"Engineering the Built Environment"

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT REPORT

CONSTRUCTION OF A NEW MAIN SEWERAGE PUMP STATION AND RISING MAIN IN KUISEBMOND, WALVIS BAY

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ABBREVIATIONS:

- AADD average annual daily demand
- ADF average dry weather flow
- AMS Aerial Mapping Solutions
- CMP Construction Management Plan
- DCI Ductile Cast Iron
- DN nominal diameter

- EIA Environmental Impact Assessment
- EMP Environmental Management Plan
- GRP Glass Reinforced Plastic
- HDPE High Density Polyethylene
- ID internal diameter
- kl/d kiloliters per day
- KPS Kuisebmond Pump Station
- l/s litres per second
- m^2 meters square
- m^3/d cubic meter per day
- m^3/h cubic meter per hour
- Ml/d mega litres per day
- mm millimetre
- Mm^3/a million cubic meters per annum
- m/s meters per second
- MWB Municipality of Walvis Bay
- NCEL Namibian Civil Engineering Laboratory
- O&M operations and maintenance
- PDD peak day demand
- PDWF peak dry weather flow
- PHD peak hour demand
- PRV pressure reducing valve
- PWWF peak wet weather flow
- TOR erms of Reference
- uPVC unplasticized poly vinyl chloride
- WWTW wastewater treatment works

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EXECUTIVE SUMMARY

Walvis Bay is situated in Erongo Region along the western coast of Namibia, about 30km from Swakopmund (a local holiday town) and 400 km west of Windhoek. The Municipality of Walvis Bay is categorized as a Class 1 Local Authority (City) and is home of the five (5) towns situated on the 1,572 km Namibian coastline.

Walvis Bay, better known as the Port City, is the second largest urban settlement in Namibia after Windhoek, the Capital City. The town area covers an area of approximately 1124km² in extent and Its population was estimated to be around 80 000 people by the year 2010 (NSA), however, it is now assumed to have at least over 100 000 inhabitants.

Walvis Bay is also earmarked to be the leading industrial town in Namibia due to its strategic location and transportation networks. Some of Namibia's biggest national projects such as the coal power station, the harbour expansion, dry docking ports, oil refinery, water distillation plants, aqua-cultural activities etc. are situated within the town area of Walvis Bay.

Due to the high growth rate of the town, about 4 to 5% per annum, because of employment opportunities and high population growth rate of about 3.6% per annum, provision of Bulk Municipal Infrastructure has been a biggest challenge to the Municipality of Walvis Bay. Kuisebmond is one of the old and built-up townships of Walvis Bay, named after the Kuiseb River and most residents of Walvis Bay live in the area.

The current bulk sewer network in the Kuisebmond area consists of a gravity sewer reticulation network and various sewer pump stations and rising main infrastructures. The population in the town of Walvis Bay has increased rapidly during the past years due to the influx of people seeking employment and other socio-economic benefits in the mining and tourism industries. As a result, a solution to meet the significant increase in water demand has been proposed.

. The existing Kuisebmond pump station infrastructure was built in 1986 and is old and is in the process of decaying at such a rapid rate that continuous replacement of infrastructure is on-going. The Pump Station was built in 1986 and has now reached the end of its lifespan. Hence, a new Sewer Pumping Station (hereinafter referred to as "KPS") and rising main was proposed to construct to replace the existing infrastructure as it reached the end of its lifespan. The proposed development and related infrastructure is one such intervention that would realistically support acceleration of MDG 1, (as well as the Harambee Prosperity Plan, Presidential Infrastructure Initiative).

The development and its related infrastructure is one of the activities that require an Environmental Clearance Certificate (ECC) before any development like construction is undertaken, as promulgated under the Environmental Management Act 7 of 2007 and its regulations.

CHAPTER 1

1. Project Objective/s

The existing Kuisebmond sewer pump station was built in 1986 serves part of the Kuisebmond area and the current flow rate is estimated to be in the range of 2400m^3/day. The Kuisebmond pump station has now reached the design lifespan and the objective of proposed project is for the design and construction supervision of a new sewer pump station and rising main to replace the existing infrastructure.

2. Location of Activity on Site

The project area is situated in the Kuisebmond Township and the existing pump station serves part of the township. The proposed sewer rising main is also envisaged to be constructed along the existing old line which runs through different developed areas.

Figure 1: The locality map and catchment area of the Kuisebmond pumps station

2.1. Pump Station Catchment Area

The area coverage and flow contributing units were traced from the as-built drawings received from the client. From this, the Kuisebmond pump station catchment area includes 3585 erven in total. However, the sewer infrastructure masterplan (February 2014) provided by MWB reported that the catchment area includes a total of 4204 erven: 4089 residential, 96 commercial and 19 industrials. It is assumed that part of the area has been re-directed to the newly build Kuisebmond Lifting station which transfer the sewer to the Cemetery Pump station.

The Kuisebmond pump station catchment area includes various built-up developments, and the spatial allocation of the different land uses as presented in **Table 2.1** below.

Land Use	No. of Erven
• Single Residential	3299.00
• Gen. Residential	78.00
• Special Designated Area	1.00
• Local Business	2.00
• General Business	121
• Light Industrial	1.00
• Institutional	22.00
• Municipal Purpose	21.00
• Public Open Space	16.00
• Private Open Space	13.00
• Street & Street Widening	11.00
Total	**3585.00**

Figure 2: Catchments Areas of Kuisebmond Pump Station

3. Population Size

The pump station catchment area is a built-up area, and hence it is assumed that no future growth or additional connection will be made. The current sewer catchment contains 3,299 single residential and 78 general residential plots.

Assuming that all these erven will be fully occupied and developed within the next 20 years with an average of 6 people per household (assuming middle income), the total number of population is estimated to be **20 262**. This population size estimation does not contain the business and industrial areas.

4. Environmental Considerations

Namland Consultants were appointed directly by Om'kumoh to carry out the EIA requirements for the Project. Due to Om'kumoh being responsible for the overall financial control of the project under the project management portfolio, Namland Consultants has subsequently been appointed by Om'kumoh as a sub-consultant on the project.

Namland is consequently responsible for both the EIA & EMP and the process is underway.

5. Existing Kuisebmond Pump Station And Rising Main

Background
Kuisebmond is one of the old and built-up townships of Walvis Bay, named after the Kuiseb River and most residents of Walvis Bay live in the area. The current bulk sewer network in the Kuisebmond area consists of a gravity sewer reticulation network and various sewer pump stations and rising main infrastructures.

The existing Kuisebmond pump station infrastructure was built in 1986 and has been serving part of the township. The station is situated on Erf 4246, allocated for municipal use, and bounded by Nathaniel Maxuilili Avenue and Frankie Abraham Street. In the eastern direction, the pump station is bordered by the existing residential developments.

The pump station is at least 34 years old, well beyond the 15-year useful life for the mechanical and electrical components and approaching the life of the concrete structure. In most instances the condition of the equipment has degraded to the extent that the systems require extensive maintenance to ensure functionality and reliability.
The pump station is now in extremely poor states of condition. Despite system-wide repairs and regular maintenance, the pump station needs replacement to provide safe and reliable operation and to accommodate the full sewer load through the system.

6. Methodology

The methodology used to complete the Environmental Impact Assessment includes field and data collection followed by analysis of the collected information. Based on the data analysis, mitigation measures and recommendations are presented.

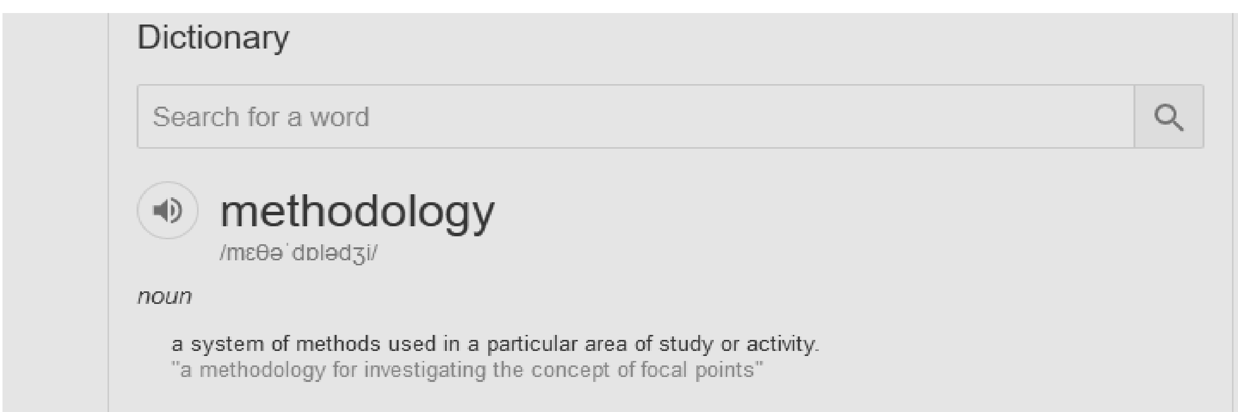
Several sources were used to complete the data collection required for this project. General information, including technical data, was gathered through meeting key personnel from the concerned local authority – Walvis Bay Municipality, Erongo Regional Council and Civil Engineers –Om'kumoh in Windhoek.

In addition to meeting key personnel from the local authorities, further data was collected through observatory field visits to consolidate the understanding of the environmental setting. A visit to the old Sewerage Pump Station and Rising Main and the surrounding region was conducted in December 2020 to inspect the physical setting. Moreover, social impacts were assessed through public discourse and interaction during the conducted site visits.

Furthermore, different types of tests were carried out to assess the quality of drinking water such as biological, physical and chemical tests. The parameters tested include turbidity and pH among others.

Desk review was also used as a source of information that could support the impact assessment study especially regarding some of the project's surroundings' description including topography, climate, etc.

Based on all the above activities, the main concerns were highlighted and analyzed as shown in the Environmental Impact Assessment Report.



CHAPTER 2

7. Legal Framework Consulted

The following table identifies the laws and policies that have been considered in the preparation of this Scoping Report:

Table 7:1: Laws and Policies Applicable to the Proposed Activity and Considered In the EIA Report

LEGISLATION/ GUIDELINE	RELEVANT PROVISIONS	IMPLICATIONS FOR THIS PROJECT
Namibian Constitution First Amendment Act 34 of 1998	"The State shall actively promote… maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future" (Article 95(l)).	Ecological sustainability should inform and guide this EA and the proposed development.
Environmental Management Act EMA (No 7 of 2007)	▪ Requires that projects with significant environmental impact are subject to an environmental assessment process (Section 27). ▪ Details principles which are to guide all EAs.	The EMA and its regulations should inform and guide this EA process.
Environmental Impact Assessment (EIA) Regulations GN 28-30 (GG 4878)	▪ Details requirements for public consultation within a given environmental assessment process (GN 30 S21). ▪ Details the requirements for what should be included in a Scoping Report (GN 30 S8) and an Assessment Report (GN 30 S15).	
Forestry Act 12 of 2001 **Nature Conservation Ordinance 4 of 1975**	▪ Prohibits the removal of any vegetation within 100 m from a watercourse (Forestry Act S22 (1)). ▪ Prohibits the removal of and transport of various protected plant species.	Even though the Directorate of Forestry has no jurisdiction within townlands, these provisions will be used as a guideline for conservation of vegetation.
Labour Act 11 of 2007	Details requirements regarding minimum wage and working conditions (S39-47).	The Walvis Bay Municipality should ensure that all contractors involved during the construction, operation and maintenance of the proposed project comply with the provisions of these legal instruments.
Health and Safety Regulations GN 156/1997 (GG 1617)	Details various requirements regarding health and safety of labourers.	
Public Health Act 36 of 1919	Section 119 states that "no person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other	

LEGISLATION/ GUIDELINE	RELEVANT PROVISIONS	IMPLICATIONS FOR THIS PROJECT
	condition liable to be injurious or dangerous to health."	
National Heritage Act 27 of 2004	Section 48(1) states that "A person may apply to the [National Heritage] Council [NHC] for a permit to carry out works or activities in relation to a protected place or protected object".	Any heritage resources (e.g. human remains etc.) discovered during construction requires a permit from the NHC for relocation.
Burial Place Ordinance 27 of 1966	Prohibits the desecration or disturbance of graves and regulates how bodies may be unearthed or dug up.	Regulates the exhumation of graves.
Water Act 54 of 1956	The Water Resources Management Act 24 of 2004 is presently without regulations; therefore the Water Act No 54 of 1956 is still in force: ▪ Prohibits the pollution of underground and surface water bodies (S23 (1)). ▪ Liability of clean-up costs after closure/ abandonment of an activity (S23 (2)).	The protection of ground and surface water resources should be a priority. The main threats will most likely be concrete and hydrocarbon spills during construction and hydrocarbon spills during operation and maintenance.
Town Planning Ordinance 18 of 1954	Subdivision of land situated in any area to which an approved Town Planning Scheme applies must be consistent with that scheme (S31).	The proposed use of the project site must be consistent with the Walvis Bay Town Planning Scheme
Townships and Division of Land Ordinance 11 of 1963	Details the functions of the Township Board including what they consider when receiving an application for Township Establishment (S3).	The proposed layout and land uses should be informed by environmental factors such as water supply, soil etc. as laid out in Section 3.
Road Ordinance 1972 (Ordinance 17 0f 1972)	▪ Width of proclaimed roads and road reserve boundaries (S3.1) ▪ Control of traffic on urban trunk and main roads (S27.1) ▪ Rails, tracks, bridges, wires, cables, subways or culverts across or under proclaimed roads (S36.1) ▪ Infringements and obstructions on and interference with proclaimed roads. (S37.1) ▪ Distance from proclaimed roads at which fences are erected (S38)	The limitations applicable on RA proclaimed roads should inform the proposed layout and zonings where applicable.
Sustainable Urban Energy Planning: A Handbook For Cities And Towns In Developing Countries (SUEP:2004)	Provides a comprehensive list and case studies to implement energy saving measures.	Implementing energy-efficiency and carbon mitigation measures. Conserve natural resources with city planning.

CHAPTER 3

8. Description Of Project Surroundings

The Chapter provides an overview of the baseline studies on the biophysical and social environmental conditions, with which the proposed project will interact. This information has been sourced from observations made during a site visit and existing literature from previous research conducted in the area. This chapter also identifies sensitivities pertaining to key environmental features as well as potential impacts resulting from the proposed project in relation to these sensitivities.

8.1. Biophysical Environment

Walvis Bay is located on the Namibian coastline in the arid Namib Desert. The arid conditions are as a result of dry descending air and upwelling of the cold Benguela Current. Thick fog or low stratus clouds are a regular occurrence Walvis Bay. This is due to the influence of the Benguela Current and forms the major source of water for the succulent and lichen flora in the Namib Desert.

Winds generated from the high-pressure cell over the Atlantic Ocean blow from a southerly direction when they reach the Namibian coastline. As the Namibian interior is warm (particularly in summer), localized low-pressure systems are created which draws the cold southerly winds towards the inland desert areas. These winds manifest themselves in the form of strong prevailing south-westerly winds, which range from an average of 20 knots (37 km/h) during winter months to as high as 60 knots (110 km/h) during the summer.

Winds near Walvis Bay display two main trends; high velocity and frequency south to south-westerly winds in summer and high velocity, low frequency east to north-easterly winds during winter. During winter, the east winds generated over the hot Namib Desert have a strong effect on temperature, resulting in temperature in the upper 30 degrees Celsius and tend to transport plenty of sand.

Table 8.1 Presents A Summary Of Climate Conditions / Data In The Walvis Bay Area.

ELEMENT OF CLIMATE	DESCRIPTION
• **Average annual rainfall (mm/a)**	0-50
• **Variation in annual rainfall (%)**	< 100
• **Average annual evaporation (mm/a)**	2400 – 2600
• **Water deficit (mm/a)**	1701 - 1900
• **Temperature**	Average maximum: Between 24 °C in March/April and 19.3 °C in September Average minimum: Between 16.5 °C in February and 9.1°C in August Average annual >16 °C
• **Fog**	Approximately 900 hours of fog per year
• **Wind**	Prevailing wind is average to strong south westerly

Climate Change and Sea Level Rise - Since 1960 the global average sea level rise is 1.8 mm per year while the average sea level rise for Walvis Bay is approximately 2 mm per year (Consulting Services Africa et al. 2009). Since most of Walvis Bay is at 2 m above sea-level or less, this may have significant impacts on the town and port. Although future predictions on climate change and sea level increases are based on many variables, it is clear that in future the frequency of climate extremes will increase.

The present day worst case scenario is that an extreme sea level of +1.5 m above land levelling datum (LLD) (LLD is approximately equal to mean sea level) will occur every 100 years. By 2030, this is predicted to occur once every year mostly due to an increased frequency of storm events associated with climate change. The major impacts associated with this will be increased erosion of the shore line as well as inundation of low lying areas.

8.1.1. Topography and Vegetation

Constituted by the ephemeral Kuiseb River; the Namib sand sea south of the river and the gravel plains to the north; beaches and Atlantic coastline; these rich environments exist in dynamic relationships to one another, "the result of river, marine, wind and man-induced processes" (Kruger 2016).

Here sand rests at about 32 -34% above the horizontal. This is where life on the dune is concentrated. Animals and plants of the desert have devised unique adaptive strategies, surviving with little rain - less than 15mm per annum - and deriving maximum benefit from the high humidity generated by fog sweeping off the coast. Seeds can lie dormant for years, animals can aestivate by seeking shelter in the summer months.

Smaller animals like lizards and beetles can retreat on a daily basis below the sand. Larger animals can migrate or seek shade. Most rely on fog and wind-blown detritus as a source of food. Trianthema hereroensis is the common succulent found on the sand between Swakopmund and Walvis Bay. The plant absorbs fog water through its leaves. These plants grow on the dune sea south of the Kuiseb River only as far inland as the fog regularly penetrates. It is an important source of food and shelter for many dune animals. Its seeds are eaten by beetles, and when green, oryx and gerbils forage on the leaves.

The ability of the desert to sustain this rich bio-diversity should not distract from the fundamental fragility of this environment. The desert is easily disturbed. Ecologically it is a low energy system because of the lack of water. Perennial plants grow slowly while annual ones can only grow in the years with adequate rain. As a result it requires a longer period of time for the vegetation of the area to recover from disturbance than if the rainfall was higher.

North of the ephemeral Kuiseb River are gravel plains, clearly distinguishable from the desert sands in satellite photographs of the area. This area is flatter and presents a harder surface than the constantly shifting dunes to the south. These plains are characterized by sandy soils often associated with crystalline gypsum or salt deposits. These soils have a surface capping scattered with many cobbles and pebbles.

This delicate crust supports the small shrub Arthraerua leubnitzea, endemic to the Namib. The plant germinates with the occasional rain and is then supported by fog. There is also a diversity of fog-dependent lichens. If this crust is disturbed it may never recover, providing instead another place for erosion to begin when the rain eventually falls. In this area where the lichen crusts often constitute the dominant plant growth, any vehicle tracks seemingly last forever. Gray's lark (Ammomanes grayi), is endemic to the gravel plains.

8.2. Social Environment

The section aims to identify trends that are related to the importance of the assessment and determine potential impacts and/or implications of each that are relative to the project. It is important that the key-socio-economic trends in Walvis Bay are understood as a basis for the assessment as they are of major importance.

8.2.1. Key Population statistics

The Erongo Region and Walvis Bay specifically, is one of the fastest growing regions in terms of population size in Namibia. The population growth rate of Walvis Bay for the period 2001 to 2011 is 4.7% while that of the Erongo Region is 3.4% and that of Namibia 1.4%. In Walvis Bay, this growth can firstly be attributed to in-migration of job-seekers (42.63%) and secondly to in-migration by people who obtained jobs in Walvis Bay prior to moving. This goes hand in hand with a decline in rural populations of the Erongo Region.

During the last census of 2011, unemployment in Walvis Bay was 27% which is significantly lower than the Namibian level of 37%. The average annual household income in the Erongo Region during the 2009/2010 Namibian Household Income and Expenditure Survey was N$ 84,989 which is second to only the Khomas Region with N$ 132,209 (Namibia Statistics Agency, 2012). The main source of income in the Erongo Region is from salaries and wages with about 80% of households relying on this type of income (Namibia Statistics Agency, 2012).

8.3. Geophysical Aspects

The desert climate is warm and dry, but this is influenced by the cold water upwelling of the Benguela Current of the Atlantic Ocean, which, in contact with the warm desert air, produces water vapor (fog) that moderates the air temperature. The area experiences south-westerly winds throughout the year and strong north-easterly winds during winter months (June – August). The north-easterly winds sweeps over the Namib Desert which brings sandstorms and dust to the coastal region.

Soil conditions consist of compressed barren holomorphic soils, rich in salt content which are common in Walvis Bay and other coastal towns like Swakopmund, Luderitz, Oranjemund and Henties Bay. Various anthropogenic material and particulates such as ceramics, plastics, and heavy metals can be found on site.

Due to urbanization and development, the site has been transformed into a human habitat and urban environment. The site and surrounding area contain man-made buildings, foundations, underground services and paved streets that have changed the geography of the natural environment. The site is away from the ocean and 5m above sea level and is at the same height as adjacent erven and surrounding streets. Therefore no major earthworks are required for site development. The high water table is not fit for human consumption due to the ocean salinification. Instead, limited freshwater is pumped from the aquifers for human consumption.

CHAPTER 3

9. Public Consultation / Participation

Public consultation is an important component of an Environmental Assessment (EA) as it provides potential Interested and Affected Parties (I&APs) with a platform whereby they can raise any issues or concerns relevant to the proposed project. This assists the environmental consultant in considering the full spectrum of potential impacts and to what extent further investigations are required.

In addition, the public consultation process also grants I&APs an opportunity to review and comment on all the documents produced throughout the EA process. This is done in accordance with both the Environmental Management Act's EIA Regulations, as well as International Best Practice Principles.

A list of all issues and concerns that have been identified during the Public Consultation Process is provided in the Issues and Responses Trail. Public consultation is an important component of an Environmental Assessment (EA) as it provides potential Interested and Affected Parties (I&APs) with a platform whereby they can raise any issues or concerns relevant to the proposed project. This assists the consultant in considering the full spectrum of potential impacts and to what extent further investigations are required.

9.1. Interested and Affected Parties

To ensure all I&APs were notified about the project, notices regarding the project were placed in widely circulated in national newspapers and the local Municipal Notice Board, inviting members of the public to register as I&APs. A Public meeting was held at the Walvis Bay Rugby Stadium auditorium on 28 December 2020 as from 1000 to 1200 Hours. However, no one pitched up except for the three Namland Consultancy officials.

Table 9.1: List of Consulted Stakeholders / directly involved in the Project

Name	Organisation	Contacts
Ben Shigwedha	Namland Consultants	bshigwedha@namland.com.na
Immanuel M. Hama	Namland Consultants	081 277 2797
Paulina N. Simbotwe	Namland Consultants	081 878 6677

Other Consulted Stakeholders include:

Name	Organisation	Contacts
Namgula Amatsi	Walvis Bay Municipality	
Lovisa Haulaula	Walvis Bay Municipality	
Paulina N. Simbotwe	Walvis Bay Municipality	
	Walvis Bay Municipality	
	Om'kumoh Engineers	

9.1.1. Issues Raised

No issues/comments/objections to the application were raised by any potential Interested and Affected Parties.

9.1.2. Communication with IAPs

Section 21 of the EIA Regulations (RN: MET, 2012) details steps to be taken during a given public consultation process and these have been used in guiding this process. Communication with I&APs about this proposed development was facilitated through the following means:

- A **Background Information Document (BID)** was compiled that contained essential information about the proposed developments. The BID was sent to all potential I&APs;
- **Notices** were placed in the press, briefly explaining the development and its locality, inviting the public to register as I&APs; and
- **Environmental Site Notice** of the proposed activity was up on the site from 1 December to 31 December 2020, when it was taken down by the EAP

CHAPTER 4

10. DESCRIPTION AND CONDITION OF EXISTING PUMP STATION

10.1. General Arrangement And Description

The pump station currently services the local wastewater catchment via a network of gravity fed drains. The flow is then pumped into the rising main running between Kuisebmond and WWTP.

As depicted in the Figure 3 below, the pump station includes two inlet chambers, a pump house, wet sump, pump sump, generator room and a utility building. The pumping station incoming lines feed into two separate inlet manholes which are currently being used as sand trap as well.

The pump station is an underground structure, circular in plan, with a wet sump around a centered dry pump sump. The pump sump floor is about 4.4 m below the natural ground level.

It was also indicated by the operators that sewerage collected from ships and other portable sewerage facilities (like construction areas) do get discharged at the station inlets daily with an average of four (4) trucks per day.

It was noticed during the site visit that the existing utility building do not have a shower facility which is an important component for a manned pumphouse.

10.2 Historical Flow Data

The flow data of Kuisebmond pump station as measured at the WWTW has been received from MWB for historical flow analysis. No flow record of the incoming sewer flow into the pump station is available and the flow data received has been recorded only at the outlet of the existing pumping main.

10.1.1. Historical Average Daily Flow

The flow data analysed includes the average daily flow for a total period of 32 years, from July 1987 to June 2020. The historical flow data is structured to reflect the average daily flow on monthly basis for each fiscal year. There were missing monthly flow data for August 1999/00, September 2012/13, and October 2012/13, these have been interpolated for the purpose of this analysis.

The historic flow data indicated that the average monthly daily pumping flow ranges between **903m^3/day** and **3696m^3/day**. However, it has been noted that the daily flow fluctuates between **1500m^3/day** and **3000m^3/day** in most cases.

As shown in the Figure 4 below, it was observed in the historical flow data that the average daily flow trend increased through time which can be linked to linked to the incremental developments takes place within the catchment area over the years. The historical aerial images observed on Google Earth leaping to the past also reinforce this assumption.

The significant increase in daily flow the years can be related to the construction of various new developments following the provision of municipal services in the area and associated socio-economic activities.

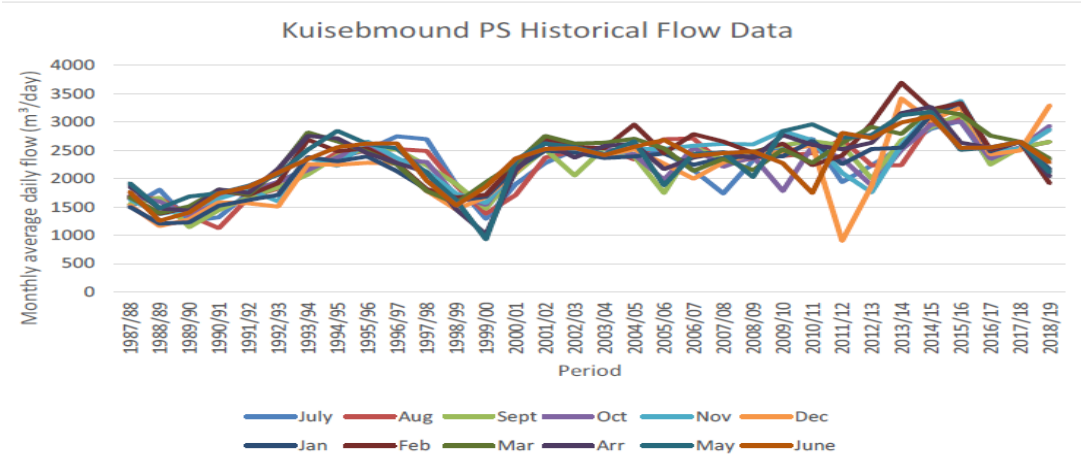


Figure 10.1: Kuisebmond existing pump station historical average daily flow data

- **Historical Hourly Flow**

Historical hourly flow data were received from MWB for a period of 10 months (January 2020 – October 2020) and the information was analyzed consecutively to grasp the various seasonal and periodic fluctuations. The data contains the minimum, maximum and average flow recorded at the WWTW on hourly basis and the average flow is calculated to be **96.5m³/hr.**

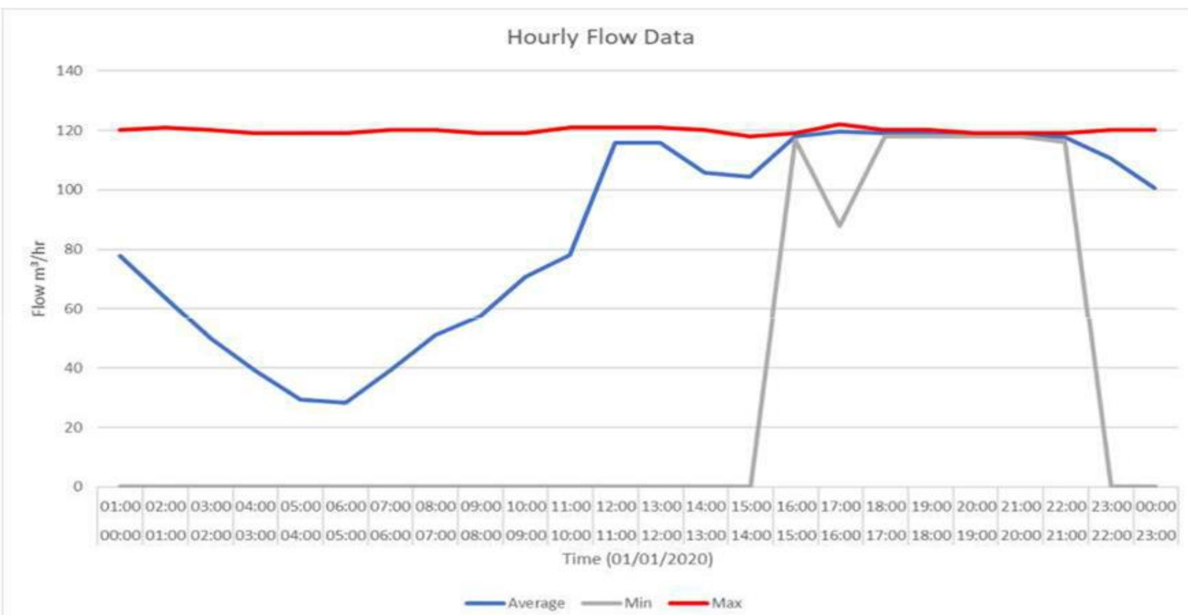


Figure 10.2: Kuisebmond existing pump station historical hourly flow data

10.2. Civil And Structural Components

The existing structures being older than 34 years and coupled with the corrosive nature of the project area, most of the civil/structural components showed a sign of dilapidation and serious structural damages. The facility's concrete works have severe cracking and reinforcement corrosion (***Figure 10.3***). The deterioration of the concrete shows that special care need to taken in the design and construction of any new structures in the area.

Figure 10.3: Civil/structural condition of Kuisebmond existing pump station

10.3. Mechanical And Electrical Components

The Kuisebmond Pump Station is pumping directly to the WWTW, the existing mechanical and electrical equipment are in a fair working condition. The pump and motor configuration contains the following main components.

- 2 x T6A-B Gorman Rupp pumps with a 30kW motor each operating at approximately 1560rpm.
- Duty point: Flow (Q) at 43.33 l/s with a total Head (H) of 13.09m

Figure 10.4: Mechanical/electrical condition of Kuisebmond existing pump station

The sewer masterplan received from the client reported that the Kuisebmond Pump Station is operating well within its ideal range and the T6A-B pumps seem to be well suited for the existing operation required. However, a typical data for running hours of the pumps per day was requested from ***Eco Projects*** and the information received showed that the current 1+1 configuration is not sufficient to accommodate the current operation. The typical pump running flow record data indicated both pumps start and stop simultaneously and run for 15 hours per day in average.

Referring to ***Figure 10.4*** above, in most cases a continuous pumping flow is recorded between 09H00 and 24H00 and on weekends, the pumps run non-stop for a longer duration with a minimum and maximum flow ranging between **100m³/hr** and **140m³/hr**.

Therefore, it can be concluded with certainty that the existing pumps with the 1+1 configuration are not sufficient for the current operation. It is apparent that a pump would run 24 hours nonstop and the pump station can be overloaded when one pump is not functioning due to breakdown or routine maintenance.

Despite the longer running hours at a flow rate beyond the pumps duty point, it was further noted that the recorded maximum number of pump start is ***116 per day*** (4.8 per hour) which is within the recommended limit of ***six (6)*** starts per day for motors up to 35 kW.

Table 10.1: Typical pump running hour per day

	Pump 1		Pump 2	
Date	Start/day	Runtime (Hr)	Start/day	Runtime (Hr)
2 Nov 2020	87	15.45	87	15.45
3 Nov 2020	99	13.16	99	13.16
4 Nov 2020	89	13.47	89	13.47
5 Nov 2020	106	12.91	106	12.91
6 Nov 2020	90	14.22	90	14.22
7 Nov 2020	99	13.84	99	13.84
8 Nov 2020	87	14.6	87	14.6
9 Nov 2020	75	15.67	75	15.67
10 Nov 2020	48	19.32	47	19.33
11 Nov 2020	102	14.89	102	14.89
12 Nov 2020	82	15.83	82	15.83
13 Nov 2020	100	13.46	100	13.46
14 Nov 2020	116	12.44	116	12.44
15 Nov 2020	76	16.33	80	15.44
16 Nov 2020	84	15.16	84	15.16
17 Nov 2020	85	13.73	85	13.73
18 Nov 2020	102	14.25	107	12.67
19 Nov 2020	88	14.66	88	14.66
20 Nov 2020	82	13.45	82	13.45
21 Nov 2020	86	15.15	87	15.11
22 Nov 2020	103	15.18	102	13.7
23 Nov 2020	82	15.06	82	15.06
24 Nov 2020	71	15.32	71	15.32
25 Nov 2020	33	19.43	33	19.43

The picture on the right from ***Figure 10.4*** above depicts that the original electrical/instrumentation installation was already upgraded once, and the existing electrical/instrumentation components are in a general good working condition.

The current installation comprises of the below equipment:

- 2 x 30kW Motors (56A at full load @ 0.84 P.F.)
- 2 x Motor Control Panels complete with (Hour Meter, Amp Meter, Auto Manual Selector and Trip Indication)
- Telemetry Board complete with Backup Board
- Endress & Hauser FMU90 Ultra Sonic Level Transmitter
- Cummins Power Generation Change-Overboard
- Cummins Back-Up Generator (400VAC, 50HZ, 100KVA Prime Rated)

10.5 Existing Rising Main

The existing sewer rising main, Ø300mm AC, runs between the pump station and the WWTW for a total length of 3500m. Although the requested actual as-build drawing of the existing rising main is not received from the client, as indicated above the pipeline runs through various existing developments including municipal roads.

The feedback received from the client regarding the condition and status of the pipeline indicated that, there is not any operational problem being experienced currently. However, considering the pipeline being in operation for longer than 34 years coupled with the corrosive nature of the soil and the sewage characteristics, it can be realistically stated that the pipeline is reaching its life span.

The pipeline being situated in a developed area along streets and in backyards and sometimes within biologically sensitive environments, repair and maintenance of the pipeline will be a difficult exercise once it starts to leak.

10.6 Planning & Design History

MWB completed a Sewer System Master Plan in February 2014 to plan and program the projects required for improving the existing sewer infrastructure. The pump station, and mechanical & electrical equipment were reported to be in a good and working condition despite the dilapidating condition of the civil/structural components.

The recommended approach of the master plan for Kuisebmond pump station at the time was an optional re-routing of the existing rising main to the central pump station than to the WWTW.

CHAPTER 5

11. DESIGN STANDARDS, CRITERIA, AND PROCEDURES

In preparation of the Concept and preliminary Designs, we have used the selected design guidelines, criteria and procedures as outlines in the sub-section below. Hence, we request MWB to comment or approve before we move on to the next step of the project detail design and documentation.

11.1. Design Horizon

The following design horizons have been proposed for used in the design of various project components.

a) Pumps, Motors, Controls & Communication Equipment – 15 years
b) Pumplines (uPVC) – 20 years

c) Other Structures – Steel – 30 years
d) Other Structures – Concrete, Brick, Earth – 50 years

11.2. Population Size

The sewer catchment contains 3299 single residential and 78 general residential plots. In the absence of actual census data for the specific project area, we have assumed that the residential erven are fully developed and occupied with an average of 6 people per household (assuming middle income as per the red book), and the total number of population is estimated to be about **20 262**.

It was further discussed and confirmed by the client that the current pump station catchment is a fully built-up area and there will not be any additional connection to the network that will contribute to the sewer load.

11.3. Sewer Flow Calculation And Load Analysis

11.3.1. Sewer Design Criteria

In Namibia most of the municipal infrastructures are designed in accordance with the relevant South African standards, applicable local requirements, and municipal by-laws pertinent to the specific development. The changes in design standards were usually brought about by changes in the applicable technologies and political or socio-economic changes.

During the design process, the following sources will be used:

- Guidelines for Human Settlement Planning and Design- Volume 2 (2000): The Red Book. This source was used extensively and wherever possible.
- SANS10252: Water Supply and Drainage for Buildings- Part 1, Edition 2 (2004).

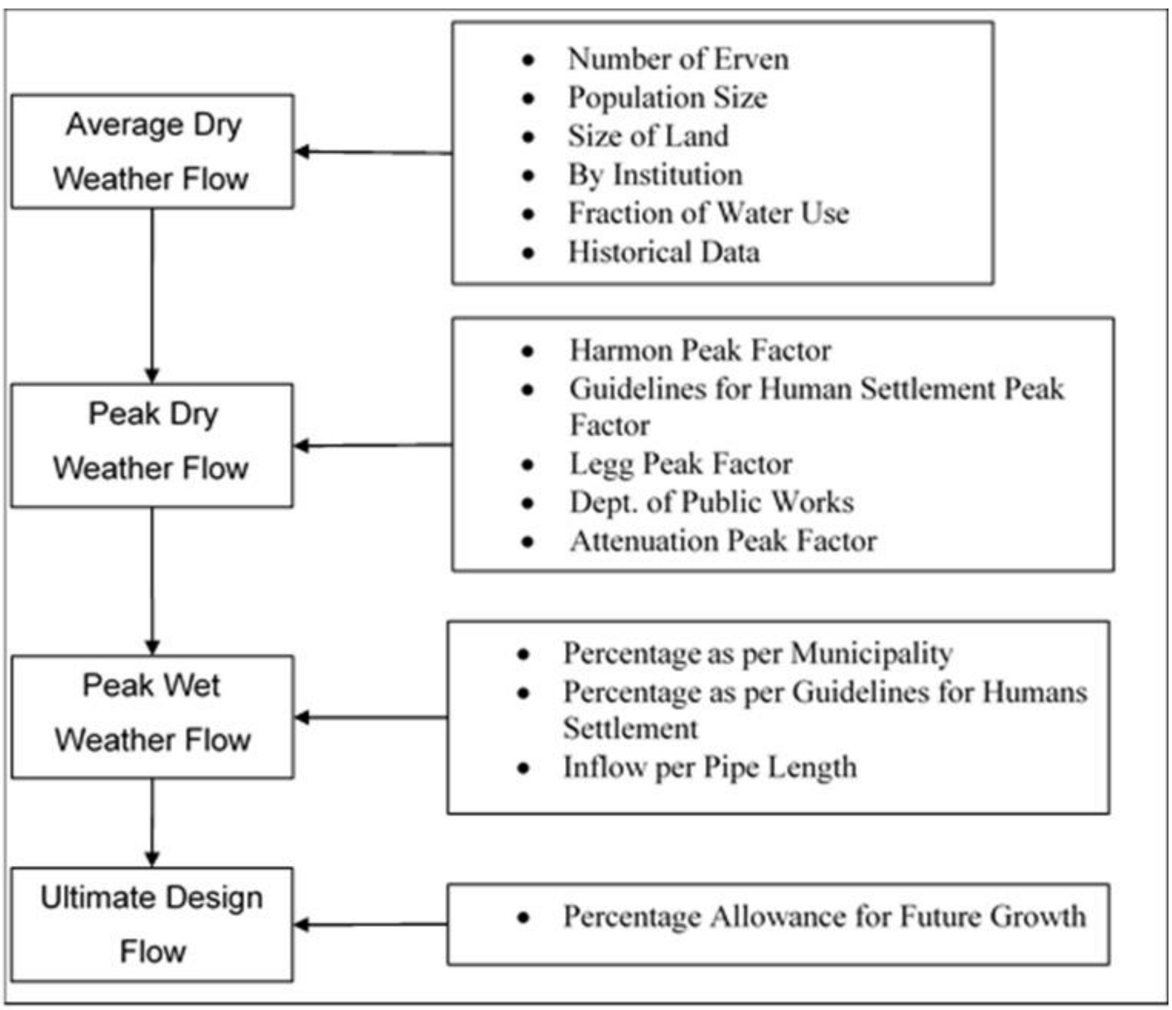
- SANRAL Drainage Manual
- Minimum Standards for Civil Engineering Services in Townships- Version 2: City of Cape Town Transport for Cape Town October 2010 Version 3.0.

11.4. Design Flow Determination

The design flow calculation is made considering the following scenarios:

- Historical flow data as captured in the pump station SCADA system
- Theoretical flow calculation based on the flow catchment area coverage and
- land use type

To determine the size of the pump station and pipework required, the volume of sewage flow at peak wet weather conditions must be determined. The peak wet weather flow is a combination of the average dry weather flow at peak times combined with storm water infiltration. The following procedures was followed for flow calculation and further optimization, and the different flow components are discussed in detail in the sub-sections below.



(a) Average Dry Weather Flow (ADWF)

The average dry weather flow is the average flow that can be expected over the full duration of a day (24 hours) during off peak periods and when there is no rain event. Depending on the information available, the average dry weather flow can be determined from the following approaches:

- Recorded historical flow data:
- Number of erven:
- Population size:
- Size of the land:
- By Institution: and
- Fraction of Water Use

(a) Peak Dry Weather Flow (PDWF)

The peak dry weather flow is typical of an area that has not experienced rain lately and this flow will occur early in the morning and late in the evenings when residents are at home and are using bathroom facilities.

The peak dry weather flow is obtained from multiplying a peak factor to the average dry weather flow. As a population is gets bigger, the peak factor reduces as the chance that everybody in a large population will be discharging bathroom water at the same time is less than the chance of everybody in a small population discharging water at the same time. The peak factor is therefore a function of the size of the population.

The peak factor can be determined by using either the:

- Harmon Peak Factor:
- Guidelines for Human Settlement and Planning: and
- Legg-formula

(b) Peak Wet Weather Flow (PWWF)

Peak wet weather flow is a combination of the average dry weather flow at peak conditions combined with storm water infiltration. This will typically occur during a rain event early in the morning or late in the evenings. The storm water ingress into the sewerage reticulation system could be due to roof rainwater being discharged into the sewage system, ground water seeping in through faulty pipe joints or cracked manholes, etc.

PWWF = ADWF x PF + % storm water ingress

d) Ultimate Design Flow (UDF)

Where there is the potential of the area being expanded, reserve capacity should be allowed for. Usually, for developing areas, a reserve capacity of up to 50% on top of the design flow is to be allowed for the design, therefore:

Ultimate Design Flow = ADWF x PF x Infiltration Rate x 1,5

11.5 Sewer Demand Norms and Design Criteria

Referring to the project area land use type as indicated in the town planning drawing received from the client, the following sewer demand norms and design criteria are proposed for the purpose of theoretical flow calculation:

- ✓ **Sewage Outflow:**
  - Residential (High Income) 1 000l/day/erf
  - Residential (Medium Income) 750l/day/erf
  - Residential (Low Income) 500l/day/unit
  - Business 1000 l/day/unit
  - Industrial 5000 l/day/unit
  - Institutions 500l/day/unit
- ✓ Daily Peak Factor: 2.5
- ✓ Infiltration factor: 15%
- ✓ Minimum and Maximum flow velocities:
  - Minimum self-cleaning velocity 0.7m/s
  - Maximum flow velocity 2.5 m/s
- ✓ **Minimum Pipe cover:**
  - In servitude: 600 mm
  - In road reserves: 1000 mm

11. 6 Structural Design Criteria

The basic aim of structural design on the project will be to ensure that the sump and building structure constructed under the project is not only safe but stable enough for use during the design horizon established. To achieve this international design codes will be followed, most probable loads that will impact the structure during their life span will be identified and used to ensure a seamless load transfer, material selection will be such as to ensure sustained performance of the structures during the life span.

11.7 Design Standards

The design standards presented in Table 11.1 below will govern the design of structural works.

Table 11.1: Structural Design standards

Material	Design code	Title
Design loads	SANS 10160	Basis of structural design and actions for buildings and industrial structures: Part 1: Basis of structural design Part 2: Self-weight and imposed loads. Part 3: Wind actions. Part 5: Basis for geotechnical design and actions. Part 6: Actions induced by cranes and machinery. Part 8: Actions during execution.
Concrete	SANS10100	Part 1: Reinforced Concrete Part 2: Concrete Material Execution of Works
	SANS 2001-CC1:2007	Construction works Part CC1: Concrete works (structural)
	BS8007:1987	Code of practice for design of concrete structures for retaining aqueous liquids
Steel	SANS 10162	The structural use of steel: Part 1: Limit-states design of hot-rolled steelwork. Part 2: Limit-states design of cold-formed steelwork. Part 4: The design of cold-formed stainless steel Structural members.
	SANS 2001-CS1	Construction works – Part CS1: Structural Steelwork.
Masonry	SANS 10164	The structural use of masonry Part 1: Unreinforced masonry walling

11.8 Design Loads

During the life span of the pump station various loads will impact on the structure and during design these loads will be considered in such a combination as to cause the worst predictable effect. The combination of the loads will be in line with the standards presented above. Amongst the loads to be considered will be:

- **Returned earth pressure** – the effect of the soil around the sump will be considered using the soil parameters as identified by the geotechnical investigations
- **Water pressure** – Two different water pressures will be considered; one is the pressure of ground water on the walls of the sump and another pressure of water contained in the sump. The height of the ground water will be based on geotechnical investigations and tidal information whereas the contained water height will be based on the height in case of emergency.
- **Surcharge load** – consideration will be made to traffic load around the sump during construction and operation. The code prescribes a minimum 10KN/m^2. This will be compared to load from wastewater delivery trucks and construction loads with the worst loading used for surcharge.
- **Ground floor live load** – a 5KN/m^2 load will be used for live loading design in the pump room area whereas other areas will use 1.5KN/m^2 load
- **Roof loading** – the roof will be designed for a live load allowing for maintenance works on the roof.
- **Wind loading** – the roof will be designed for a wind load due to wind action on the roof. A basic wind speed of 30m/s will be used in design.
- **Self-weight** – due consideration will be made of the self-weight of all materials incorporated into the permanent works. These will include concrete, masonry, and steel

11.9 Material Durability

During the life span of the structures the environment will have significant effect that would potentially cause deterioration of materials that make up the structure. Such deterioration could lead to unacceptable appearance or in the worst-case useability of the structure to be compromised. Thus, the design will look at these environmental conditions and specify how best to prevent material deterioration before the design structure reached the required life span. The conditions under consideration in this project will be:

- **Saline ground condition** – the geotechnical investigation confirmed the corrosivity of the ground water due to the high salinity. The chlorine effect on reinforcement embedded within concrete will need special consideration works.
- **Saline humid condition** – whereas Walvis Bay hardly receives rain the high humidity of the town is laden with salt which on permeable concrete and steel surface is detrimental. Consideration for this will need to be made
- Wastewater corrosivity – wastewater has the potential to cause corrosion of concrete surfaces and due consideration to this will need to be made in design of the sumps.
- **Fire** – the potential of fire damage will need to be given consideration such that minimal duration fires should not have catastrophic effects. The strategy in line

with standards is to choose an acceptable performance limitation of the materials used in the structure.

11.10 Foundation Parameters

The foundation design will be such as to ensure that the loads transfer is spread to the ground without exceeding the soil carrying capacity. The load carrying capacity of the soil at the pump station site has been shown to be poor by the geotechnical investigation, only up to 50KPa capacity. Recommendations have been given to improve the ground to a carrying capacity to 200KPa. At the same time only raft foundations have been recommended and these will be adopted to ensure foundation sustainability.

CHAPTER 6

12 ELECTRICAL, CONTROL & INSTRUMENTATION

The standards presented in ***Table12.1*** will govern the design and installation of electrical, control and instrumentation work:

Table 12.1: Electrical, Control and Instrumentation design standards

Material	Design code	Title
Electrical Installations	SANS 10142-1:2012	The wiring of premises Part 1: Low-voltage installations
Earthing/Grounding	SANS 10292:2013	Earthing of low-voltage (LV) distribution systems
Lightning Protection System	SANS 10199:2016	The design and installation of earth electrodes
	SANS 10313:2012	Protection against lightning - Physical damage to structures and life hazard
	SANS 1063:2015	Earth rods, couplers and connections
Transformers	SANS 60076-1:2011	Power transformers – Part 1: General
Electrical Installations	SANS 10142-1:2012	The wiring of premises Part 1: Low-voltage installations
Earthing/Grounding	SANS 10292:2013	Earthing of low-voltage (LV) distribution systems
Lightning Protection System	SANS 10199:2016	The design and installation of earth electrodes
	SANS 10313:2012	Protection against lightning - Physical damage to structures and life hazard
	SANS 1063:2015	Earth rods, couplers and connections
Transformers	SANS 60076-1:2011	Power transformers – Part 1: General

Instrument & Control Installation	SANS 60529:2013	Degrees of protection provided by enclosures (IP Code)
	SANS 61643-1:2006	Low-voltage surge protective devices
Functional Safety Safety Instrumneted Systems	SANS 61511-1 : 2003	Functional safety - Safety instrumented systems for the process industry sector
	SANS 61508-0:2014	Functional safety of electrical/electronic/programmable electronic safety-related systems
EMC Electromagnetic Compatibility	SANS 61000-1-1:1992	Electromagnetic compatibility (EMC) Part 1: General Section 1
ICSS - Integrated Control & Safety Systems	IEC 61131-1 :2003	Programmable controllers – Part 1: General information

12.1 Construction Material

Material choice for the construction project will be undertaken to ensure that the facility has a higher probability of performing in the design horizons identified. Due consideration will be made of the aggressive functional and environmental conditions that the materials will be subjected to. Key required materials for the construction and operation of the facility are concrete, steel, and piping and are discussed in the sub-sections below.

12.2 Concrete

Reinforced concrete is a composite material that has specific deficiencies which will be exploited by the nature of sewerage on one hand and the Walvis Bay area corrosive environment on the other.

In sewer collecting sumps where wastewater ponds for one reason or another, anaerobic reaction develop which lead to production of hydrogen sulphide. The hydrogen sulphide ends up reacting with carbon dioxide found in the atmosphere leading to production of carbonic acid. The carbonic acid led to carbonation of concrete and formation of biogenic sulphuric acid which will eventually strips the concrete surface of material. The typical anaerobic reaction of sewer flow and the associated effect on the concrete surface is shown below.

The carbonation of the concrete when it reaches the reinforcement level it leads to reinforcement corrosion. Also, the stripping of surface material of concrete exposes reinforcement bars to corrosive environment, especially in Walvis Bay which contains chloride laden humid air. Corrosion of reinforcement bars ultimately leads to cracking of concrete structures as corroded bars require more volume.

The prevention of both conditions is to design and construct concrete to be as impermeable / waterproof as possible. Based on prevailing standards the following will be the guiding criteria

- Minimum very severe environmental exposure for design:
- Sump concrete will be designed with a maximum 0.2mm crack width:
- Concrete strength class of C40 will be used:
- Minimum cement content of 325Kg/m^3 and a water/binder ratio of 0.55: and
- Concrete surface inside and outside will be painted with an approved waterproofing paint:

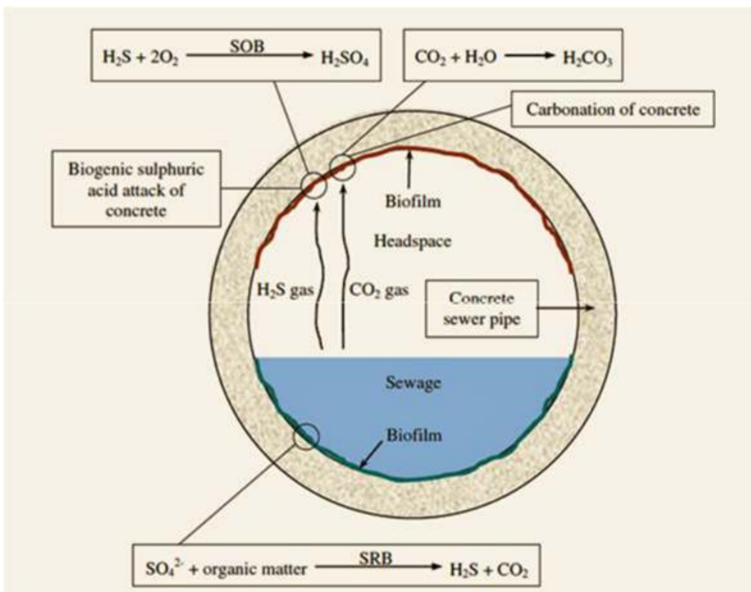


Figure 12.1: Schematic showing biogenic concrete corrosion process

12.3 Steel

Steel will be used for pipes in the pump station and roof structure. The biggest challenge of steel is the risk of corrosion due to the generally humid conditions of Walvis bay and the pump station in particular. To make matters worse the humidity is laden with sodium chloride from the Atlantic Ocean water. The approach to ensuring durability of steel elements will be:

- All steel pipes will be grade minimum stainless-steel grade 316L: and
- All exposed structural steel will be minimum stainless-steel grade 316L Stainless steel grade 316L is less reactive to corrosive agents prevalent in Walvis Bay.

12.4 Pipeline

Numerous factors are involved in the evaluation and selection of material for sewer pipeline construction and are dependent on the following anticipated conditions under which the system operates:

- Type of wastewater:
- Abrasion or scour conditions:
- Installation requirements:
- Corrosion conditions:
- Flow requirements (pipe size, slope and velocity):
- Product characterization (length, fittings and connections):
- Cost effectiveness (material, installation, maintenance and life expectancy); and
- Physical characteristics (soil condition, pipe stiffness, loading strengths)

Even though the effect is minimal for rising mains where the sewer normally flows full, part of the pipe surface exposed to sewer gases is subjected to corrosion due to the following reasons (refer above):

- generation of hydrogen sulphide gas (H2S) in the sewer effluent
- release of H2S from the effluent: and
- Formation of sulphuric acid (H2SO4) as a result of bacterial action.

While the selection of material type is dependent on the various conditions, uPVC is mostly specified for underground applications up to 250mm diameter and GRP and reinforced concrete with a protective lining is normally specified for sewers larger than 250mm diameter.

However, considering the corrosive nature of the project area external environment and the sewer flow, concrete pipe material is subjected for corrosion and hence uPVC pipe materials are proposed to be suitable for this project.

CHAPTER 7

13 PROCESS DESIGN AND PUMP SELECTION

13.1 Design Flow Calculation

The flow calculation used the following two (2) scenarios:

- Theoretical flow calculation based on the flow catchment area coverage and land use type; and
- Historical flow data analysis as captured in the pump station SCADA system in comparison with the calculated theoretical flow.

The detail flow calculation and design of subsequent pump station components including rising main sizing, pump selection, wet well sizing, and emergency storage calculation. The estimated current and future flows are presented in the table below.

Table 13.1: Calculated theoretical design flow

	Current Demand			Future Demand		
Design Flow	l/s	m^3/min	m^3/hr	l/s	m^3/min	m^3/hr
Average Dry Weather Flow (ADWF)	21.60	1.30	77.77	31.15	1.87	112.14
Peak Dry Weather Flow (PDWF)	51.59	3.10	185.74	75.46	4.53	271.65
Peak Wet Weather Flow (PWWF)	54.59	3.28	196.54	79.89	4.79	287.60

- *The current and future average daily dry weather flow is calculated to be **1 866.48m³/day** and the **2 691.36m³/day,** respectively.
- The current and future daily Peak Wet Weather flow is calculated to be **4 716.96 m³/day** and **6 902.4 m³/day**, respectively.

The current sewer demand was calculated considering all the single residential units as high density (500l/day/erf), and the future demand was calculated assuming all the single residential units will be fully developed to medium density (750/day/erf).

the historical flow record of the pumping station depicted that the average daily flow ranges between **903 m³/day** and **3696 m³/day.** The historical record also further depicted that the hourly pumping flow ranges between **96.5 m³/hr** and **262 m³/hr**.

However, it should be noted that the historical flow data is measured at the inlet of the WWTW and it records the pumping flow, not the incoming sewage at the inlet of the pump station.

The calculated future design flow ranging between **112.14 m^3/hr** and **287.60 m^3/hr** reasonably relate with the existing operating scenario and ensure adequate capacity to accommodate the current and future demands.

Hence, the Peak Wet Weather Flow (PWWF) of ***287.60 m^3/hr*** is accepted as a realistic demand and used to size the new pump station.

13.2 Rising Main Sizing

Taking into consideration of the recommended minimum self-cleaning velocity of 0.7m/s and a maximum velocity of 2.5m/s, to avoid excessive head loss, the selection of suitable size rising main was carried out for all the possible flow scenarios.

The flow velocity and total frictional loss calculation were also undertaken both for the existing **Ø300mm** AC and new **Ø300mm uPVC** pumping lines and summarised as follows:

Table 13.2: Comparison of existing and new pumping lines

Design Parameter	Ø300mm AC pipe	Ø300mm uPVC pipe
Total Length (m)	3500	3500
Design Flow (m^3/hr)	287.89	287.89
Flow Velocity (m/s)	**1.130**	**1.130**
Static Head (m)	4.763	4.763
Fictional Loss (m)	24.62	11.88
Total Dynamic Head (m)	**29.39**	**16.65**

Referring to the flow calculations and design requirements, the existing Ø300 mm AC pumping line is sufficient to accommodate the existing and future flow requirements. However, considering that the pipeline is reaching the operating life span it is therefore recommended to replace the line with Ø315 mm uPVC, Class 12.

Considering ease of the construction work in terms of affecting the existing infrastructures, and future maintenance work the three (3) different pipe routes have been identified for client's input and feedback.

Figure 13.1: Schematic layout of the proposed rising main routes

13.3 Pump Selection

Following the situational analysis of the operation of the existing pump station, it is proposed to have a 2+1 pumping configuration for the following main reasons:

- to accommodate the seasonal and hourly flow fluctuations and allow optimum pumping solution:
- to make sure that the pumps will not run for a duration longer than the recommended operating hours per day:
- to provide sufficient capacity for any exceptionally maximum and minimum flows: and
- to provide backup and spare capacity during pump breakage and regular maintenance

Since there are two duty pumps, the peak flow is divided in half, which halves the required pump capacity. Hence the required flow capacity of each pump is PWWF/2,

= ***139.3m³/hr (38.7 l/s)***

Therefore, the required duty point of the pumps is ***38.7 l/s @ 16.65m*** total head if the existing rising main is replaced with a new Ø315mm uPVC pipe. Otherwise, the required duty point will have to be ***38.7 l/s*** @ ***29.39 m*** to use the existing Ø300mm AC pumping line.

Based on the indicated duty points, the ***T6CSC-B-4 Groman-Rupp pump*** is envisaged to be suitable and the pump curve is shown in ***Figure 10*** below.

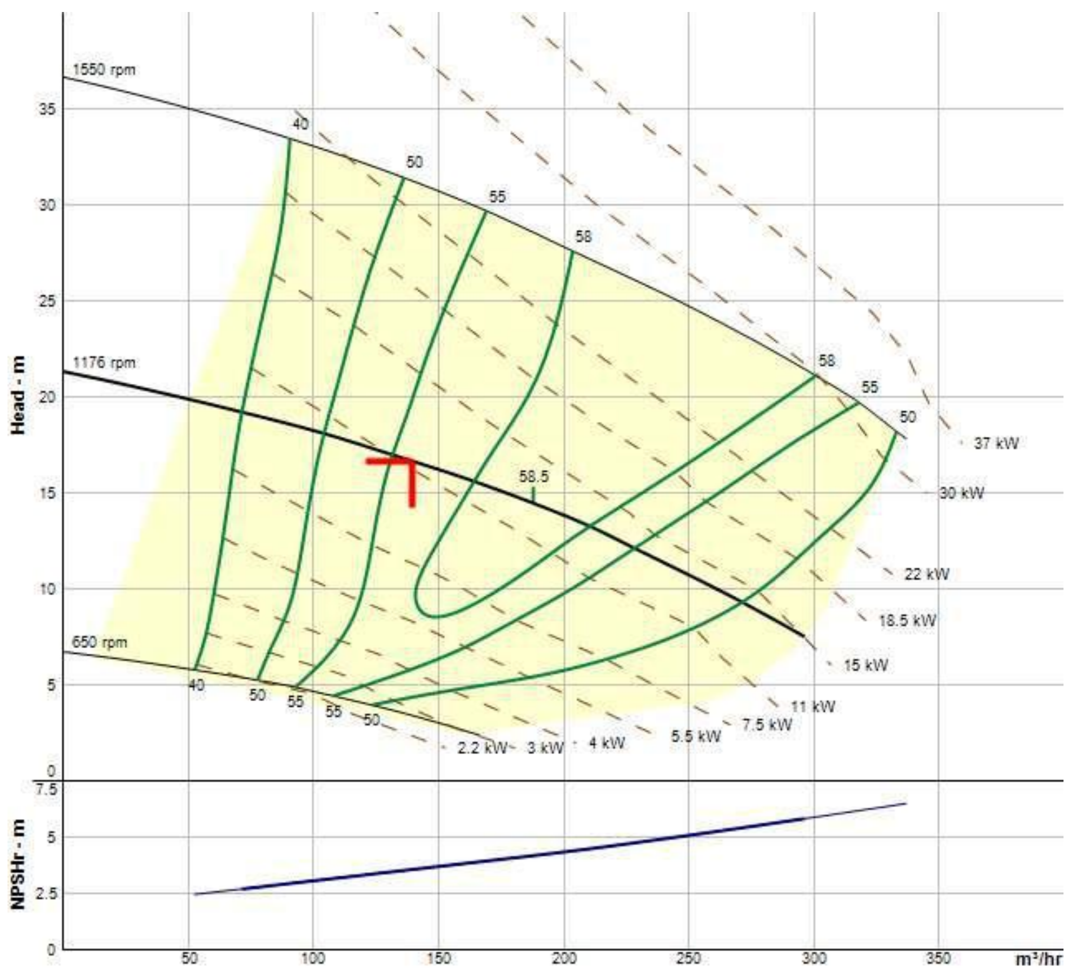


Figure 13.2: Selected pump curve.

13.4 Wet Well Sizing

The wet well is sized to provide adequate storage of sewage between pump starts. According to the pump manufacturer's criteria the minimum cycle time for pumps with motor size up to 35kW is 10 minutes (6 starts per hour). The equation used to determine the working volume is as follows:

T

Q

= 4

Where, V = Working Volume between pump starts, m³

T = Pump cycle time = 10 minutes=600 s

Q = Pump flow rate, m^3/s

Assuming a pump cycle time of 20 minutes (3 start per hour), the minimum required working volume is calculated to be **24m³.** However, the working volume can also be further reduced to ***12m³*** if the maximum recommended number of starts per hour is considered, 6 start per hour (10 minutes cycle time).

Therefore, a working volume of **24m³** is accepted as a suitable size. Moreover, considering the operational and service & maintenance requirements, it was recommended to have a wet well surface area of **15.9 m²** (L=6.9m and W=2.3m) and total operating depth (H) to be **1.5m.**

13.5 Emergency Storage

The minimum required emergency storage volume, for the 1.5hr, 2hr & 4hr durations will be 431.4m³, 575.2m³ and1150.4m³ respectively.

In addition to the wet well volume of ***24m***³, additional volume of ***20 m³*** is available as in the sand trap area to serve as an emergency storage. Since the available storage at the pump sumps will not be sufficient, the existing sewer network and manholes shall also serve as an emergency storage.

The pump station catchment area drawing received from the client indicated that, the total length of the existing sewer network is about ***95 999 m*** long and conservatively assuming the whole network to be Ø160mm uPVC pipeline, the available emergency storage is about ***1 610.76m³.*** The actual available capacity is envisaged to be more than the calculated volume, and this can be calculated if the as-built information of the sewer network is available.

Therefore, the existing sewer network and the pump station spare storage capacity will have a combined volume of at least **1 630.76m³** which can accommodate the required **4 hrs** of emergency storage volume.

13.6 Proposed Electrical/Instrumentation Installation

It is proposed that the electrical and instrumentation systems to be similar to what were installed at most recently constructed sewer pump stations. This will be beneficial for the client in terms of operator training, maintenance training and keeping of spare parts. The new installation will comprise of three parts, mainly electrical, back-up power and instrumentation. Please see below for more details on the proposed equipment and works.

- **Electrical Installation**

I. 400VAC Motor Control Centre (SABELCO)

- Incomer Section complete with Main Breaker with Lock-Out Handle, Surge Arrestors, CT's and PM2200 Power Monitor
- 3 x Motor Starters complete with Main Breaker with Lock-Out Handle, ATV650 Schneider VSD, Auto/Manual Selection, Emergency Stop, Running/Trip Indication and VSD HMI
- Control Section complete with Power Supply, Siemens S7-1200 PLC or similar and approved, I/O Modules and Schneider Magelis HMI unit
- 3-Phase Welding Maintenance Plug Feeder
- 3-Phase Auxiliary Feeder for Building Distribution Board
- 1-Phase Aircon Feeder

II. Building Installation

- Supply and installation of interior lighting
- Supply and installation of interior and exterior weatherproof power sockets
- Supply and Installation of hot dip galvanised cable tray and wire mesh systems

- **Back-Up Power**

Installation and integration of existing Cummins 400VAC, 50HZ, 100KVA prime rated backup generator with Utility Supply and new 400VAC Motor Control Centre.

- **Instrumentation Installation**

I. Instruments

- Endress & Hauser or similar and approved Pressure Transmitter for plant outlet pressure.
- Endress & Hauser or similar and approved Electro Magnetic Flowmeter for plant outlet flow complete with remote HMI unit.
- Endress & Hauser or similar and approved Ultrasonic Level Transmitter for continues sump level.
- Endress & Hauser or similar and approved Methane Gas monitoring transmitter.
- EGE or similar and approved now flow sensor for pump dry run protection.
- Endress & Hauser or similar and approved Float Switch for pump flood alarm

II. Telemetry

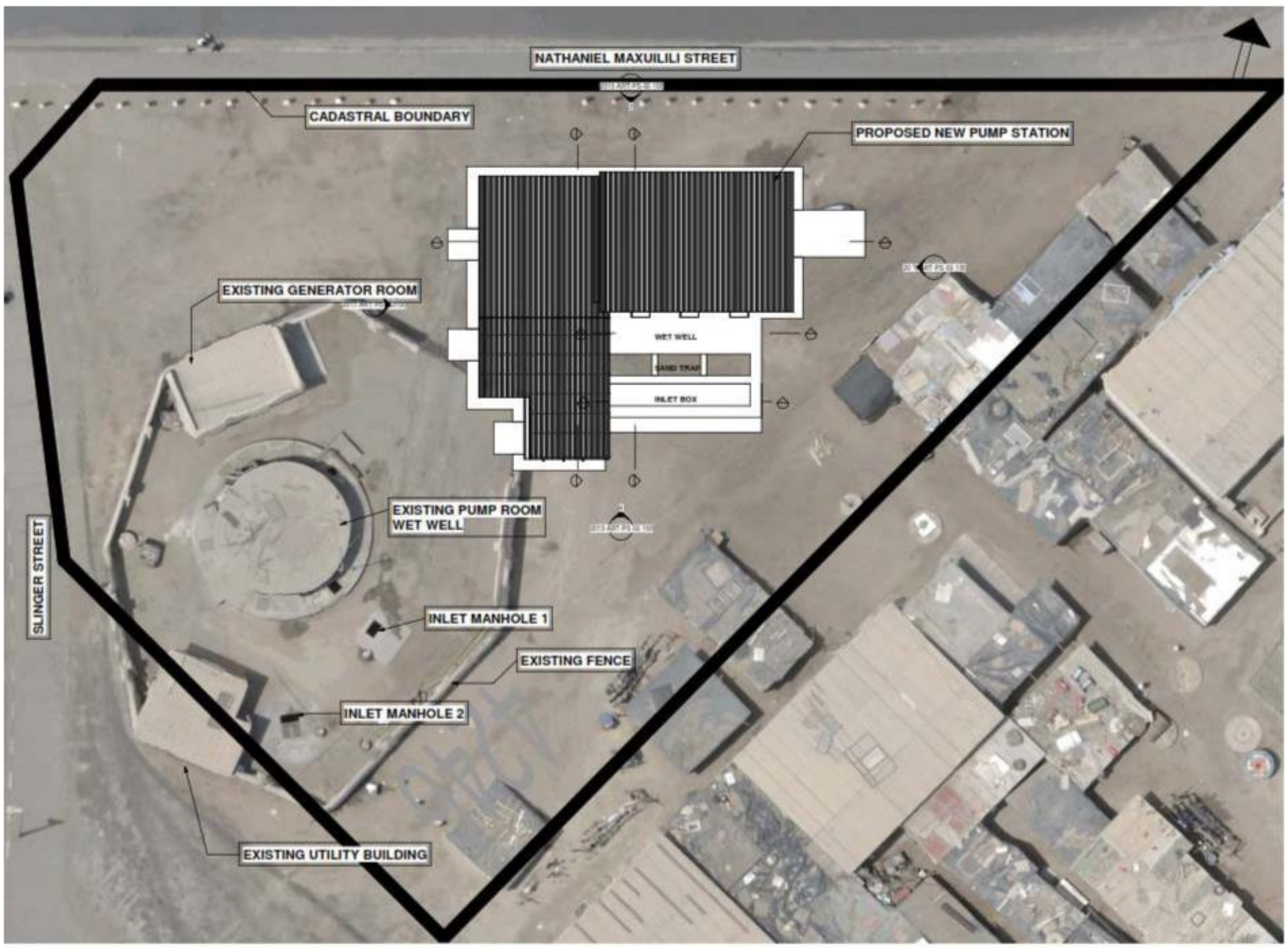
- SSE Telemetry System complete with Power Supply, RTU, I/O Modules, MDS Radio and external antenna
- Battery Back-up for Telemetry System

13.7 Proposed Conceptual Layout And General Arrangement

An option study was completed to determine what type of pump station configuration would be preferable for this site. The main selection criteria include, available space and existing services, engineering viability, operational preference, cost effectiveness and aesthetics.

The proposed conceptual layout and general arrangement drawing is shown below.

Figure 13.3: Conceptual layout and proposed general arrangement and drawing



CHAPTER 8

14 PROJECT IMPLEMENTATION

14.1 Preliminary And Detail Project Design

The consecutive preliminary and detail designs will commence up on the receipt of the client input and comment on this inception report. As outlined in this report, the design team will require the client confirmation on the design assumptions made, design criteria selected, and proposed conceptual layout and general arrangement drawings.

This EIA Report includes most of the preliminary design information as required by the client, and hence the report with be will be firmed up with the client input and re-submit as a preliminary design report.

14.2 Construction Management

The proposed new development will require various operation in a constrained area the site work predominantly involves removal of site material to the proposed subgrade level of the new structure, construction of water retaining concrete works, pumping of underground water continuously, and protection of the existing pump station. This will require a maximum excavation depth of up to seven (7) metres below existing ground levels.

A Construction Management Plan (CMP) will be prepared prior to construction works commencing and submitted to MWB for approval. This document will include environmental management controls to be implemented during the construction period, including any specific requirements specified in any future Resource Consent.

The ECMP will include, but not be limited to the following components:

- Site access arrangements during construction
- Construction noise management
- Public amenity and safety
- Environment monitoring requirement

It is intended that the adjacent pedestrian and traffic access roads will remain open during the period of construction works.

14.3 Construction Challenges

Amongst construction challenges that will need to be planned for include the following:

- **Risk of excavation collapse at the sump** – due to the substantial depth of the sump and the proximity of existing structures consideration will need to be made to prevent construction works that lead to real danger:
- **Risk of excavation collapse for pipeline** – as a pumping main the flexibility to limit excavation depth exist and thus mitigate against the risk of collapse. The danger of the available alignment is the existence of development along the pipeline route and thus important to manage this risk:
- **Dewatering** – the high-water table presents three challenges: ensuring water free working area, avoiding excessing pumping leading to excavation collapse and finally disposal of pumped water. A strategy will be developed that mitigates against all three of these risks:
- **Traffic disturbance** – there will be disturbance to traffic during construction which will be mitigated in line with the EMP that is a product of the EIA process: an
- **Disposal of excavated material** – any excavation produces excess material lthat need to be disposed of. The EMP will provide guideline on how this will be undertaken such as not to negatively affect people in the town.

Planning against these challenges includes design solutions chosen and ensuring that the tender documents clearly highlight the risk contractors are exposed to. In doing this it ensures that during construction supervision there are no unnecessary squabbles of responsibilities.

14.4 Construction Sequencing

The replacement pump station will be constructed while the existing station remains in service by following the construction sequencing plan outlined below:

- Construct new pump station and rising main:
- Construct re-routing of incoming pipelines and manholes:
- Connect new pump station to the new rising main:
- Test new pump station with existing station serving as backup:
- Permanently disconnect the existing pump station and rising main:
- Demolish the existing pump station structures and de-commission the existing rising main: and
- Permanently modify the pump station area and construct any other services including, landscaping, parking, new fencing, and other required utilities.

CHAPTER 9

15 ANALYSIS OF ENVIRONMENTAL IMPACTS

15.1 Summary of Impacts

Table 15.1 summarizes the impacts for each activity related to the project and presents the magnitude, frequency, likelihood and consequence of each impact.

Table 15.1: Summary of Impacts

Activity	Type of Impact	Magnitude	Frequency / Duration	Likelihood	Consequence (+/-)
CONSTRUCTION PHASE					
Site Preparation	Construction of the New Main Sewerage Pump Station And Rising Main may cause increase in traffic in the area	Medium	Only during construction	Medium	Negative
	Construction of a temporary site offices and lay down area may have a limited impact on the topography	Medium	Only during construction	Medium	Negative
	Commercial activities hindered because of the difficulty of access	Medium	Only during construction	Medium	Negative
General use of vehicles and machinery	Water for wash down of vehicles and machinery on site may contaminate groundwater	Significant	Only during construction	Low	Negative
	Spills or leaks of fuels, lubricants or chemicals from machinery and vehicles may contaminate groundwater	Significant	Only during construction	Low	Negative
	Source of noise	Medium	Only during construction	High	Negative
	General laborers presence on site	Medium	Only during construction	Medium	Negative
	Inadequate storage and management of litter	Medium	Only during construction	Medium	Negative
	waste and liquid wastes prior to disposal	Medium	Only during construction	Medium	Negative
	Effluent from construction workers' temporary amenities leaching into	Significant	Permanent	Medium	Negative

	groundwater, carrying nutrients and micro-organisms				
	Contamination of the storm water from litter and construction wastes and untreated effluent from temporary workers' amenities	Medium	Only during construction	Low	Negative
	Odor generated from sewer of worker's amenities	Significant	Only during construction	High	Negative
	Traffic due to transport of personnel	Medium	Only during construction	Medium	Negative
Excavation works	Heavy noises near schools can affect learning	Medium	Only during construction	Minimal	Negative
	Dust emissions generated from earthworks due to loading and unloading of materials on site and from uncovered truckload in addition to the potential dust emissions that could occur as a result of excavation for the new main sewer pump station and rising main network	Minimal	Only during construction	Medium	Negative
	Contamination of storm water from exposed soils	Minimal	Only during construction	Medium	Negative
	Generation of excavation material to be disposed of	Medium	Only during construction	High	Negative
	Potential public safety concerns associated with the excavation works for the installation of the water supply network	Low	Only during construction	Low	Negative
Manhole construction	Potential worker accidents from constructing manholes	Significant	Only during construction	Low	Negative
Breaking of existing concrete bases of the old pump station and rising main	Generation of debris to be disposed outside the project site	Medium	Only during construction	High	Negative
	Dust emissions during breaking of concrete that might affect workers health	Medium	Only during construction	High	Negative
Disposal of debris hauling to	Traffic congestion	Medium	Only during construction	Medium	Negative
	Adverse impact on the health of the workers and residents in and	Significant	Only during construction	Medium	Negative

an approved location	around the due to deterioration of the air				
	Adverse impact on the health of the workers and residents in and around the due to deterioration of the air quality, increase of noise and traffic	Significant	Only during construction	Medium	Negative
	Volatile emissions during earthwork phase from solvents and fuels stored or used on the Project site	Significant	Only during construction	High	Negative
	Exhaust and dust emissions from construction vehicles and machinery	Medium	Only during construction	High	Negative
Facility façade	Negative visual effect on aesthetics	Minimal	Permanent	Low	Negative
Installation of electric cables to connect pumps with the power source	Use of potentially harmful materials (e.g. PCB)	Significant	Permanent	Low	Negative
OPERATIONAL PHASE					
Delivery of Sewerage Treatment Plant supplies	Increase traffic of vehicles required to deliver materials and supply for the treatment processes	Low	Permanent	Low	Negative
Waste generation	Chemicals coagulation, settled water from pre-sedimentation	Minimal	Permanent	Low	Negative
Pump room operation	Halted operation due to electricity cuts	Medium	Single event occurrences	Low	Negative
	Pollution in case generators are needed	Minimal	Permanent	Medium	Negative
	spills and propagation of chemical elements (e.g. PCB, oil, etc.)	Significant	Permanent	Medium	Negative
	Risk of leakage from fuel storage tanks	Significant	Permanent	Medium	Negative
	Noise pollution	Minimal	Permanent	High	Negative
Water treatment plant facility	Additional use of energy to operate the pump station (electricity)	Minimal	Permanent	Low	Negative
	Aesthetics	Minimal	Permanent	Low	Negative
Land use around facility	Deterioration of landscape vegetation that exists at the proposed	Minimal	Permanent	Low	Negative

15.2 Analysis of Negative Impacts and Mitigating Measures

After a qualitative study of the potential impacts that are caused by the construction of the new Construction of a New Main Sewerage Pump Station and Rising Main, mitigation measures were developed to attenuate negative impacts as much as possible.

The project is an expansion of an existing plant, therefore the impacts will be minimal when included to those generated from the current facility.

Excavation and construction activities will be restricted to daytime only for less noise and dust impact.

Traffic impact at the site location is minimal during construction of the water treatment plant since it is a remote area where traffic is almost negligible. In the village, provisions will be made for a shared worker's transport from workers accommodation to the proposed Project site and avoid transportation activities during traffic peak hours (8:00 AM – 9:00 AM and 5:00 PM to 6:00 PM).

Palm Trees shall be planted around the site to improve the visual impact and reduce noise and dust.

Further mitigation measures are elaborated in **Table 16.1.**

With the population increase and the influx of job seekers, the implementation of this project is necessary to meet with the population needs. Almost 50 000 inhabitants will benefit from the proposed development.

15.3. Long-Term or Cumulative Effects

Management regulations and appropriate operation procedures are required to achieve full control.

16 ENVIRONMENTAL CONSIDERATIONS DURING IMPLEMENTATION

16.1 Environmental Impacts and Mitigation Measurers

The mitigation actions and approaches of all identified impacts are presented in Table 7.1

Table 16.1: Impacts And Mitigation Measures

Activity/Impact	Mitigating Actions and Approaches
Construction of a temporary site offices and lay down area may have a limited impact on the topography	Limit earthworks to the minimum required for the proposed facilities such as site office
Commercial activities hindered because of the difficulty of access	Local residents should be employed during the construction phases wherever feasible
Water for wash down of vehicles and machinery on site may contaminate groundwater	Provision of uncontaminated water for dust suppression and wash down of vehicles and machinery
Spills or leaks of fuels, lubricants or chemicals from machinery and vehicles may contaminate groundwater	Spill control measures should be implemented to prevent spills from infiltrating into the groundwater table. Measures should include appropriate materials handling and storage procedures, and development of contingency plans in the event of a spill
	Make sure all machinery and vehicles are fitted with appropriate mufflers,

Noise pollution during construction	and that all mufflers and acoustic treatments are in good working order;
	Make sure all machinery and vehicles are regularly maintained and broken parts (such as mufflers) are replaced immediately

Activity/Impact	Mitigating Actions and Approaches
	Make sure all machinery and vehicles are operated efficiently and according to the manufacturers specifications, by trained and qualified operator
	Make sure that activities likely to cause adverse noise impacts are timed to have least impact on surrounding land users and other site activities (such as the residential areas)
	Make sure all personnel are issued with hearing protection and are advised of its proper use
	Consultation of earthwork hours with affected residents and nearby sensitive receivers
Inadequate storage and management of litter, construction waste and liquid wastes prior to disposal	Waste management measures should be implemented to prevent litter and debris and liquid wastes from entering soil excavations
Effluent from construction workers' temporary amenities leaching into groundwater, carrying nutrients and micro-organisms	Provision of temporary amenities for workers. Effluent should be treated or suitably disposed off-site

Contamination of the storm water from litter and construction wastes and untreated effluent from temporary workers' amenities	Waste control measures should be implemented to prevent litter and construction waste from infiltrating into the groundwater table
	Provision of suitable workers' amenities facilities. If possible, effluent should be disposed of off-site at a nearby STP
High volume of excavation and filling may alter flow paths within the portions under construction	Re-use any excess excavation material generated by the construction within the site or on the other nearby projects. The deposit of waste to landfill is a last resort.

Activity/Impact	Mitigating Actions and Approaches
	Reduce as much as possible difference between cut and fill
Odor generated from sewer of worker's amenities	Provision of suitable workers' amenities, located within the construction area and, if possible, downwind from residential areas
	Regular maintenance of workers' amenities, including the emptying of effluent storage tanks
Traffic congestions	Provision of shared worker's transport from workers accommodation to the proposed Project site
	Installation of warning signs and specified speed limits (site roads should reduce traffic speeds to 20 km/hr)
	The use of local construction materials where practical to avoid long jorneys
	Provision of adequate lighting on site road and parking areas

	Timing of construction activity, such as restricting construction traffic to designated roads during designated times, avoiding peak hour traffic
	Design a traffic plan to make sure that traffic avoids, where possible, congested and heavily populated areas and dusty roads
Heavy noises near residential plots can affect tranquility	Construction works within 100m of schools should be restricted to outside school hours (such as before and after school, during school holidays or weekends, or left as the final stage of works); Wire fence meshing, dust screens or wooden hoardings should be installed to delineate the construction area and therefore decrease impacts; The access points for construction vehicles should be a minimum of 100m from smallholdings / plots access

Activity/Impact	Mitigating Actions and Approaches
Dust emissions generated from earthworks due to loading and unloading of materials on site and from uncovered truckload in addition to the potential dust emissions that could occur as a result of excavation for the sewer pipeline network	Minimizing the height and slope of stockpiles to ensure erosion of unconsolidated materials during rainfall events does not occur
	Side enclosure and covering, by impervious sheeting, of any aggregate or other dusty material stockpiles
	Dusty vehicle loads transported to, from and within the Project site should be covered by sheets and should not be overloaded
	Use of water sprays to decrease dust generation
	The height and slope of stockpiles should be limited to minimize erosion of unconsolidated materials during rainfall events

Contamination of storm water from exposed soils sediments	Locating stockpiles on flat areas, away from storm water. Ensure that sediment or erosion cannot reach a waterway; Diversion of overland flow around work areas / construction sites
Generation of excavation material to be disposed of	Re-use of excavated material for the project or other projects in the area
Potential public safety concerns associated with the excavation works for the installation of the water supply network	The area surrounding the excavations should be fenced off or otherwise restricted from public access to prevent injury or accident due to entry onto a construction site
Potential worker accidents from constructing manholes	Following mitigation measures are recommended for the prevention of gas emissions
Generation of debris to be disposed outside the project site	Solid waste that cannot be re-used shall be disposed of in approved landfills
Dust emissions during breaking of concrete that might affect worker's health	Use of water sprays to decrease dust emissions

Activity/Impact	**Mitigating Actions and Approaches**
Adverse impact on the health of the workers and	

residents in and around the due to deterioration of the air quality, increase of noise and traffic	Implement the air quality, noise and traffic mitigation measures as described in the relevant sections
Volatile emissions during earthwork phase from solvents and fuels stored or used on the Project site	Ensure all machinery is in good order and repair and not leaking fuel or volatile emissions from fuel tanks or fuel lines
	A full list of all volatile fuels and chemicals stored on site should be kept by the site supervisor, including accompanying volumes, locations and Material Safety Data Sheets (MSDSs)
Exhaust and dust emissions from construction vehicles and machinery	Use of modern machinery, with adequate pollution control devices. Regular maintenance and inspection programs for all construction vehicles.
	Proper and efficient operation of construction machinery and vehicles by qualified workers
	Regular maintenance and inspection program for all construction vehicles
	Minimize unnecessary operation of construction machinery, including efficiency of trip times and reduction of double handling through appropriate placement of stockpiles, haul roads, work depots and work areas
	Daily visual checks to ensure the above points are followed, particularly in regards to smoke emissions from vehicles and plants. Equipment generating smoke should be given defect notices and taken out of service until repaired and approved for re-deployment by site supervisor.
Visual effect on aesthetics	Design facilities' facades in a subtle way that matches its surroundings and reduce their size as much as possible to minimize the potential negative effects on aesthetics.

Activity/Impact	Mitigating Actions and Approaches
Use of potentially harmful materials (e.g. PCB)	Limit use of harmful materials. If unavoidable, impose monitoring and maintenance
Improper sewer dosage may alter quality	Regular monitoring of sewer content and of treatment performance

Activity/Impact	Mitigating Actions and Approaches
Halted operation due to electricity cuts	Use backup sources of power (e.g. traditional, renewable, etc.)
Pollution in case generators are needed	Use double hulled storage tanks for fuel
Contamination of water due to spills and propagation of chemical elements (e.g. PCB, oil, etc.)	Store chemicals in a contained location with no drainage connection to the water network
	Ensure that transformers are located on impermeable and contained surfaces
Risk of leakage from fuel storage tanks	Cover area where fuel storage tank is located with impervious material to limit leakage to groundwater
Noise pollution during operation	Plant trees and shrubs around facility and fitting of mufflers on equipment
Aesthetic issue	Plant trees and shrubs around facility
Additional use of energy to operate the facility (electricity)	Use alternative power sources such as solar power

Deterioration of landscape (trees and plants) that exists at the proposed new site location	Plant trees and shrubs around facility

16.2 Monitoring Environment Effects and Mitigation

During the construction phase, the resident engineer on site would designate a person to continuously monitor the activities that have been highlighted above that would cause a negative impact and that subsequently necessitate mitigation action. The monitoring would ensure that mitigation measures are strictly followed and any nonconformance would be reported to the resident engineer for correction. Some monitoring activities would include but not be limited to:

- **Site inspection**
- **Construction activities**
- **Disposal activities**
- **Worker behavior**
- **Traffic**
- **Power supply**

Such a monitoring effort would limit any negative impact from nonconformance and would enable a better implementation of the management plan.

In order to ensure that the plant and the corresponding entities (tanks, network, valves and fittings, etc.…) are properly operating there would be a team led by the Walvis Bay Municipality, designated for their follow-up. During operation this team would also monitor on a regular basis the level of water in the lake, chlorination dosage and power supply – the main potential sources of negative impacts.

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