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Environmental Implications of the Proposed Materials Handling and Ship-Loading Facility for the Export of Titanium at the Port of Mombasa, Kenya

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Abstract

A proposal has been made by Tiomin, Kenya to construct a materials handling and ship loading facility at Likoni in the vicinity of the port of Mombasa, Kenya. The proposed ship-loading site is a "brown-fields site", which has been exposed to industrial and shipping activities for many years. Mangroves form the only significant marine habitat in the bay and show stress from previous oil spills. This study evaluates if implementation of the project, which includes construction of a warehouse and a jetty, could significantly compound the pollution problem. To achieve this, the project document, describing the construction and operational activities was obtained and a specialist study to describe the physical and biological environment, the currents dynamics for the area all year round were undertaken to predict the risk of accidents related to bad weather, indicating how the currents may transport oil (in the case of oil spill) to affect the mangrove habitat. The methods used to accomplish this study included a desk-top study for published information on the area, field visits to observe and describe the environment, and use made of the method for impact identification and evaluation developed by the Coastal and Environment Services, South Africa. Potential impacts revealed by the study included changes to water quality arising from sediment loading into the marine environment due to excavation activities, changes to benthic environment due to propeller wash during manoeuvring/docking, tank cleaning etc, effects on the water column from spillage the export minerals, potential impacts from invasive species from ballast water discharges, etc. Construction impacts were evaluated to be severe but of short-term duration. Such impacts are judged to be insignificant. On the other hand, operation impacts will be routine and may have moderate to significant impacts, if mitigation measures are not put in place and sustained. On mitigation, most of these impacts reduce to low impact and significance. However, the discharge of ballast water should not be allowed. Having established that most impacts were insignificant, it was concluded that implementation of the project would not significantly compound the existing environment condition in the harbour, and as such, implementation of the project was recommended.

1. Introduction

Tiomin Resources Incorporated discovered heavy mineral sands at economically exploitable concentrations in the Msambweni District of the Kwale County, Kenya. A feasibility study, which was completed in April 2000, included a comprehensive Environmental Impact Assessment (EIA) undertaken to meet the requirements of the Kenyan Environmental Management and Coordination Act, 1999. The EIA report was presented to the Ministry of Environment and Natural Resources in November, 2000 and an environmental licence issued in July 2002. Since the completion of the feasibility study certain components of the project design have changed as is often the case with large and complex projects. This change includes the transportation and shipping arrangements for exporting the minerals, where instead of the mineral being shipped from Shimoni, will now be shipped from the port of Mombasa. Essentially therefore, the new proposal is now to develop a material handling storage and ship loading facility at Likoni on the South bank of the Mombasa Creek within the Mombasa Harbour.

The civil works which will take place at the proposed site include erection of a boundary wall and a gate; the construction of internal roads and drainage, vehicle parking area and a retaining wall; and access road to the jetty. Miscellaneous construction activities include the demolition of existing buildings, putting up a gatehouse, a weighing bridge, office and a transformer house. This will be followed by the construction of a generator/switch room plus a store, a sheltered vehicle parking area and other weigh bridge civil works. A staff changing room, canteen, toilets and an Office/Administration block. Finally, four bulk storage Silos, two of the same size, and the other two of different sizes will be constructed. Three Truck Dumping Stations will be built, which involves excavations of land, blinding and backfilling. Formworks, concreting and reinforcements will be undertaken followed by the erection of structural steel and cladding. Four access stairwells will be built. Other infrastructures to be built include conveyor tunnels, comprising of four Discharge Hopper Structures and a Conveyor Tunnel for Ilmenite followed by three Discharge Hopper Structures and a Conveyor Tunnel for Rutile and Zircon. There will also be a Conveyor Tunnel to a jetty.

Marine works will involve site investigation and report writing; mobilisation and supply of tubular piles; the construction of an Access Jetty, a Main Jetty, Berthing Dolphins and Mooring Dolphins. Other works of service nature include electrical installation and water supply, which involves mains extension, construction of a 35,000 L underground Tank and a Pump, sinking of a well and installation of a pump; and the construction of two septic tanks and soak-pits. Finally, there will be a supply of needed miscellaneous Equipment. It is these activities that are being evaluated as guided by the Terms of Reference for the study of the Near-shore/Marine Environment:

1. Description of the habitats and ecosystem along the shoreline in the immediate vicinity of the site;
2. Description of the near-shore environment in the immediate area of the site;
3. Provision of an overview of the ecological integrity and conservation value of the marine environment at the location site;
4. A study of the currents dynamics for the area all year round to predict the risk of accidents related to bad weather, bearing in mind the frequency of ships, indicating how the currents may transport oil (in the case of oil spill) and affect the mangroves;
5. Identify and evaluate significant potential impacts that might result from the construction and shipping activities;
6. Identify potential impacts that might result any potential risks and resultant impacts related to oil spill, and the handling of waste material during the operation of the facility;
7. Evaluate the severity and significance of the impacts

2. Method

This study involved an environmental chemist, two marine biologists, and an environmental planner. The methods used in the study included field visits to observe and describe the physical and biological environment; a desk study for documented information about the area, followed by impacts identification and evaluation method where the method developed by CEES, South Africa was used. In this method, standard rating scales have been defined for assessing and quantifying the significance of identified impacts. This includes relationship of the impact to temporal scales; relationship of the impact to spatial scales; determining the severity of the impact using the severity/beneficial scale, which scientifically evaluates how severe negative impacts would be, or, how beneficial positive impacts would be on a particular affected system. The severity of impacts is evaluated first without mitigation and later with mitigation, which demonstrates how serious an impact is when nothing is done; the evaluation of the impact was determined based on the likelihood of impact occurring which differs between impacts. Thus, though some impacts may be severe when they occur, the likelihood of them occurring, affects their overall significance. In this method, each criterion was ranked with an assigned score to determine the overall significance of an activity. The criterion was then considered in the two categories of effect of the activity and likelihood of the impact. The total scores recorded for the effect and likelihood were then read off from a matrix to determine the overall significance of the impact.

3. Environmental Setting

3.1 Location of Site and General Features

The site proposed for the construction of the ship-loading facility for Tiomin is located at approximately latitude 4^{o}05S and longitude 39^o 40'E. It is part of the Kilindini harbour where about 2000 ships imports and export items are handled annually. Major exports include coffee, petroleum products, meat and meat products, hides and skins, pineapple and tea. Main imports include industrial and electricity machinery, crude petroleum, assembled motor vehicles and chassis, iron and steel, agricultural machinery and tractors, pharmaceuticals, fertilizers, textiles, mineral fuels, chemicals, food and live animals. The harbour has 10 deep water berths with 10 m draft and a total length of 3044 m; 2 bulk oil jetties and 1cased oil jetty; 5container berths with a total length of nearly 600m; 2 bulk cement berths with cement silos, each with 6000 tonnes capacity; 2 lighterage and 1explosives jetty.

The harbour mouth opens into the open sea, where huge tanker plying to various global destinations. Up to 50 ships are in these lanes at any given time with up to nine of them likely to be huge oil tankers. Inward, the harbour extends into the Port Reitz creek, which has extensive areas of mangrove trees, mud flats and banks (fig 1). The creek is characterised by varying depth, with upper zones being shallow. The channels fringing mangroves have depths below 5.0 meters. The perennial Rivers Mwache, Mambone, and Chasimba (Pembe) feed into the larger Port Reitz creek. The lower sections forming the Kilindini channel where the main harbour is situated have been dredged to deepen the channel to provide water depths ranging from 30 – 40 meters (Kamau, 2002)

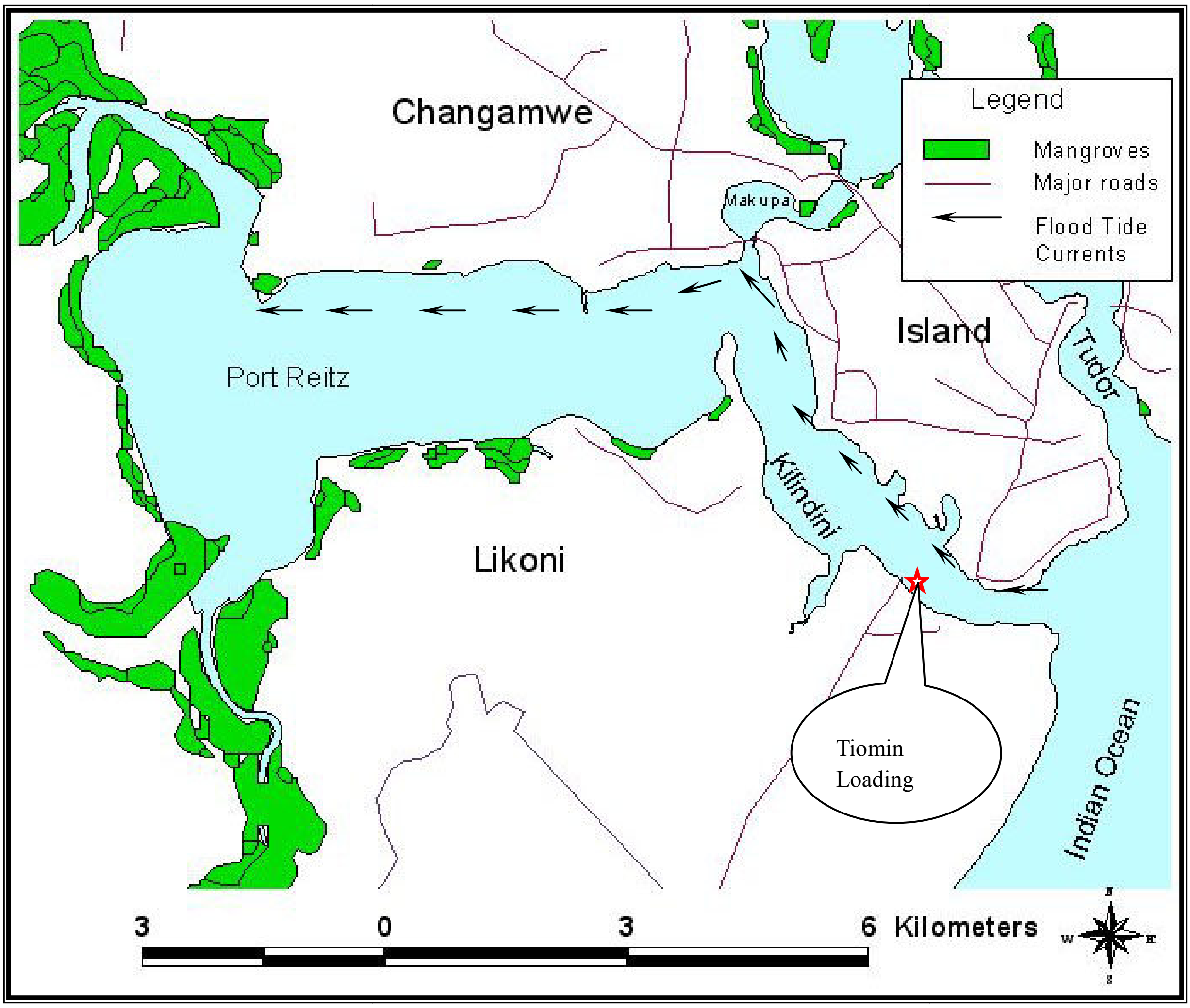


Fig.1: Map showing location of Kilindini Harbour and study area (modified from Kamau, 2001)

3.2 The Habitats and Eco-system along the shoreline in the immediate vicinity of the site

The proposed ship-loading facility site area encompasses five different zones. These are: the creek waters, the beach, inter-tidal zone, the rocky cliff and the south mainland. In the ***creek waters,*** typical zooplankton and hydrological features have been described by Okemwa (1992). Typical seawater temperature show a maximum temperature of 28.9^{o}C, running through the months of December to February, while minimum temperature 24^{o}C occurs in August. Maximum and minimum salinities of 36 and 30 *parts per thousand* (ppt) are obtained in February and June respectively. The planktonic organisms inhabiting the creek waters are mainly phytoplankton and zooplankton.

Of the zooplankton, the most dominant group are the copepods. Copepods are important organisms in the water because of the role they play as food for fish, larvae of prawns and other important crustaceans. They are also good indicators of fertility and pollution in the sea. About 100 species of copepods exist in the area, dominant families in order of abundance being Calanoida, Poecilstomatoida, Cylopoida, Harpacticoida, and Monstrilloida respectively. These groups of copepods are typical of tropical waters influenced by inland fresh water influx and oceanic water. The creeks offer nursery and feeding grounds for prawns' post-larvae and for fish (Groove et al, 1996).

The ***beach area*** is predominantly sandy. Dominant organisms in this area are Ghost crabs *Ocypode* spp (Ocipodidae). The ***inter-tidal zone*** is dominated by *Ulva* species of seaweeds mainly *U. retculata* and *U. fasciata* growing on a rocky substratum (Fig. 2a & b). The animals inhabiting the inter-tidal area are crabs and gastropod shells. The gastropod shells were identified to be mainly from family Littorinidae: *L. Scabra* (periwinkles); Muricidae: *Drupellella* spp (rock shells); Strombidae: *Strombus* spp (conch shells); and Potamidae: *Terebrallia palustris* (mangrove whelk). Some of these shells were dead and occupied by hermit crabs.


Fig. 2a

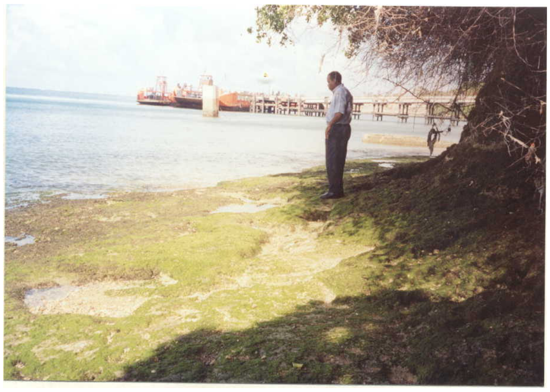


Fig. 2b

NB: *Ulva* spp of seaweeds growing on rocky substratum in the inter-tidal zone.

On the upper parts of the beach are ***rocky cliffs,*** which are made up of dead corals. On this coral rag various species of shrubs and trees grow. The lower part of the rocky cliff is dominated by coral crabs *Eriphia smithi* (Menippidae) and Grapsiid crabs (Grapsidae), which are embedded in the rock crevices. The lower parts of the cliffs have *Ulva* spp growing on them. On the cliff edge and mainland several species of trees and shrubs are found. They are denser at the cliff edge as compared to the proposed site. Some of the common trees identified on the Tiomin compound were Neem trees, *Azadiractita indica* (family: Meliaceae) and Mango trees *Mangifera indica* (family: Anacaridiaceae).

The ground layer beneath the trees and shrubs was dominated by a sedge species from family Cyperaceae that has a complex stoloniferous root system (Fig. 3a). Similarly a shrub from the family Rhamnaceae (*Colubrina ssp)* was found growing on the site (Fig.3b)


Fig: 3a. Sedge species Cyperaceae


Fig: 3b. Shrub species *Colubrina* spp (Rhamnaceae)

On the compound where the storage facilities are to be constructed we find the tree species on the Fig 4 below. These plants play an important role in preventing soil erosion from the land into the sea.

Fig 4a: Tree Species *Ficus sur*

Fig 4b: Tree species *Lannea schweinfurthii*

3.3 The near-shore environment and its use

The immediate area has extensive port facilities that handle merchant, oil, cargo and tourist ships (Fig.5a). At the mouth of the creek, the Kenya Ferry Services operate the Likoni ferry service that provides a link between the Mombasa Island and the South Coast mainland (Fig. 5b).

Figure 5a: Port facility

Fig: 5b Kenya Ferry Services

Various industries and offices are located directly opposite the proposed ship-loading facility site across the Likoni channel. These are the Bamburi Portland Cement silos, East African Molasses, the East African Storage (which deal with oil storage), Siginon freight go-downs and warehouses, Outrigger jetty and Wanainchi Marine Products among others (Fig.6).

Figure 6: Various industries and offices located on the northern side of the proposed

Adjacent to the proposed site (south mainland), are tourist restaurants, a hospital, many open-air markets, which sell vegetables, fish and residential houses. Towards the sea is a fish-landing site at the beach where fish are landed and sold to small-scale local traders who later sell them in the open-air market. Some form of artisanal fishing is undertaken using mizio traps near the site. Other businesses operating near the site are small-scale retail shops dealing with general groceries and hawking. On the south mainland after the ferry, are a very large *matatu* (mini-van taxi) terminus and a police booth.

3.4 Ecological integrity of the marine environment that could potentially be impacted by the facility

In looking at the ecological integrity and conservation value of the marine environment of the area, two categories of conservation concern need to be considered. One is *material,* the other is *spiritual*. From the material perspective, termed the "*conservation value",* the objective is to ensure sustainability of the economic resources of the area. The other, considered *spiritual,* includes the important, but less economically tangible values of species protection, biodiversity conservation and landscapes (Clark 1998). On this consideration, The area does not house any important ecosystem or habitat type; it cannot be cited as an important fishing area, nor are nursery ground for juvenile fish found within its vicinity; it is not an area of high species diversity; it cannot be described as a natural wonder; it does not provide a critical habitat for any particular species or group of species; it is not an area of any cultural significance; and its land use as already categorized is for port infrastructure development and therefore rightly designated as a commercial area. Based on this, it can be concluded that the habitat, ecosystems, species and communities of the area have very limited present or potential conservation value as attested by the results of the analysis of the five different zones defined in this study. This is supported by previous studies which presented a poor state of the environment:

Historical records show that the water quality in the area is already poor; rich in nutrients and contaminated with high concentrations of heavy metals. Mwangi et al., reported pollution by faecal matter; while Munga et al., (1993) reported pollution by oil, a problem reported much earlier by Norcosult, 1975).

The following pollution indicators were given for the Makupa Creek, (Mwangi et.al, 1995), which feeds into the Kilindini Harbour:

- High nutrients 0.2-36 mg/l subset nitrates, 0.1-7.7 mg/l subset reactive phosphate and indicator bacteria of 13-90,000 coliforms/100ml, 13-17,000 E-coli/100ml.
- No figures for hydrocarbon pollution were given in the 1993 study

Despite the high nutrient and bacterial loading, the area has shown some resilience with an abundance of copepods, an occurrence that shall be maintained even with the coming up of the proposed ship loading facility since the new facility will not handle any nutrient rich materials, neither will human wastes generated by the working force during its operations be discharged into the creek. The abundance of the copepods as an indicator of tolerable environmental quality can be explained by the complete mixing of the water of the creek due to the dominance of tidal currents and the rugged bottom topography (Odido 1987), where, contaminants, if any, are quickly diluted, spread and dispersed, rendering their accumulation and increases, impossible.

4.0 Hydrocarbon Pollution

Two recent studies on petroleum hydrocarbon pollution in the Makupa Creek have been carried out by the Kenya Marine and Fisheries Research Institute (Munga, 1995). In the first study carried out largely in 1995-6 both surficial and sub-surface, were taken for analysis to determine the presence of organic contaminants. A 20kg Wildco^{TM} gravity corer of 5m length was used for the sampling. The samples were taken from various points in the creek. Fearing that oil contamination could be transported to the proposed site, some samples were also collected from here. At this site, the bottom basement was found to be dominated by quartzo-feldspthic or carbonate sand sediments, into which gravity and piston corers, failed to penetrate. In the circumstance, samples of uppermost 5-10 cm of sediment were obtained using a Van-veen grab sampler of stainless steel construction. All sample cores were retained upright in sealed Perspex tubes during transport to the laboratory, and were sub-sampled at 2-5cm resolution on extrusion within 24 hours of collection. The samples were used for the determination of petroleum compounds by high pressure chromatography and gas chromatography. A hexane solvent was used for extraction in all instances. Emission peak spectra for n-alkanes in the range C11-C34, acquired by GC analysis of extracts for the surficial sediment from the site were determined and the following results showed that surface sediments contained high total n-alkane concentration of 15-25mg/kg, dominated by compounds in the range C_{13}-C_{17} (greater than 50% total). An additional peak at C_{20} from a sample taken from very close to the Tiomin proposed site of development was evident that the area has not suffered from any impacts of recent oil pollution as the site is somehow isolated. Similarly, while surficial sediment showed greatest enrichment in heavy n-alkane (n 32-34), the more deeply buried sediments, displayed dual peaks at n: 16

and n: 28-30. None of these signatures can be ascribed to petroleum derivatives, suggesting that crude oil spillage in the harbour during the late 1980s have no long-term sedimentary impact. The heavy alkane enrichment of recent sediments is, however, consistent with particulate or solute transport of organic waste products from the nearby Kibarani landfill.

In another study targeting saturated aliphatic hydrocarbons composed of mainly the normal alkanes from C-10 to C-34 to give an indication of petroleum pollution in the Makupa creek, KMFRI generated the resuts (see table1below).

Table: 1. Concentrations of saturated aliphatic hydrocarbons (totals of nC-10 to nC-34) and isoprenoid alkanes in Makupa creek surficial sediments.

Sampling Site	Date (Month/Yr)	Concentrations ($\mu g\ g^{-1}$ dry wt.)	Ratios Odd/Even	Pristane/Phytane
1	10/96	5.60	0.9	-
	12/96	11.21	0.6	-
	04/97	16.98	0.5	2.0
2	10/96	13.99	0.6	4.4
	12/96	7.30	0.8	-
	04/97	11.46	0.5	1.9
3	10/96	13.04	0.6	2.8
	12/96	17.28	0.6	8.2
	04/96	2.06	0.8	-

The historical studies indicated pollution of the Makupa creek sediments with hydrocarbons. Reported levels of petroleum hydrocarbons, both saturated and unsaturated, in harbour sediments ranged from 10 to 1000 $\mu g\ g^{-1}$ dry wt. From the results the following observations were made;

- The detected levels of n-alkanes with virtually no unresolved complex mixture of polycyclic aliphatic compound (UCM) suggest recent contamination from mostly refined petroleum hydrocarbons products rather crude oil. This is because biodegradation tends to remove the n-alkanes first followed by branched alkanes, usually leaving an apparently enhanced UCM signal.
- There was no pronounced preference of odd to even carbon chain alkanes, indicating that the source of contamination was mainly petroleum products.
- There was predominance of the isoprenoid pristane over phytane, indicating a certain degree of biogenic input of hydrocarbons.

These results gave an indication of the chronic contamination of the Makupa creek with petroleum hydrocarbons is attributable to primarily shipping activities in the harbour. A quick analysis of the above results showed that while sediments in most areas around the creek were heavily impacted by hydrocarbons, the proposed site of development was not so much affected. This is probably due to the influence of prevailing currents.

As for the beach and inter-tidal zones, none of its habitats can be described as critical. The beach, which is predominantly composed of sand, will be maintained in its present condition, so is the inter-tidal area colonized by crabs as the main faunal component, gastropod shells and sea weeds. The shrubs and trees found in the upper part of the beach and on the cliff edge can be lost without significant economic or conservation loss.

4.1 Annual Currents Pattern, prediction of risks of accidents related to bad weather and how the currents may transport oil in the case of oil spill

The area experiences mixed semi-diurnal tides with a mean spring amplitude of 3.2m and a neap of 1.1 m (Brakel, 1982). The NE monsoon winds blow from November-March and the SE monsoon winds blow from April-October. The precise timing and the extent of each season vary from year to year (Groove *et al*, 1986). The SE monsoons are characterised by high cloud cover, rain and wind energy, decreased temperatures and light. This is in contrast to the NE monsoon where the variables are reversed (Mc Clannahan, 1988). Norconsult (1975) carried out an intensive investigation of the tidal currents and water circulation in the Kilindini and Port Reitz creek, mainly focusing on the main port area from the entrance to the Kipevu Oil Terminal (KOT) primarily to evaluate the suitability of a wastewater discharge point for the Municipal sewage treatment works at Kipevu. The findings of this report revealed that water circulation dynamics in the Kilindini creek are strongly influenced by the tides with the strength resultant tidal currents subject to the curved channels and uneven bottom topography. Strong tidal currents were reported to occur along the breaks in the reef and at the opening of the creek.

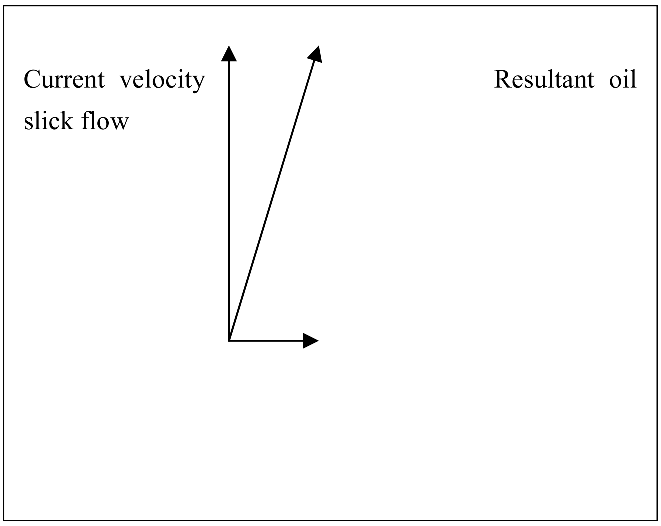
It also recognised that the wider upriver parts of Port Reitz creek accumulate large volumes of water resulting in strong currents during ebb tide and flooding tides. This phenomenon ensures efficient mixing and exchange of water in the creek. Norconsult (1975) indicated that almost complete exchange of the water in the narrow channel in the Kilindini creek occurred during a tidal cycle. This observation may not hold true when the wider Port Reitz creek is considered. An indication of the residence time in the Kilindini/Port Reitz creek system can be obtained by comparing it with the Tudor creek system. Nguli (1994) estimated the residence time of the water in the Tudor creek to be in the order of 2 weeks.

The Norconsult findings reported current speeds ranging from 0.3 to 1.9 m s^{-1}., and demonstrated that during flooding tide, the currents flow along the middle channel and hug the eastern banks of the Kilindini creek and enter the Port Reitz creek along the northern bank. During ebb tide the currents closely hug the eastern side of the Kilindini creek.

Thus, in the event of an oil spill at or near the proposed Tiomin loading facility, the tidal currents will greatly influence the direction of the flow and spread of the slick. However, the resultant direction and speed of the flow of the oil slick is a function of the velocities of the tidal current and prevailing surface winds.

In the event of an oil spill from the harbour, during the SE monsoon period (April-October), the expected direction of flow will be northwards. However if the spill occurred during the NE monsoon season, the direction of the spill will be southwards and inwards towards the harbour (eastwards).

In general therefore, the direction and speed of flow of an oil slick can be approximated by the current flow and taking into account the contribution of the wind speed (3 %) and direction (Fig.7). Thus, while the movement of an oil slick in the Kilindini creek will primarily be determined by the strength and direction of the current, the surface winds will contribute a small north-westerly to westerly component depending on the seasonal winds and the sea-land breeze.



During the SE Monsoon the wind will contribute a small northerly to north-easterly component. The effect is that an oil spill will impact the eastern and northern banks of the Kilindini and Port Reitz creeks, respectively, and the Mwache estuary. During ebb tide there is a reversal of the current, with the outgoing current still hugging the northern banks of Port Reitz and eastern banks of Kilindini creeks. Indications are that an oil slick will be transported through the narrow entrance to the Kilindini harbour, and with the help of the North to North-East blowing coastal winds, may spread into the mouth of the Tudor creek and northwards to the Mombasa Marine Park and Reserve.

During the NE Monsoon, the relatively weaker coastal winds will allow the stronger sea-land breeze to influence the flow direction and speed of the oil slick, particularly during the afternoon. An oil slick will most likely impact the eastern side of Kilindini creek and the shores of Port Reitz. The Current pattern during flood tide along Kilindini and Port Reitz creeks is shown in the Map below (Fig. 1) indicating where an oil spill would end if it occurred at the harbour at the given time.

5 Construction and Operational impacts

5.1 Impacts during Construction

This section presents both short-term and long term impacts. Removal of vegetation cover and excavations will expose soils to wind and water erosion. This is a severe impact which will lead to increased siltation in the marine environment in the immediate vicinity of the site. However, being a short-term, and temporary activity, its overall impact is insignificant. Noise levels will also increase, but the increase is typical of those generated by earth moving equipment, ranging from 70-90 dB (A). This noise level constitutes an occupational hazard, and a nuisance to neighbours. Being short-lived, its overall significance is low. Vibrations and movement of materials will impact on the inter-tidal crabs and gastropods, making them suffer short term shocks and may relocate to other areas before coming back. Debris from excavation may litter the sandy beach with coral pebbles of varying sizes, affecting smoothness and uniformity of the beach sands by introducing variations in particle sizes. This change could be long term, and therefore significant. Construction will also result in the emission of various air pollutants characteristic of the usage of gasoline and diesel as fuel oil. Anticipated air pollutants include Nitrogen Oxides, Hydrocarbons, Carbon Monoxide, Sulphur Dioxide and particulate matter. Vehicular traffic may also contribute to fugitive dust. These impacts though severe, are short-term and therefore insignificant. Long –term impacts include change in landscape, which shifts from a natural to a built-up commercial environment. This change is acceptable in a commercial environment. Excavations may expose the underlying coral rock basement to surface water infiltration, making groundwater vulnerable to contamination. This impact may be severe. However, located on the edge of the ocean, the groundwater is saline, rendering the impact insignificant. The jetty for loading heavy sands mineral products through conveyors to waiting ships which will be built is the pier type. This type of jetty does not interfere with circulation pattern of the water and as such results into an insignificant impact on the marine environment.

5.2 Impacts arising from Operational Activities

During the operational phase of the facility, the main sources of impact may arise from ballast water and potential oil spills. Ballast water may contain oily water and invasive species. The impact of oil in water depends on type and dynamics of the ocean. Since we are talking of fuel oil, this may persist in water for a long time and its impact may be regional and undesirable. With containment measures in place, this impact can be reduced to one of moderate but insignificant in the type of environment being analyzed. Invasive species may interfere with the eco-system functions of native species, constituting a long term impact. Dealing with invasive species from Ballast water is unclear in this part of the region, where mapping of the port for native species has just began. Invasive species can be catastrophic and pose very significant impact when ballast water is discharged. Such discharges must not be allowed.

Incidences related to oil spills during the operational phase of the project are real and cannot be wished away. They may arise from accidental discharges (during on, or off-loading operations); operational discharges (e.g. washing tanks, dirty ballast or machinery space); and marine accidents (grounding, collision). The impacts of spilled oil are considered in terms of the degree to which the natural environment is altered. This in turn depends in a number of factors among which are the nature of the oil (type, volume, and persistence), time of spill, clean-up effectiveness and its impacts, shore zone processes and man's activities. Oil that resides in the shore zone for long time periods will have greater impact than oil that is rapidly dispersed by natural processes. At the project site, operational or accidental oil spills may not be important and therefore insignificant. However, any major oil spill will be of concern, acknowledging the importance of the Kenya coast.

6. Summary of Findings, Conclusions and Recommendations

The proposed ship-loading site is part of the overall Kilindini Harbour. The site is already exposed to industrial and shipping activities as its designated land use is commercial. Construction of the proposed ship-loading facility and its follow-up operational activities may therefore not have any significant impacts to worsen the already existing situation. Located is a sheltered area, the Kilindini Harbour has experienced very few shipping accidents related to current patterns or weather changes. Also due to the good natural depth of the channel, propeller wash during manoeuvring and docking will have no impact on the bottom environment. The study has also found that there will be no impact on the water column at the site due to spillage of the minerals being handled. Composed of heavy sands, any mineral spillage will quickly settle to the bottom to be assimilated. Regarding potential oil spills, the study has found that the impacts that could arise from them are low. The bunkering of the ships at the site could be a potential cause of accidental spills and therefore pollute the marine environment. However, the study has found that bunkering of ships is a port activity and can be dealt with, making such type of impact insignificant. The wind and current regime is predictably known, the direction of oil flow in case of an accident can therefore be easily determined and effective mechanisms put in place to protect existing resources as such this impact is insignificant. The management of ballast water is an emerging subject of international importance and the shipping fraternity has regulations to manage this. The study has also found that no significant changes to the water quality would occur both during the construction and operational phases of the project. Also while the construction may expose the area to erosion, accelerated run-off, and possibly siltation into to the marine environment, the impacts are insignificant as they would disappear immediately the construction work is over. Operational activities are also manageable and mitigation measures can adequately address this. The study has also found that there will be no impact on the water column at the site due to spillage of the minerals being handled. Composed of heavy sands, any mineral spillage will quickly settle to the bottom to be assimilated and become part of the geology of the area without any impacts.

From the findings, it is concluded that the site is already exposed to industrial and shipping activities. The construction of the proposed ship-loading facility and its follow-up operational activities may therefore not have any SIGNIFICANT impacts to worsen the already existing situation. Consequently, it is recommended that the construction works should commence, but, guided by standard procedures and good practises. The management of operational impacts should be sourced out to the Kenya Ports Authority as a as a merchant port, as its management has adequate facilities and experience to deal with such impacts. The problem associated with ballast water discharges is one of international concern and the shipping fraternity is well sensitized about it. As such, this should be addressed within international protocol. Finally, since the project will deprive local fishermen of their landing site, effort should be made to relocate the local fishermen to another nearby site.

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