KURRENT TECHNOLOGIES LIMITED

BASELINE SEDIMENT & WATER QUALITY DATA FOR

LAMU COAL POWER PLANT- 2015

BASELINE WATER AND SEDIMENTS QUALITY ASSESSMENT REPORT FOR LAMU COAL PLANT.

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Prepared for: Kurrent Technologies Ltd

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Project Title	***BASELINE WATER & SEDIMENT QUALITY SURVEY FOR THE UPCOMING LAMU COAL POWER PLANT***
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PROJECT QA/QC

Rev.	*Date*	*Prepared*	*Reviewed*	*Approved*
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This baseline data collection report has been carried out to the best of our knowledge and ability and within the terms of contract with the client and is limited to the exercise of reasonable care. This report is not intended to relieve the Establishment from their contractual obligations. This report reflects our findings at the time and place of intervention and is issued under the General Conditions of Service.

SGS

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ABBREVIATIONS

KTL	*Kurrent Technologies Limited*
USEPA	*United States Environment Protection Agency*
ANZECC	*Australian and New Zealand Environmental Council*
NEMA	*National Environmental Management Authority- Kenya*
EMCA	*Environmental Management Co-Ordination Act- Kenya*
SOP	*Standard Operating Procedure*
ISO	*International Standard Organization*
GPS	*Global Positioning System*
ERL	*Effects Range- Low*
ERM	*Effects Range- Median*
TEL	*Threshold Effects Level*
PEL	*Probable Effects Level*
BOD	*Biological Oxygen Demand*
TPH	*Total Petroleum Hydrocarbons*
PCB's	*Polychlorinated Biphenyls*

1. MARINE WATER & SEDIMENTS

Overview.

In compliance to the Kenyan Environmental (Impact Assessment & Audit) Regulation 2003, Kurrent Techologies Limited contracted SGS (K) Ltd to undertake quality assessment of the sediment and water for the immediate Lamu Coal Power Plant project. This report provides information on the environmental conditions (soil and water) within the project area that the project may change.

Environmental values are described for the potentially impacted area in accordance with the environmental legislation and associated statutory instruments, including the requirements of the Kenya Environmental (Impact Assessment & Audit) Regulations 2003 and EMCA 2003.

Baseline information on sediments/ soils and water within the vicinity of the project area have been summarized as per SGS Kenya analysis report numbers MA15-00219.001- 013 and MA15-00219.001-007 respectively.

Numerical water quality modelling (based on the analysis results) was undertaken to inform the discussion of potential impacts of the project on water quality in the project area and to assess the subsequent potential impacts on drinking water sources, seagrass, mangroves and benthic habitats.

Monitoring and mitigation measures for the construction and opeartional phases of the project are recommended based on the assessment of potential impacts.

2. Description of ASSESSMENT AREAS AND POLLUTANT Sources

The area under survey for the project is mainly agricultural with special domestic occupancy and borders the Indian Ocean.

2.1 Soil/ Sediment sampling points

A total of seven sampling points were considered for soil study; four within the project area and seven around the project site. The sampling points were marked by a GPS and indicate as per below:

Table 1: soil monitoring/sampling locations

SAMPLING POINT	POINT COORDINATE		Site description.
	Latitudes	Longitudes	
SAMPLING POINT 1- **KWASASI NEAR BEACON 1**	-2.0857	40.907133	*This is the proposed site area and its soil data will be of importance to evaluate the direct impacts the project may have on the sediment/soil of the area*
SAMPLING POINT 2- **KWASASI NEAR BEACON 2**			

SAMPLING POINT 3- **KWASASI NEAR BEACON 4**	-2.09475	40.907116	
SAMPLING POINT 4- **KWASASI- MID OF THE PROJECT SITE AREA**	-2.086174	40.914954	
SAMPLING POINT 4- **NDUNUNI**	-1.98125	40.845766	*This is a community village and its baseline data will assist in assessing future impacts of the activities from the plant*
SAMPLING POINT 5**-PATE ISLAND**	-2.143195	40.996488	*This is a community village with archaeological history and its baseline data will assist in assessing future impacts of the activities from the plant*
SAMPLING POINT 6- **MBELEMBELE WETLAND**	-2.172364	40.828983	*The wetland was witnessed as a water habitat for wild animals*

The major sources of the pollutants on site agricultural (fertilizer), domestic discharges and wild animals.

2.2 Water sampling points

A total of thirteen sampling points were considered for soil study; four within the project area and seven around the project site. The sampling points were marked by a GPS and indicate as per below:

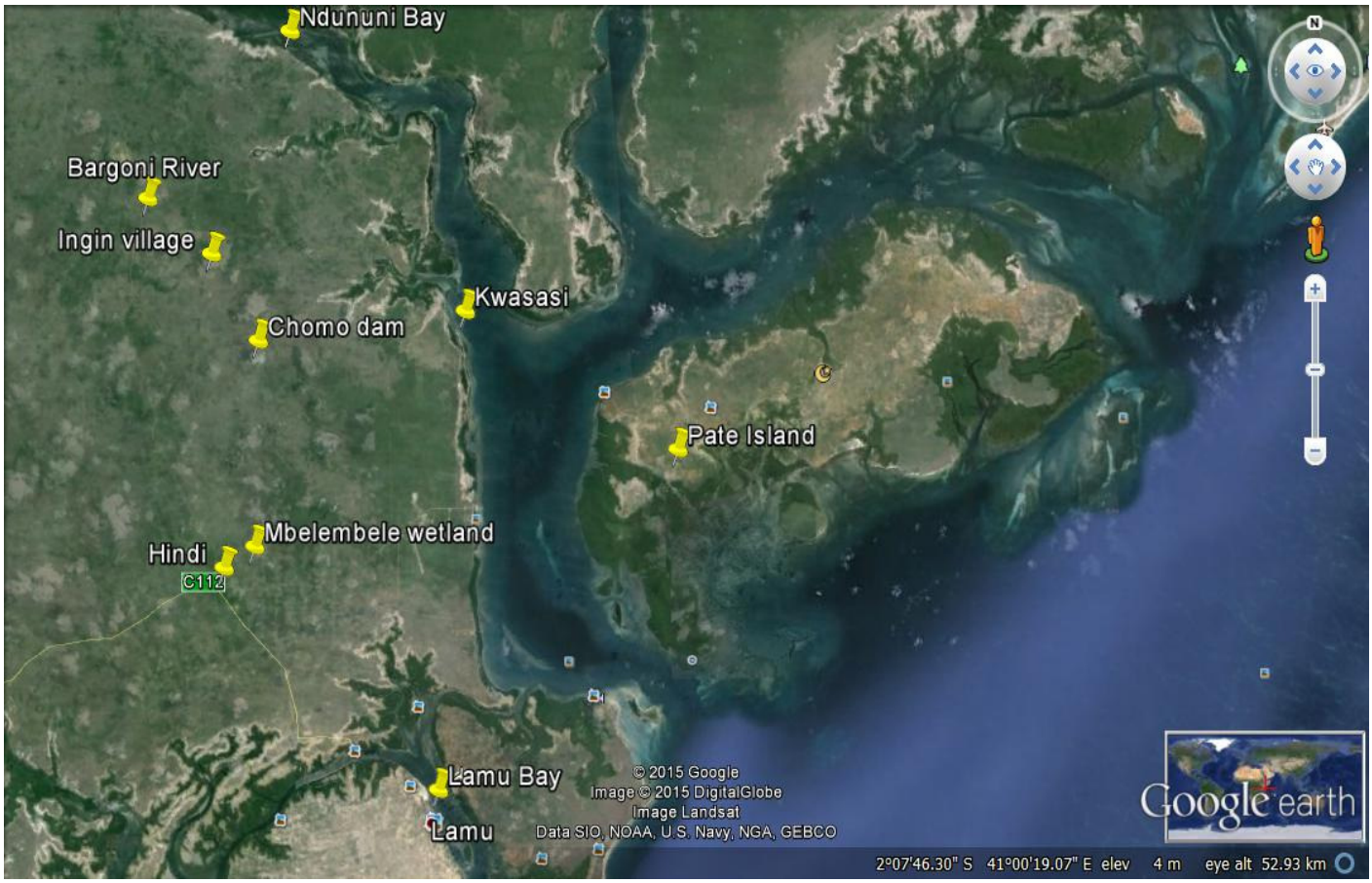
Table 2: Water data monitoring locations

SAMPLING POINT	POINT COORDINATE		Site description.
	Latitudes	Longitudes	
SAMPLING POINT 1- **NDUNUNI BAY**	-1.98125	40.845766	*This is a community village and its baseline data will assist in assessing future impacts of the activities from the plant*
SAMPLING POINT 2- **BARGONI RIVER**	-2.04256	40.78765	*This is a community village and its baseline data will assist in assessing future impacts of the activities from the plant*
SAMPLING POINT 3- **PATE ISLAND**	-2.13872	40.99983	*This is an Island in the Lamu Archipelago and lies between Lamu and Kiunga and is highly inhabited by residential with farming and fishing as the major source of income*
SAMPLING POINT 4- **MANDA BAY**	-2.11059	40.95480	*This is an Island of the Lamu Archipelago of Kenya. The island is linked by boat to the plant area. Maize, simsim and cassava farming is undertaken by the locals*

SAMPLING POINT 5- **HINDI BOREHOLE**	-2.18010	40.81651	*This is a small trading centre along Lamu- Kiunga road approximately 30 km from Lamu Island. This is largely a commercial centre.*
SAMPLING POINT **6**- **CHOMO DAM**	-2.096026	40.83148	*This is a community dam that is used for providing water to the locals*
SAMPLING POINT 7**- MBELEMBELE WETLAND**	-2.172364	40.828983	*The wetland was witnessed as a water habitat for wild animals*
SAMPLING POINT 8**- MBELEMBELE BOREHOLE**	-2.17684	40.82511	*Mbelembele is a settlement village to the North of the project area and is inhabited by farmers and fishermen*
SAMPLING POINT **9- INGIN VILLAGE**	-2.06351	40.81308	*This is a village approximately 5 km North of Lamu town. This village is inhabited by farmers and fishermen*
SAMPLING POINT 10**- MANDA BAY**	-2.10814	40.943418	*This is an Island of the Lamu Archipelago of Kenya. The island is linked by boat to the plant area*
SAMPLING POINT 11**- LAMU BAY**	-2.26372	40.90167	*This is also part of Lamu Archipelago of Kenya. It is one of the oldest and best preserved Swahili settlements in East Africa. The Island is linked by boat to the plant area*

The major sources of the pollutants on site agricultural (fertilizer), domestic discharges and wild animals.

Figure 1: Aerial View of the sampling points



3. Description of Environmental Values

3.1.2 Environmental Values

The environmental values of Lamu Coal plant project area can determined by the existing beneficial uses of the area including conservation, human, spiritual and cultural significance.

During site assessment, various water types within the project area have been identified. The project area is located in Kwasasi, Northeastern Coastal mainland off Hindi- Kiunga Road and the relevant water type is inshore marine water, rain water and domestic (borehole) water.

Environmental values of Lamu area can be categorized as follows

1. **Cultural and spiritual values** – the water have anthropological, archaelogical, historic, sacred or scientific significance or value
2. **Primary recreational use**- diving, swimming, surfing, water skiing and wind surfing
3. **Secondary recreational use**-fishing and boating
4. **Visual recreational use**-viewing the water without contact

These environmental values and applicable water quality Guidelines for the water bodies within the project area are summarized in table 3 below.

Table 3: Environmental Values and applicable water guidelines within the project area

Environmental Values	Management Goal	Applicable Guidelines
Human Consumer	Food grown and or caught in the environment meets human consumption guidelines as provided in FDFA	ANZECC 2000
Wild animals	Water and vegetation in the environment is fit for wild animals consumption	-
Modified aquatic ecosystems	Maintain biological integrity of systems where the water quality is not pure and is slightly to moderately disturbed ecosystem	ANZECC 2000
Wetland	Meet guidelines where possible or not to deteriorate water quality values	ANZECC 2000
Fishing	Protect environment for fishing purposes. Meet guidelines where possible or not deteriorate water quality	ANZECC 2000
Nursery habitat	Protect habitat for fish nursery purposes. Meet guidelines where possible or not deteriorate water quality values	ANZECC 2000
Habitat for Native plants	Protect native for habitat plants like mangroves. Meet guidelines where possible or not deteriorate water quallity values	ANZECC 2000
Habitat for native and migratory animals	Protect native for habitat native and migratory animals. Meet guidelines where possible or not deteriorate water quallity values	ANZECC 2000
Indigeneous traditional owner cultural resources	Protect and restoreindigeneous and non-indigeneous cultural heritage consstent with relevant policies	-

2.1.3 Water quality

Regional indicator values as per EMCA which indicates that if exceeded, would indicate a potential environmental problem and so trigger a management response including further investigation. This regulation provides for the sustainable management of water used for various purposes in Kenya. The regulation contains discharge limits for various environmental parameters into public sewers and the environment. The table below indicates the maximum discharge limits of various environmental quality parameters as applies to this project.

Table 4: Guidelines for Physicochemical, metals and microbiological indicators at the project vicinity

Parameter	EMCA regulations for discharge to environment- 3RD schedule
pH	6.5- 8.5
Total suspended solids	30 max
Total dissolved solids	1200 max
Fluorides	1.5 max
Residual chlorine	0.1 max
Oil & greases	Nil
Total Nitrogen	2 max
Total Cyanide	Nil
Phosphate in water	-

Chemical Oxygen Demand	50 max
Total phenols	0.001 max
Biological Oxygen Demand	30 max
Sulphates	0.1 max
Salinity	-
Arsenic	0.02 max
Cadmium	0.01 max
Chromium	2 max
Copper	1 max
Iron	-
Nickel	0.3 max
Selenium	0.01 max
Zinc	0.5 max
Total phosphorus	-
Total coliform count	-
Ecoli	Nil
Permanganet index	-

Anionic Surfactants as MBAS	-

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Water Quality Monitoring

Baseline water quality was therefore collected from domestic water sources, the ocean and water collection points for wild animals for laboratory analysis. Samples were collected for analysis from a total of fifteen sampling locations. Insitu water quality measurements for temperature and pH was undertaken on site during sampling. The analysis results were compared to the Kenyan EMCA standards for discharge to the environment and the ANZECC 2000 guidelines.

Table 5: summary of water quality results as per Analysis report nos. MA15-00222.001- MA15-00222.013 attached.

	Ndunduni bay	Bargoni river	Pate Island borehole	Manda Bay borehole	Hindi borehole	Mbele Mbele Wetland	Mbele Mbele borehole	Chomo dam	Engin wetland	Manda bay 1	Manda bay 2	Manda Bay 3	Lamu Bay
pH	6.6	6.68	7.20	6.1	7.37	6.98	7.6	6.93	7.22	7.75	7.36	7.67	7.62
Total suspended solids	2	6	5	2	2	2	2	4	2	2	2	2	5
Total dissolved solids	***31,860****	133	***4,512****	***30,660****	***1036.8****	***31,860****	468	67.20	***30,360***	***31,560***	***31,680***	***30,600***	***32,886***
Fluorides	***1.77****	0.55	0.96	***1.93****	0.41	***1.77****	0.21	0.10	***1.77****	***2.54****	***1.52****	***1.70****	1.50
Residual chlorine	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Oil & greases	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total Nitrogen	***5.80****	***0.9***	***64.84****	***0.88***	***38.74****	***5.80****	***45.66****	***9.28****	***3.80****	***4.42****	***4.70****	***1.46***	***133.63***
Total Cyanide	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Phosphate in water	0.90	0.20	0.90	0.90	0.10	0.90	0.30	Nil	Nil	1.10	0.30	0.30	0.10
Chemical Oxygen Demand	***1876****	***577****	***225****	***1204****	***659****	***647****	***452****	***1176****	***2058****	***1526****	***975****	***475****	***596****
Total phenols	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Biological Oxygen Demand	***1038****	***320****	***125****	***669****	***366****	***356****	***235****	***528****	***1022****	***704****	***483****	***250****	***351****
Sulphides	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Salinity	34.7	1.2	4.1	33	1.8	1.3	1.5	0.9	31.8	34.1	34.1	32.7	35.3
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Chromium	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Copper	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Iron	<0.007	1.02	<0.007	<0.007	<0.007	12.57	<0.007	2.92	<0.007	<0.007	<0.007	<0.007	0.34
Nickel	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.002	0.02	<0.002	<0.002	0.01	<0.002	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total phosphorus	0.02	0.27	0.63	0.14	0.26	12.23	0.07	0.17	0.02	0.13	0.05	0.08	0.18
Total coliform count	23	ND	110	23	240	>1800	79	240	8	11	23	22	>1800
Ecoli	***8****	ND	***8****	ND	***13****	***>1800****	***23****	***14****	ND	ND	***2****	***2****	***>1800***

Permanganet index	Nil	Nil	1.96	Nil	0.16	Nil	1.57	4.81	0.49	Nil	Nil	Nil	Nil
Anionic Surfactants as MBAS	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

*the yellow highlights have exceeded the limits as per EMCA 3rd schedule.

Most of the insitu water quality parameter taken at the surface of the water column were relatively stable with the exception of Total dissolved solids, which tended to be higher near the ocean.

- pH was generally representative of coastal water bodies i.e. acidic range due to traces of salt
- suspended solids in all the sampling points were minimal/ and below the acceptable guidelines
- Most of the metals could not meet the adopted detection limits. However, Total Nitrogen, Flourides and Arsenic exceeded the acceptable guidelines
- Biological Oxygen Demand and Chemical Oxygen Demand exceeded the specifications as per the 3rd schedule.
- Microbiological status of the water is relatively stable except at the Lamu bay and Mbelembele wetland. The former is used as a discharge point for Lamu Island raw effluent while the former is a grazing a water habitat for wild animals hence high coliform status.

2.1.4 Sediment quality

This section discusses the sediment/ & soil characteristics of Kwasasi and the likely characteristics of both the sediments that will be disturbed by the construction and operation of the project.

The recommended guidelines were proposed on the basis that they could be implemented in the near term, using existing data. The screening level values are considered to be tentative and two levels are normally considered which includes:

- Low level- which is the lowest that toxic effects become apparent
- Severe level- representing concentrations which could effectively eliminate most of the benthic organisms. .

During site survey, a total of seven soil samples were taken from the site and the areas sorrounding the proposed site area. All the samples were analysed for metals, nutrients and PAH at SGS laboratory.

All results for which guidelineThe results as per analysis report numbers MA15-00219.001- 007 reveals

- Elevated levels of Iron – which is representative of the coastal soils which are salty
- Mercury levels were below the detection limit- note that coal burning is a key source of methylmercury in the environment
- Traces of TPH were detected in the soil samples though below the ANZECC guidelines

The table below presents the ERL, ERM, and TEL & PEL for the parameter that applies to this project.

Table 6: Guidelines for Sediment quality at the project vicinity

PARAMETER	***GUIDELINES (mg/kg)***			
	ERL	***ERM***	***TEL***	***PEL***
Arsenic	8.2	70	7.24	41.6
Cadmium	1.2	9.6	10.0	0.68
Chromium	81.0	370.0	52.3	160.0
Lead	46.7	218	30.2	112.0
TPH	-		-	

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Table 7: summary of sediment quality results as per analysis report nos. MA15-00219.001- MA15-00219.007 attached

	Site area- Kwasasi- near beacon 1	Site area- Kwasasi- near beacon 2	Site area- Kwasasi- near beacon 4	Ndununi bay	Pate Island	Mbele Mbele Wetland	Site area- Kwasasi (mid of the project area)
Total Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TPH C6-C44	0.91	5.72	8.33	4.64	3.37	<0.01	5.76
TPH C10-C16	17.18	12.13	11.20	8.11	6.13	12.76	8.18
TPH C16-C22	0.02	0.40	0.95	<0.01	<0.01	<0.01	0.24
pH	7.46	7.44	7.54	7.94	7.75	7.86	7.75
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium	1.83	2.39	1.32	2.78	2.44	2.60	1.92
Chromium	3.35	4.41	6.15	5.05	7.81	13.41	5.23
Copper	3.70	2.26	4.03	1.63	2.82	11.34	2.26
Iron	982.90	1,219	1,856.93	2,364.14	3,666.46	3,386.82	3,084.59
Nickel	<0.02	0.60	2.41	4.29	<0.02	<0.02	2.12

Lead	4.21	5.07	7.95	6.69	13.72	13.82	13.69
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	14.91	7.80	9.85	8.28	8.41	15.08	7.56
Mercury	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total phenols	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

The results of the study were as follows:-

- Traces of petroleum hydrocarbons were detected in all the sampling sites
- The concentration of metals detected were below the Medium Effect Range (ERM)

The results are therefore complient to the ANZECC 2000 specifications and are representative of the sediments within the proposed site are and its sorrounding.

2.1 Potential Impacts and Mitigation Measures

This section outlines the potential impacts of the construction and operation of the Lamu Coal power plant and propose measures to mitigate and monitor these impacts. For the purpose of this impact assessment, the following activities were cosidered to fall within construction and operation:

- Construction
  - ✓ Construction of the boundary walls
  - ✓ Dreding and placement of the plant within the site
- Operation
  - ✓ Runoff/ discharge of stormwater from the plant

2.1.1 Impacts of construction on the water quality

Construction of the boundary wall will involve placement of core material and rock into the boundary wall sorrounding the project. The project area is adjacent to the ocean and therefore the construction will result in the generation of visible turbid plume which may reduce penetration of light over the adjacent seagrass beds.

There will be an increased risk of remobilization of the mud wave during elevated wave conditions. There will further be the potential for the waves to erode core material during storm conditions that may arise in the course of construction.

There is the potential for spillages of oils and fuels from construction equipment to impact on both water and sediment quality

2.1.2 Monitoring and Mitigation Measures

Generation of turbid plumes during construction will be visually monitored and photographed on daily basis. If it becomes apparent that the plumes are visible above the natural background turbidity, a specicialist will be consulted about the need to deploy a silt curtain to minimize the migration of the plume.

No refuelling or maintenance of construction equipment will occur hapharzardly on the site; refueling and maintenance will be done at common place i.e. garage reducing the potential for significant spills and fuels to occur. All construction materials shall undergo regular maintenance and pre-start inspections will be undertaken on a daily basis to identify any leaks.

Spill kits for land and water based spills will be present on the site and personnel trained in their use. Emergency response procedures will be established

2.1.3 Impacts of stormwater and catchment runoff

Following the construction exercise, there is the potential for sediments to be entrained in the stormwater runoff and released to the water bodies. Though the runoff water is unlikely to be contaminated with nutrients, organics, hydrocarbons or metals, it is noted that it will flow through some agricultaral fields and water bodies and hence the need to address the quality of the storm water

RECOMMENDATIONS

Continuous future assessments on water and sediment quality are highly recommended within the construction phases of the project and when the project has finally been commissioned. These assessments shall validate the effectiveness of the proposed mitigation measures.

……END OF REPORT