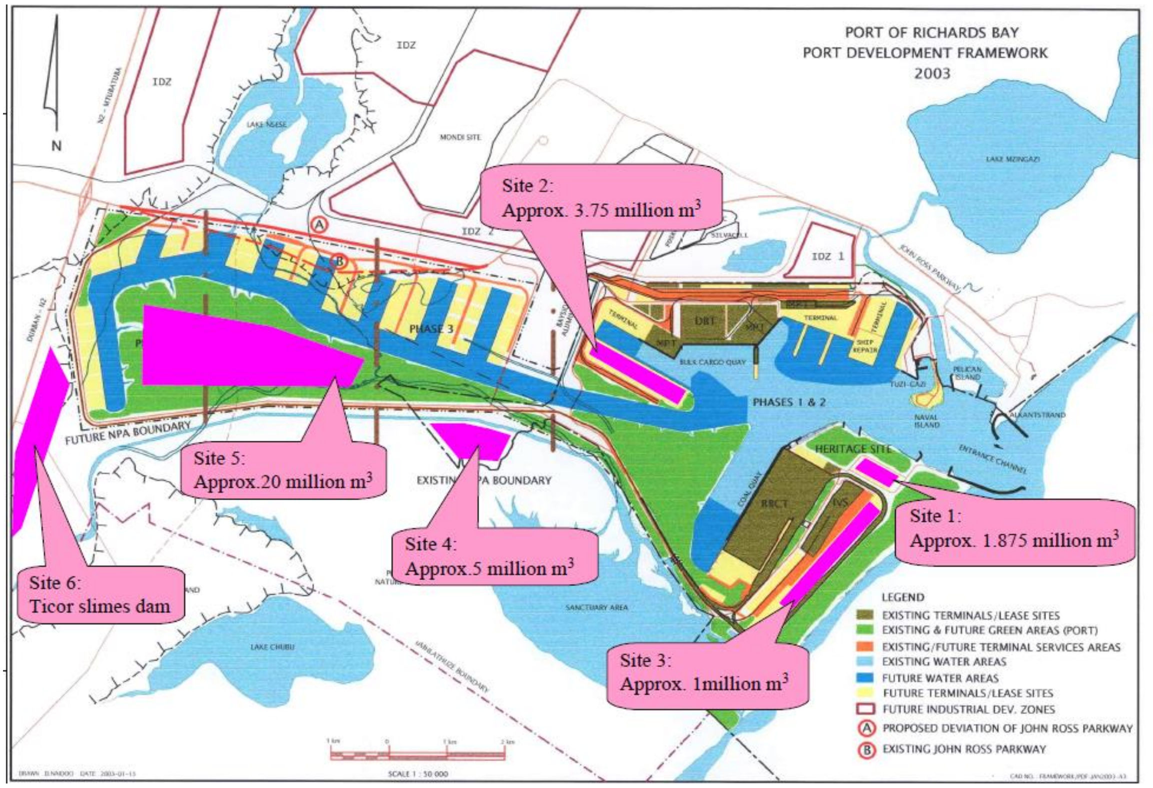

Figure 3-1: Location of potential dredge disposal sites on land (CSIR 2004)

3.3 BENEFICIAL USES OF DREDGE SPOIL

The analysis of the samples provided by the TNPA indicates that contaminants are sufficiently low in concentration that no special measures are required in order to dispose of or utilise the material (CSIR, 2004). The sample analysis also indicated the material to comprise 37% of medium to very fine sand and 55% of silt and 8% clay. It is assumed for the purpose of this study that these soil characteristics apply to all material to be dredged up until the year 2060. The possible beneficial uses of this material are discussed and preliminary judgements of the potential scope of such beneficial uses in Richards Bay are provided. This information was taken from the SEA Sustainability Framework (CSIR, 2005).

3.3.1 Engineering uses

This involves the use of the dredged material in construction, for commercial or industrial purposes.

- **Land creation (sand, silt)**
  At this stage no need for land creation is identified in Richards Bay. It is assumed for the purpose of this study that this conclusion applies to all material to be dredged up until the year 2060.
- **Land improvement (sand, silt)**
  Land improvement implies improvement of the quality of soil and/or making the land functional by elevating it above flood levels. Dredged material that is fluvial in origin (derived from topsoil and organic matter) may be used on land of poor agricultural quality. As for land creation, fine or coarse material can be employed. Employing appropriate techniques for disposal and dewatering, land improved using fine material could be used for farming or recreation (playing fields, parks and/or golf courses). At this stage no need for land improvement is identified within this study in Richards Bay.
- **Offshore berms (sand)**
  Offshore sand berms can be constructed for shore protection. A well-designed shore-parallel berm absorbs part of the wave energy approaching the beach so that the wave climate at the beach is less severe. Such berms can also provide sand nourishment to the beaches, through their shoreward migration under prevailing wave action. They have been previously evaluated (e.g. CSIR, 1994) as a nourishment method (i.e. as feeder berms) for the northern beaches in Richards Bay. Evidence of successful feeder berms has been identified and the dynamics of such berms evaluated. Successful employment of feeder berms could result in a reduction in dredging effort. However, this approach has not yet been adapted in the Port of Richards Bay.

  A consideration in the placement of sand would be the suspension of fine material in the water column. The effect of this suspension (and ultimate deposition of the material) would require assessment and may result in a need to initially separate out sand from silt and clay. It is possible that turbidity could be minimised by altering the exact location of disposal (and possibly employing beach disposal as an alternative at times) according to the wave and flow conditions at the time of disposal.

- **Beach nourishment (sand)**
  There is a clear need for sand for beach nourishment on the northern beaches of Richards Bay, in addition to sand routinely supplied from maintenance dredging operations. Placement of additional sand would remedy severe long-term erosion whereby the shoreline has retreated by up to 60 m.
  As for the above case, the placement of sand would result in the suspension of fine material in the water column. The effect of this suspension (and ultimate deposition of the material) would require assessment and could result in a need to initially separate out sand from silt and clay.
- **Capping of waste sites (sand, clay)**
  Sand material can be used for capping of contaminated material disposal sites on the seabed. Sand, clay or mixed materials can be used. There is at present no requirement for this in Richards Bay.
  Capping may be needed at landfill sites. This would require clay. As only 8% of the dredged material is indicated to be clay (from available sampling), this would require separation from the sand and silt and dewatering. In Richards Bay, this process is likely to be costly and would still result in the need to dispose of the other 92% of spoil material. Clay for capping will probably be more readily available from other sources.
- **Replacement fill (sand)**
  Fill is a beneficial use that can be considered when dredged material has superior physical qualities compared to soils near the dredging site. Sand is most useful as replacement fill for areas where the soils engineering properties are poor, a typical example being backfilling behind new quay walls in clayey areas.
  There is a clear need for such fill material in Richards Bay at present and in the future. However, to enable the dredge spoil to be used for this, the usable sand fraction would need to be separated from the remainder of the material, employing either mechanical means (a sand/silt separation plant) or natural means (dumping material in the surf zone or near shore, allowing wave and current action to remove fines, and re-dredging).

3.3.2 Agricultural/product uses

- **Construction materials (sand, silt)**
  Sand can be used in the production of bituminous mixtures and mortar/concrete. However, this would require separation of the sand component.
  If the sand content does not exceed 30% and if the material conforms to specifications (to be tested), dredged material can be used as raw material for making bricks or ceramics.
  At this stage no clear need for such construction materials is evident int Richards Bay.
- **Topsoil (silt)**
  The high silt content (68 % including clay) makes the material suitable for topsoil e.g. parks, sports fields or agricultural land. No clear long-term need for this is identified in Richards Bay. The salinity of the dredge spoil would need to be

reduced by means of gradual dewatering and flushing by rain. The dewatering and salinity reduction processes may take up to several years, depending on the material composition.

- **Aquaculture (silt)**
  Silt material can be used for creating habitats for fish. This requires unused open waterway areas, which will be limited in future within the port environment.
  Some existing waterways in Richards Bay are highly productive. The "green area" of the port including the Bhizolo canal and nearby shallows provides important habitat for wading birds. It is thought that approximately two-thirds of the prawn population on the Thukela Banks utilise the Bhizolo Canal as juveniles (Klages et al., 2004). Taking this into account, limited additional opportunity for aquaculture is evident in Richards Bay.

3.3.3 Environmental enhancement

- **Upland habitats (sand, silt)**
  Material can be used for improvement or creation of habitats for birds or land animals. Land creation and/or improvement are discussed above in Section 3.3.1).
  Open areas may presently be available for habitat improvement in Richards Bay. However, it is unlikely that these areas will remain open in the long-term.
- **Fisheries improvement (sand, silt)**
  Fishery resources can be improved by appropriate placement of dredged material (e.g. bottom relief created by mounding of dredged material may provide refuge habitat for fish).
  Employment of a site for creating fish habitat was discussed above in the context of agricultural/product uses. The limited open waterway availability indicates no evident opportunity in Richards Bay at this stage.
- **Wetland creation (silt)**
  An assessment of whether existing, possibly degraded wetlands could benefit from dredge disposal would need to be conducted.

3.3.4 Discussion on beneficial use

Two beneficial uses already exist in Richards Bay: beach nourishment and replacement fill. To date these have been conducted without employing sand separation methods.

Other possibilities that could be explored further (without sand extraction) are:

- Land creation
- Land improvement
- Offshore berm creation
- Wetland creation
- Brick/ceramic manufacture
- Topsoil

In future, the need to reduce turbidity/deposition from fine material (depending on the location of disposal) may necessitate sand separation. The extraction/separation of sand from fine material (details discussed in CSIR, 2004) could open up other possibilities for beneficial use, such as sand for construction materials (e.g. bituminous mixtures and mortar). However, the demand for sand for both beach nourishment and for fill overrides any alternative sand use. In addition, the issue of how to dispose of the large percentage of remaining fine material would not be solved.

Most of the beneficial dredge disposal options would only account for a fraction of the total volume which needs to be disposed of up until the year 2060. For example, even if a square kilometre of recreational/agricultural/habitat land (5 m high) were created with dredge spoil, this would account for only about 18% of the total volume of material. Thus, while beneficial uses may provide high environmental "profile" for the port, such uses would not relieve the need to dispose of massive volumes of spoil.

If a strategic decision is made by the Port of Richards Bay to implement beneficial use/s of dredge spoil (despite the fact that this would only account a fraction of the total spoil) further studies of the beneficial options identified above would be recommended.

4. TASK 3: POTENTIAL ENVIRONMENTAL IMPACT OF DISPOSAL OPTIONS

The further feasibility of the Richards Bay Port Expansion Programme will require environmental authorisation. During the Environmental Impact Assessment (EIA) process for authorisation, a detailed assessment will be made on each of the potential impacts that can be expected as a result of dredged material disposal.

For offshore disposal, a detailed description and characterisation of the waste is an essential precondition for the consideration of alternatives and the basis for a decision as to whether the material may be dumped and it must include:

(a) origin, total amount, form and average composition;

(b) properties: physical, chemical, biochemical and biological;

(c) toxicity;

(d) persistence: physical, chemical and biological; and

(e) accumulation and biotransformation in biological materials or sediments.

Once all the impact evaluations are completed and the monitoring requirements are determined, a permit to dispose of the sediment offshore may be issued.

5. TASK 4: FINAL DISPOSAL OPTION

From all previous studies that were conducted the following key factors are identified:

- An estimated 13 million m^3 sediment will result from the proposed port expansion and coal terminal.

- Of this sediment, 16 % is sand, and 59% is silt and clay and 25% is rock.
- A small, but unknown volume is Level I and Level II copper and chromium contaminated.
- Presently, available land for deposition is about 5 million m^3.

Currently, the sandy portion in dredge material is separated from finer silt and clay particles using a sand trap. Sandy material is discharged to the beach at Alkantstrand by means of pumping through a pipeline. Fine material which is unsuitable for discharge onto the beach is disposed offshore by opening the bottom doors of the hopper above the offshore dump site. Sand separation of the 13 million m^3 will result in 2.1 million m^3 sand, 7.6 million m^3 silt / clay and 3.2 million m^3 rock.

The 2.1 million m^3 sand, can be used as permanent fill material for the port expansion (5 million m^3 available).

The 3.2 million m^3 rock can mostly be accommodated as permanent fill as well. Some additional rock material dredged could be used in other construction related activities depending on the nature of the rock (0.3 million m^3).

The following options, or a combination thereof, can be considered for the 7.6 million m^3 saline silt / clay.

- Off shore disposal (current periodic maintenance material is disposed of 3.5 km south of the port entrance)
- Onshore disposal (CSIR, 2004, Figure 3-1)
  - Site 4: South of the Mhlatuze River with more than 5 million m^3 of permanent storage capacity.
  - Site 5: Approximately 2 km east of the N2 highway and 8-10 km from the port, with approximately 29 million m^3 of permanent storage capacity.
  - Site 6: The Ticor slimes dam is adjacent to the N2 highway and can be used for disposal in the long term. The potential volumes that could be disposed of have not been precisely calculated.

6. MITIGATING MEASURES FOR THE DISPOSAL OF DREDGE MATERIAL

Aurecon (2013) identified a number of possible measures to mitigate the impact of dredging on the environment, which includes amongst others the following:

- Reduction in the size of the sand dredging area;
- Limiting the mud disposal rate;
- Limiting the overall dredging rate;
- Restricting the type and number of dredgers permitted within the main navigation channels;
- Decreasing the time frame over which the dredging operation is to take place, to avoid the daily re-suspension of sediments;
- Suctioning of sediments that have resettled to curb the impacts of the daily re-suspension of sediments;
- Avoid dredging during rough seas;
- Should blasting be required, it should be carefully planned

It is also suggested that any metal contaminants, e.g. copper and chromium, be separated from the dredge material at the sediment separation plant before disposal.

7. CONCLUSION

This evaluation indicated various possibilities to manage dredge material that can be considered. This includes the disposal of dredge material on land or off-shore as well as various options for the beneficial use of the materials. The final disposal option may be a single solution of a number of solutions that best manage the environmental impacts. The environmental impact of each option must be investigated should the decision to continue with the Richards Bay Port Expansion Programme be reached.

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