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FRONTIER SALDANHA UTILITIES

Saldanha Regional Marine Outfall

Concept Options Trade-Off Assessment Report

277760 – 00-CS-REP-0001

12 June 2013

WorleyParsons RSA

31 Allen Drive, Loevenstein, 7530 Bellville, South Africa

Tel: +27 (0)21 912 3000

Fax: +27 (0)21 912 3222

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PROJECT 277760 - SALDANHA REGIONAL MARINE OUTFALL

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1. INTRODUCTION

Frontier Saldanha Utilities (Pty) Ltd ('Frontier Saldanha Utilities') have appointed WorleyParsons RSA (Pty) Ltd. ('WorleyParsons') to provide Engineering Services in respect of investigating options for disposal of effluent to sea from Frontier Saldanha Utilities' proposed separation plant in the Saldanha area. The expected effluent flow rate is considered to be in the order of 98.9 litres per second or 8.55 Ml/d.

The intention is that following construction of the West Coast District Municipality (WCDM) desalination plant, the separation plant will share the outfall pipeline from the desalination plant. However, as the construction date for the desalination plant is uncertain, it is proposed to develop the design and submit an Environmental Impact Assessment (EIA) for a 'temporary' outfall solution that would be constructed and operated until the desalination plant is operational.

The outfall pipeline is to be designed to accommodate effluent from three potential sources:

- Frontier Separation (Pty) Ltd Rare Earths Separation Plant (SSP);
- Chlor Alkali Holdings Pty Ltd (CAH) Chlor Alkali Plant;
- a proposed municipal Waste Water Treatment Works (WWTW) by WCDM.

The scope of work entails two phases; the concept development of outfall options which constitutes phase A of the study and phase B which is comprised of a preliminary design of a marine outfall for the preferred option. The scope of work is summarised below:

- first phase: Concept Options Trade-off Assessment;
    - Three (3) marine pipeline routes/options to be identified and assessed;
    - Concept cost estimates to be developed to +/-50% level
    - Recommendation of preferred option to take forward
- second phase: Preliminary design of preferred option to +/-15% cost accuracy level

This report summarises the results of the first phase Trade-Off Assessment.

It is noted that outfall options in and around Danger Bay have been considered. As directed by Frontier Saldanha Utilities, pipeline routes into Saldanha Bay, similar to those considered for the West Coast District Municipality (WCDM) desalination plant, have not been considered in this study as they were identified unsuitable by the WCDM desalination plant studies.

This report references and should be read in conjunction with the design criteria detailed in the Basis of Design (BoD) (WorleyParsons report 277760-00-CS-REP-0001, May 2013).

2. GENERAL INFORMATION

2.1 Abbreviations

The abbreviations summarised in **Table 2-1** are used throughout this report.

Table 2-1: Abbreviations

Abbreviation	***Definition***
CAPEX	Capital Expenditure
EPC	Engineering, Procurement and Construction
CD	Chart Datum
EIA	Environmental Impact Assessment
HDD	Horizontal Directional Drilling
OPEX	Operational Expenditure
RHDHV	Royal Haskoning DHV (onshore pipeline designers)
SSP	Saldanha Separation Plant
WCDM	West Coast District Municipality
WP	WorleyParsons
WWTW	Waste Water Treatment Works

3. CONCEPT OPTIONS SELECTION

3.1 Selection Criteria

The initial identification and selection of options for the outfall pipeline route was based on various relevant criteria, including the following:

- distance from suitable points of connection to the Royal Haskoning DHV designed onshore section of pipeline, which follows the route of the WCDM pipeline from the proposed desalination plant at Danger Bay to the reservoir inland;
- suitability for adequate dispersion of effluent;
- minimising interference from and to future construction of WCDM desalination plant and pipelines;
- restrictions posed by land ownership;
- known seabed features;
- preliminary assessment of likely constructability issues and
- understanding of environmental impact issues developed from WCDM desalination plant environmental impact assessment process.

Based on these criteria, three options were selected as summarised below and as shown on the Outfall Options Locality Plan (277760-CS-DLP-001 Rev D) attached in Appendix 1.

The Outfall Options Locality Plan was tabled and the three options discussed and agreed with Frontier Saldanha Utilities at the Trade-Off Options meeting held at WorleyParsons' offices in Cape Town on 30th April 2013.

3.2 Option 1

The Option 1 route connects to the onshore pipeline at the north corner of the proposed desalination plant site. The pipeline then follows a route approximately south along and just inside the desalination plant footprint western boundary and through the dunes to the sea. It is proposed that the pipe will continue along the same alignment through the surf zone to deeper water, however at some point it would likely be necessary for the pipe to turn south east to a discharge point in a less sheltered part of the bay for adequate dispersion of the effluent.

The principal philosophy behind the initial selection of this route as an option was:

- by following the boundary of the desalination plant site the potential disruption to/from the desalination plant construction would be reduced;

- the north west end of the bay represents the most sheltered area for ease of construction for the pipeline and
- the route represents the shortest direct route to the sea from the connection point.

3.3 Option 2

The connection point for the Option 2 route would form an effective continuation of the desalination plant proposed pipeline route directly to the sea to the southeast of the desalination plant site.

The principal philosophy behind the initial selection of this route as an option was:

- the total length of pipeline (onshore and offshore combined) to be constructed at this stage would be significantly reduced;
- a route avoiding the desalination plant and associated pipelines would minimise the potential disruption to/from the desalination plant construction and
- discharging the effluent into a significant distance from the desalination plant intake pipeline would reduce any potential recirculation issues for the desalination plant intake;

3.4 Option 3

The connection point for the Option 3 route to the onshore pipeline is the same as for Option 1. The pipeline would then follow a route approximately west to enter the small rocky bay to the west of Danger Bay.

The principal philosophy behind the initial selection of this route as an option was:

- a route avoiding the desalination plant and associated pipelines would minimise the potential disruption to/from the desalination plant construction and
- discharging the effluent into a separate bay would avoid any potential recirculation issues for the desalination plant intake.

3.5 Additional Options

Two further options were initially considered but were not considered as viable for further assessment.

3.5.1 Partial construction of final desalination plant outfall pipeline

The option to construct part of the WCDM desalination plant pipeline at this stage to avoid the duplication of the future construction activities, particularly the pipeline shore crossing, was considered. However this was not judged feasible for the following reasons:

- as there are two pipelines (intake and outfall) for the desalination plant, the shore crossing construction would need to include sections of both pipes to avoid the need for future shoreline crossing works. The cost of this would be excessive;
- if a partly constructed desalination plant outfall is used for the separation plant effluent, it would be necessary to disrupt the effluent flow at the time of the construction and commissioning of the desalination plant and remaining pipeline sections. As the extent of the disruption could not be determined at this stage, this represents a considerable future risk for Frontier Saldanha Utilities and
- significant additional design effort would be required to progress the desalination plant pipelines designs to the level required to allow this option to proceed. This would result in additional costs and schedule delays for Frontier Saldanha Utilities.

3.5.2 Jacob's Bay Route

Due to significant reductions in the total length of the onshore pipeline, a pipeline discharging into Jacob's Bay (north of Danger Bay) could present significant capital cost savings. Jacob's Bay would also appear to offer advantages for the construction of the outfall pipeline, due to a sheltered environment within the bay and reasonable access to the site.

However we understand that this route was considered unsuitable for the WCDM desalination plant intake and outfall due to the environmental impacts and public opposition. Although the details of the separation plant outfall would be different, the advice provided by the Frontier Saldanha Utilities environmental impact assessment consultant was that this option would face similar issues and would be unlikely to receive approval. Therefore Frontier Saldanha Utilities instructed that this option should not be assessed further.

4. OPTIONS TRADE-OFF ASSESSMENT

4.1 Assessment Method and Criteria

To determine the preferred route option, a matrix has been developed consisting of relevant criteria separated into categories and subcategories against which each option could be measured. The assessment criteria categories identified as appropriate for the assessment are:

1. coastal Processes & Effluent Dispersion;
2. pipeline Design and Construction;
3. potential Impact on and of Future Desalination Plant Construction;
4. financial;
5. marine Ecological Impact and
6. terrestrial Ecological Impact.

The assessment procedure has been developed as follows:

- each category has been weighted as a proportion of 100 per cent, to represent its importance in relation to the overall feasibility of the option;
- each category has been divided into relevant subcategories, also weighted as a proportion of 100 per cent of the parent category;
- each option has been allocated a score from 1 (lowest/best) to 10 (highest/worst) against each subcategory. A score of zero applies where a subcategory is not relevant to the option;
- the score for each option for a subcategory is multiplied by the percentage weighting of that subcategory;
- the weighted scores for each subcategory are summed to determine an overall subcategory score for each option;
- the subcategory scores are multiplied by the percentage weighting of the parent category and summed to determine a final score for each category and
- each option is ranked by score, with the lowest scoring option recommended as the preferred option.

The categories, subcategories and relevant weighting are summarised in Table 4-1 below.

Category	Weighting	Subcategory		Subcategory Weighting
1. Coastal Processes & Effluent Dispersion	10%	1.1	Effective effluent dispersion from outfall	30%
		1.2	Vulnerability of pipeline to major storms (particularly in excess of design event)	30%
		1.3	Vulnerability of pipeline to coastal erosion	25%
		1.4	Impact of presence of pipeline on coastal processes	15%
			Total:	100%
2. Pipeline Design and Construction	20%	2.1	Geotechnical/geophysical/bathymetric - survey requirements	5%
		2.2	Pump station - access routes & services	10%
		2.3	Pipeline maintenance - accessibility	5%
		2.4	Pipeline construction method: connection to onshore pipeline to back of dunes	15%
		2.5	Pipeline construction method: through dunes to high water mark	15%
		2.6	Pipeline construction method: through surf zone	25%
		2.7	Pipeline construction method: seabed beyond surf zone to pipeline end	25%
			Total:	100%
3. Potential Impact on and of Future Desalination Plant Construction	5%	3.1	Potential for recirculation of effluent discharge to affect desalination plant intake	40%
		3.2	Potential for desalination plant/intake/outfall pipeline construction to damage or disrupt operation of SSP outfall	20%
		3.3	Potential for SSP outfall location to cause difficulties for desalination plant or pipelines construction	20%
		3.4	Ease of future connection into desalination plant outfall pipeline	20%
			Total:	100%
4.Financial	15%	4.1	Estimated Construction Cost (+/- 50%)	90%
		4.2	OPEX considerations (subjective only, comparison with lowest cost option, no costing)	10%
			Total:	100%
5. Marine Ecological Impact (Note: Inputs provided by CSIR.)	20%	5.1	Disturbance of Intertidal Sandy beach systems	15%
		5.2	Disturbance of Subtidal macro faunal communities	15%
		5.3	Disturbance of Rocky intertidal and subtidal biota (including blasting)	20%
		5.4	Effects of discharge in low-oxygen benthic zones	15%
		5.5	Effect of discharges (brine, sewage and REM) on marine biota at discharge point	20%
		5.6	Impact on inshore fisheries	15%
			Total:	100%
6. Terrestrial Ecological Impact (Note: Inputs provided by CSIR.)	30%	6.1	Rocky outcrops (very high sensitivity for both fauna and flora; low rehabilitation potential)	40%
		6.2	Sensitive Vegetation and associated Species of Conservation Concern - Saldanha Granite Strandveld	40%
		6.3	Critical Biodiversity Areas and Ecological Support Areas	20%
Total:	100%		Total:	100%

Table 4-1: Assessment Criteria and Weighting

The environmental assessment of the options (Category 5: Marine Ecological Impact and Category 6: Terrestrial Ecological Impact), including the identification of category and subcategory criteria,

weighting proportions and scoring have been proposed and assessed by the EIA consultant, CSIR, independently of the technical and financial assessments prepared by WorleyParsons. The results of CSIR's assessments have been included in the assessment matrix at the request of Frontier Saldanha Utilities for comparative purposes only. WorleyParsons has not had any influence on, commented on or accepted any responsibility for any part of the environmental assessments provided by CSIR.

The criteria, weighting and scoring were discussed and agreed with Frontier Saldanha Utilities at the Options Trade-Off meeting of 23rd May 2013.

The key issues considered in the assessment of each option are summarised in Sections 4.2, 4.3 and 4.4 below. The assessment also includes the comparison of the CAPEX estimates as detailed in Section 5. The completed assessment matrix is attached in Appendix 2.

The assessment of the options included a site visit on 3rd May 2013 to visit each option location.

4.2 Option 1 Assessment

The approximate location of Option 1 is indicated in Figure 4-1. The following key points were noted during the site visit and subsequent assessment of Option 1.

4.2.1 Assumed Pipeline Design and Construction

Our assessment of Option 1 is based on the following assumptions:

- a fairly shallow burial of the pipeline across the beach and through the surf zone will be acceptable, using a post lowering construction technique (pipeline placed on surface then excavation around pipe to lower into sand), in order to:
    - avoid excavation in rock, which is known to be fairly close to the surface and
    - avoid the need to construct a cofferdam or access jetty;
- no armour rock or other protection will be placed above the pipe through the surf zone. Instead a continuous concrete weight collar would be attached to the pipe through the surf zone to provide some protection from damage and stability to the pipe;
- beyond the reach of excavators working on the beach the pipeline would be placed on the surface of the seabed. Intermittent concrete weight collars would be used. Some self-burial of the pipeline into the sand would be expected;
- due to the known presence of rock outcrops near the surface, some degree of blasting to remove localised high rock may be required. This would be undertaken by divers operating from the beach;
- the pipeline on the surface with weight collars may be sufficiently stable under the design wave conditions to avoid the need for additional protection. However further modelling and

analysis will be required to confirm this. Our cost estimate is based on the assumption that armour rock protection offshore will be required;

- construction would be undertaken by South African contractors using locally available standard construction plant. The design would need to reflect the limitations of the construction plant and equipment and
- our assessment and cost estimate does not include the provision of power supplies to the pump station.

This construction method will be substantially cheaper than deeper burial of the pipeline. However it may result in a fairly limited cover above the pipe, which may lead to occasional exposure of the pipeline and an increased risk of damage due to vandalism or trafficking of vehicles above the pipe.

Frontier Saldanha Utilities need to understand and accept this increased risk, which should also be recorded in the EIA. If this risk is not deemed acceptable, it may be necessary to bury the pipe deeper through the beach and surf zone which would significantly increase the cost (see Section 5).

Figure 4-1: Option 1 Proposed Shore Crossing Location

The following construction issues have also been identified, among others:

- access along the pipeline route to the shore is relatively good, however some improvement would likely be required during construction. The improvement works would also benefit the desalination plant construction;
- appropriate space would be required to establish a stringing yard for the pipeline and
- the presence of large rocks offshore from the headland creates a relatively sheltered environment for the shore crossing works.

To allow greater confidence in the suitability of the proposed construction method, we recommend additional investigations into the geotechnical conditions be undertaken. This could include additional probes to ascertain sediment depths along the pipeline route and the excavation of onshore trial pits to determine the depth to the rock and basic properties of the rock (e.g. can it be excavated by a standard excavator).

4.2.2 Coastal Processes and Effluent Dispersion

In general we expect effective dispersion of the effluent from Option 1.

At this stage we have assumed that the outfall outlet will need to be located at -10m Chart Datum (CD) to allow adequate dispersion of the effluent. Furthermore we have assumed that the pipeline may need to head towards the southeast to discharge into a slightly less sheltered area. This is subject to confirmation from the results of the dispersion modelling.

The shore crossing (the most vulnerable part of the pipeline) is in a relatively sheltered location. Previous analysis of the shoreline stability in Danger Bay indicates a reasonably stable shoreline. Therefore we do not expect the pipeline to be particularly vulnerable to exposure due to long-term coastal erosion and the pipeline should be relatively well protected in the event of major storms in excess of the design storm event. The appropriate burial depth for the pipeline will be determined during the preliminary design phase.

4.2.3 Potential Impact On and Of Future Desalination Plant Construction

The potential for recirculation of effluent through the WCDM desalination plant intake pipe has been identified as a potential risk. However Frontier Saldanha Utilities has confirmed the intention that once the desalination plant is operational the SSP pipeline will be decommissioned with the SSP effluent diverted through WCDM outfall. Therefore as there will be no concurrent operation of the pipelines there will be no risk of recirculation following commissioning of the desalination plant.

There may though be a temporary risk of recirculation during the commissioning of the desalination plant before the SSP effluent is diverted and the temporary outfall decommissioned. Additional numerical modelling of the effluent dispersion is to be undertaken to refine the outfall location to minimise this risk.

The outfall runs through the footprint of the proposed desalination plant site and runs relatively close to the desalination pipeline route, so there is some risk of damage or disruption to the SSP outfall during construction of the desalination plant. Similarly the presence of the SSP outfall may cause complications for the desalination plant construction.

Frontier Saldanha Utilities should ensure comprehensive records of the details of the construction of the SSP outfall are taken, stored and made available to the desalination plant design consultants and construction contractors to reduce the risks of disruption.

4.2.4 Environmental Assessment (CSIR)

The area falls within a Critical Biodiversity Area which is a planning tool of CapeNature. If the WCDM desalination plant is constructed in line with the WCDM planning, this area will be degraded and will impact less on biodiversity compared to the pipeline in Option 2. The intertidal sandy beach system will be disturbed. The pipeline will cross approximately the same distance as option 2.

4.3 Option 2 Assessment

The approximate location of Option 2 is indicated in Figure 4-2. The following key points were noted during the site visit and subsequent assessment of Option 2.

4.3.1 Assumed Pipeline Design and Construction

Option 2 is generally similar to Option 1. Therefore the proposed shore crossing and offshore construction method are the same and many of the assumptions and factors detailed in Section 4.2.1 apply equally to Option 2.

However there are some differences as noted below:

- option 2 would represent a reduction in the overall combined length of the onshore discharge pipeline and marine outfall. Hence the total combined cost of the initial pipeline construction would be reduced. However once the WCDM desalination plant is constructed, it would be necessary to construct additional onshore pipeline to connect the outfall to the desalination plant site. Therefore the lifetime cost Option 2 would be greater;
- the length of the onshore component of the outfall pipeline is significantly longer than for Option 1, leading to an increased cost for the marine outfall in isolation;
- access to the pipeline route and shore crossing location is more difficult due to the uneven landscape through the dunes. Access improvement works would be greater than for Option 1; they will also not benefit the future desalination plant construction;

- there is a greater change in height between the top of the dunes and the beach, which will require the excavation of a deeper trench and more temporary works for the onshore component of the pipeline and
- the shore crossing location is more exposed at the Option 2 location, which may create some additional schedule and safety risks during construction.

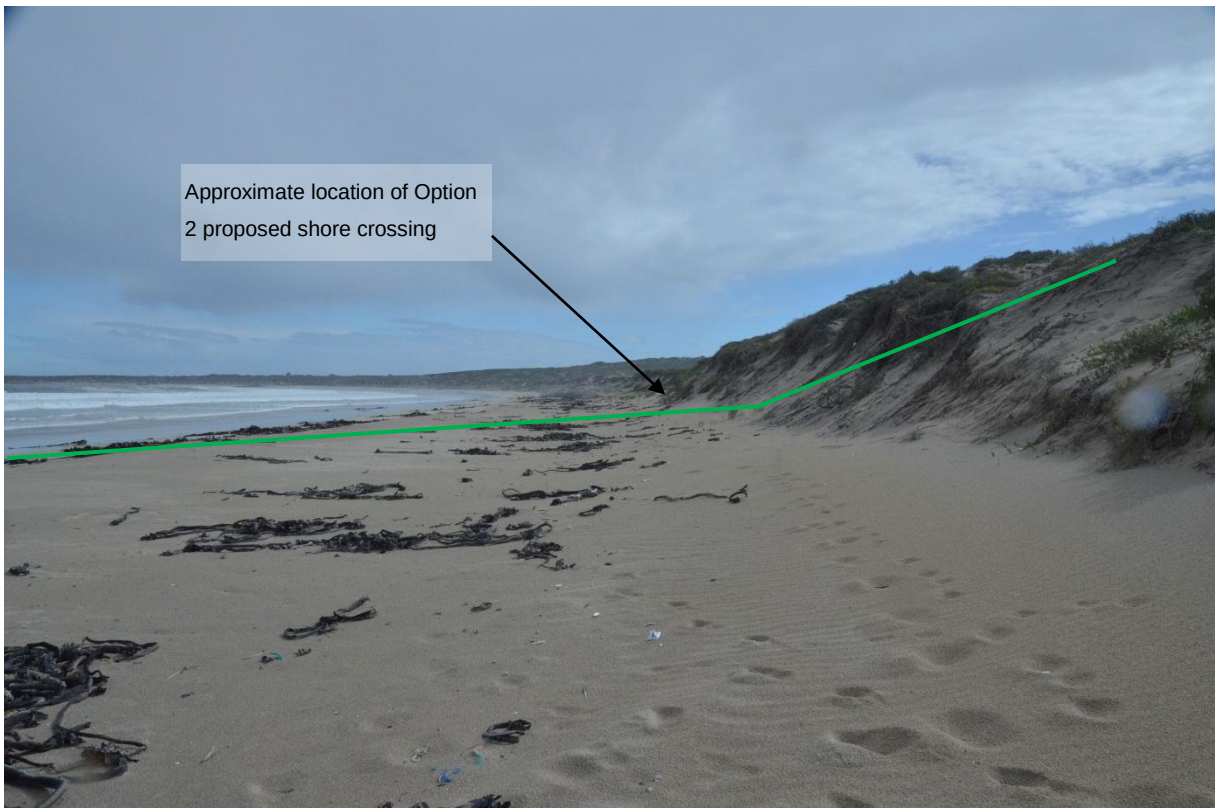

Figure 4-2: Option 2 Proposed Shore Crossing Location

As with Option 1 the assumed construction method will be substantially cheaper than deeper burial of the pipeline. However it may result in a fairly limited cover above the pipe, which may lead to occasional exposure of the pipeline and an increased risk of damage due to vandalism or trafficking of vehicles above the pipe.

Frontier Saldanha Utilities need to understand and accept this increased risk, which should also be recorded in the EIA. If this risk is not deemed acceptable, it may be necessary to bury the pipe deeper through the beach and surf zone which would significantly increase the cost (see Section 5).

To allow greater confidence in the suitability of the proposed construction method, we recommend additional investigations into the geotechnical conditions be undertaken. This could include additional probes to ascertain sediment depths along the pipeline route and the excavation of onshore trial pits to determine the depth to the rock and basic properties of the rock (e.g. can it be excavated by a standard excavator). Also an offshore geophysical survey would be required as this area has not previously been surveyed.

4.3.2 Coastal Processes and Effluent Dispersion

In general we expect effective dispersion of the effluent from Option 2.

At this stage we have assumed that the outfall outlet will need to be located at -10m Chart Datum (CD) to allow adequate dispersion of the effluent. This is subject to confirmation from the results of the dispersion modelling.

The shore crossing (the most vulnerable part of the pipeline) is in a more exposed location than that of Option 1. Previous analysis of the shoreline stability in Danger Bay indicates a reasonably stable shoreline. Therefore we do not expect the pipeline to be particularly vulnerable to exposure due to coastal erosion although the pipeline may be more vulnerable to exposure and damage from major storms in excess of the design storm event than Option 1. The appropriate burial depth for the pipeline will be determined during the preliminary design phase.

4.3.3 Potential Impact On and Of Future Desalination Plant Construction

Option 2 is located some distance from the desalination plant site and pipeline so disruption during construction and commissioning of the desalination plant is unlikely.

Nevertheless Frontier Saldanha Utilities should ensure comprehensive records of the details of the construction of the SSP outfall are taken, stored and made available to the desalination plant design consultants and construction contractors to reduce the risks of disruption.

4.3.4 Environmental Assessment (CSIR)

The area falls within a Critical Biodiversity Area which is a planning tool of CapeNature. If the WCDM desalination plant is constructed in line with the WCDM planning, this area will be degraded and will impact more on biodiversity compared to the pipeline in Option 1. The intertidal sandy beach system will be disturbed. The pipeline will cross approximately the same distance as option 1.

4.4 Option 3 Assessment

The approximate location of Option 3 is indicated in Figure 4-3. The following key points were noted during the site visit and subsequent assessment of Option 3.

4.4.1 Assumed Pipeline Design and Construction

The shoreline at the location of Option 3 is completely different from Options 1 and 2 in that it is a rocky shoreline covered with numerous boulders. Similarly the overland portion of the outfall would partially cross the rocky headland.

The bay is also considerably more exposed than Danger Bay; very challenging wave conditions were noted during the site visit and the presence of large rocks offshore would present a significant hazard to marine plant operations.

Figure 4-3: Option 3 Proposed Shore Crossing Location

Therefore the design assumptions for Option 3 are very different from Option 1 and 2, as discussed below:

- due to the rocky uneven shoreline and seabed, a trench would need to be excavated to provide a sound base for the pipeline through the surf zone. This would be excavated through rock which would be substantially more time consuming and expensive than excavating in sand. It is also likely that significant blasting would be required;
- furthermore an access jetty would be required through the surf zone to allow access to excavate the trench. This is a major and costly temporary works element;
- to protect the pipeline once installed in the trench, tremie concrete would be placed as backfill;
- considerable works would also be required offshore to prepare a suitable base for the pipeline. It is possible that a steel pipe would be required rather than HDPE, which would be more expensive;
- to protect and stabilise the pipe in the more dynamic wave environment, larger armour rock may be required;
- the exposed nature of the site will represent considerable risks for the construction and may lead to considerable downtime during the works and
- for the onshore section of the outfall, excavation of a trench through rock would also be required, at greater cost than excavation through sand.

It is also possible that following a more detailed assessment of the design and construction requirements that trench based installation of the pipeline would not be feasible and horizontal directional drilling (HDD) would be necessary.

Therefore due to the challenging location and major temporary works required, Option 3 would be a much more costly and risky option than either Option 2 or 3.

4.4.2 Coastal Processes and Effluent Dispersion

In general we expect effective dispersion of the effluent from Option 3.

At this stage we have assumed that the outfall outlet will need to be located at -10m Chart Datum (CD) to allow adequate dispersion of the effluent. This is subject to confirmation from the results of the dispersion modelling.

Due to the rocky shoreline we do not expect the pipeline to be vulnerable to exposure due to long-term coastal erosion. However due to the exposed location the pipeline may be vulnerable to damage from major storms in excess of the design storm event.

4.4.3 Potential Impact On and Of Future Desalination Plant Construction

Other than the connection to the onshore pipeline, Option 3 is located away from the desalination plant site and pipeline so disruption during construction and commissioning of the desalination plant is unlikely.

Nevertheless Frontier Saldanha Utilities should ensure comprehensive records of the details of the construction of the SSP outfall are taken, stored and made available to the desalination plant design consultants and construction contractors to reduce the risks of disruption.

4.4.4 Environmental Assessment (CSIR)

For option 3 the pipeline would need to cross a rocky coast, cobble terrace just above high water mark and exposed granite east of this. The area has a very high sensitivity for both fauna and flora with low rehabilitation potential. The pipeline will traverse highly sensitive Saldanha Granite Strandveld and thus CSIR recommends this as a no go option.

5. CAPEX ESTIMATES

The Capital Expenditure (CAPEX) estimates for each option have generally been prepared to a target accuracy of +/- 50%. However the cost estimates vary significantly depending on the design assumptions. Therefore we have prepared cost estimates for several alternatives for each option to allow a clear understanding of the implications of changes to the design assumptions.

The alternatives for which estimates have been prepared include:

- Option 1:
    - 1A – post lower pipe through surf zone, no armour protection required offshore (beyond the surf zone);
    - 1B – post lower pipe through surf zone, armour protection required offshore;
    - 1C – pipe buried in deeper trench through beach/surf zone for additional protection, no armour protection required offshore;
    - 1D - pipe buried in deeper trench through beach/surf zone for additional protection, armour protection required offshore;
- Option 2:
    - 2A – post lower pipe through surf zone, no armour protection required offshore;
    - 2B – post lower pipe through surf zone, armour protection required offshore;
    - 2C – pipe buried in deeper trench through beach/surf zone for additional protection, no armour protection required offshore;
    - 2D – pipe buried in deeper trench through beach/surf zone for additional protection, armour protection required offshore;
- Option 3
    - 3D – pipe buried in trench through beach/surf zone, armour protection required offshore.

The cost estimates for each option are presented in **Error! Reference source not found.**. A breakdown of the estimates is attached in Appendix 3.

Table 5-1: CAPEX estimates for each option

Alternatives	Option 1	Option 2	Option 3
A	R 27 403 413	R 29 612 134	-
B	R 33 866 859	R 34 023 692	-
C	R 70 534 196	R 72 417 916	-
D	R 76 997 641	R 76 829 474	R 78 620 124

The costs have been estimated based on:

- The cost estimates prepared for the WCDM Desalination Plant marine pipelines;
- Our experience of the industry and previous projects;
- Discussions with an experienced marine contractor (Murray & Roberts Marine) to refine the proposed construction methodology and costs.

At this stage no operational costs (OPEX) have been determined.

The design assumptions presented in Section 4 and upon which the trade-off assessment has been based are for the following options and associated cost estimates:

- Option 1B: **R 33 866 859**
- Option 2B: **R 34 023 692**
- Option 3D: **R 78 620 124**

Therefore it can be seen that the difference in costs between Option 1 and Option 2 are, at this stage, minimal (within the margin of error) and both are substantially less than for Option 3.

However it is important to note that if it is determined that the pipeline must be buried deeper through the surf zone the costs would increase significantly, potentially by a factor of around two.

There are a number of reasons why this might be necessary, including but not limited to:

- the desire of Frontier Saldanha Utilities to minimise the risk of potential future damage or disruption to the pipeline;
- requirements of the EIA and ,
- unforeseen geotechnical or metocean conditions.

6. ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULE

A preliminary engineering, procurement and construction (EPC) time schedule presenting high level design, procurement and construction activities is provided in Appendix 4. The following notes and assumptions form the basis of the schedule:

- dates have been included for project approvals, including the EIA process. These dates are indicative only and it is outside WorleyParsons scope to determine the relevant dates. Any changes to those dates will alter the overall EPC schedule;
- the schedule assumes that pipeline route option 1 will be selected;
- the schedule assumes that the design and construction assumptions presented in Section 4 and used in the assessment of the options will be appropriate for the final design and construction, including the following;
    - the post lowering construction method has been assumed for the pipeline shore-crossing and through the surf zone. It is assumed the excavation will be done using a land based long reach excavator with no sheet pile cofferdam or access jetty construction to facilitate trench excavation;
    - offshore the pipeline will be laid on the natural seabed with no trench construction required and
    - offshore the pipeline will need to be covered with rock, mass concrete or concrete block mattresses to provide sufficient stability to the pipeline.
- it is expected that the procurement and supply of pipes, precast weight collars and other fittings will be critical; at this stage a 12 week period has been assumed and this will need to be confirmed with pipe suppliers during the next stage of the design process and
- it is assumed that bed rock will not be encountered during pipeline trench excavation; this will need to be confirmed with additional jet probe surveys once the preferred pipeline route has been determined.

7. CONCLUSION AND RECOMMENDATIONS

Following the completion of the Concept Options Trade-Off Assessment as detailed in this report, the following principal conclusions can be drawn:

- the options assessment matrix identifies **Option 1** as the most suitable route, as summarised in Table 7-1 below;

Table 7-1: Summary of Options Assessment Matrix Total Weighted Scores

	Option 1	Option 2	Option 3
Matrix Total Score	34	41	67

- Option 1 is also the lowest cost option (although the difference between the costs for Option 1 and Option 2 is minimal and within the margin for error);
- we believe that Option 1 (and Option 2) can be constructed without the need for extensive temporary works and excavation in rock;
- the offshore section of pipeline may need protection to ensure its stability under the design wave conditions;
- the estimated Option 1 cost (+/-50%) based on these assumptions is **R 33 866 859**;
- however there are risks associated with the assumptions and changing the design to remove those risks would significantly increase the cost (approximately double);
- further studies and design development is required to better understand the risks and develop greater confidence in the design, construction method, schedule and cost for the preferred option;
- the difference between Option 1 and Option 2, considering the outfall pipeline in isolation, is not substantial and Option 2 remains a feasible alternative and
- Option 3 is not feasible and should not be considered further.

From these conclusions we therefore present the following recommendations to Frontier Saldanha Utilities for the next stage of the works:

- select Option 1 as the preferred marine outfall route;
- undertake additional studies and design development for Option 1 in order to validate the design and construction assumptions to improve confidence in the estimated cost. We recommend the additional studies and design activities include but not be limited to:

1. additional probes on the beach, through the surf zone and offshore along the Option 1 pipeline route to improve the knowledge of the sand depths;
2. consider excavating trial pits along the onshore and beach section of the Option 1 route to validate the probe findings and gain a better understanding of the rock properties;
3. undertake additional dispersion modelling to refine the location of the Option 1 outfall (if the outlet can be located closer to the shore in shallower water there may be significant reductions in estimated costs);
4. undertake additional modelling of the design wave conditions and subsea pipeline stability checks to better understand the requirements for protection of the pipeline (if any) and
5. undertake additional modelling of the shoreline stability to better understand the risks of exposure of the pipeline that might lead to an increased risk of damage.

- at this stage do not discount Option 2 completely. It is possible that the results of some or all of the above will complicate the design and construction of Option 1 so that Option 2 becomes a more attractive option (for example if sand depths for Option 2 are found to be considerable greater than for Option 1) and
- for relatively additional cost, the above studies could also be undertaken for the Option 2 location as well. Undertaking the studies simultaneously for both locations would be considerably cheaper than repeating them at a different time. In particular we recommend that consideration be given to undertaking probes and trial pits at both locations during the same site investigation.

APPENDIX 1: OUTFALL OPTIONS LOCALITY PLAN

17°52'30"E -105000 -104500 17°53'0"E -104000 17°53'30"E -103500 -103000 17°54'0"E -102500 17°54'30"E -102000

-3652000 -3652500 -3653000 -3653500 -3654000 -3654500

32°59'30"S 33°0'0"S 33°0'30"S

N

WCDM Desalination Plant: Preferred Pipeline Route

Marine Outfall Route Options

Proposed Onshore Outfall Pipeline Route Route

Desalination Plant Site

Cadastral Boundaries

1

2

3

-5

-10

-15

-10

-10

Danger Bay

Note: Marine Outfall Routes and Termination Locations Indicative Only
Exact Routes to be Confirmed

AMENDMENT				
NO.	DATE	CHECKED	DONE BY	DESCRIPTION
A	26/04	TCC	RK	ISSUED FOR SQUAD CHECK
B	29/04	TCC	RK	ISSUED FOR CLIENT REVIEW
C	02/05	TCC	RK	CADASTRAL BOUNDARIES CLARIFIED / ROUTE AMENDED
D	22/05	TCC	RK	BATHYMETRY ADDED. OUTFALL POSITIONS AMENDED

SCALE FOR REDUCED PLAN
0 10 20 30 40
40mm ON ORIGINAL DRAWING

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer. Do not scale.

WorleyParsons
resources & energy
P.O.Box 398
BELLVILLE 7535
TEL:(021) 912 3000
FAX:(021) 912 3222
e-mail: capetown@worleyparsons.com

DESIGNED	TCC
DRAWN	RK
CHECKED	FS

CONSULTING ENGINEER
DATE
CLIENT
DATE

CLIENT: FRONTIER SEPARATION (PTY) LTD

PROJECT: SALDANHA REGIONAL MARINE OUTFALL (SRMO)

DRAWING DESCRIPTION: LOCALITY PLAN: OUTFALL OPTIONS

SCALE: 1:10 000 (On Original A3)

DATE: MAY 2013

DRAWING NUMBER: 277760-CS-DLP-001

REV NO: D

APPENDIX 2: TRADE OFF ASSESSMENT MATRIX

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Saldanha Regional Marine Outfall (SRMO) Concept Options Trade Off Assessment

Ranking: Each subcategory to be scored out 10. 1 = least impact, 10 = most impact) Categories and subcategories weighted proportionally out of 100%	Weighting	Route Option 1	Route Option 2	Route Option 3
Typical Pipeline Details: Approximate Pipeline Length (m) (from point of connection to onshore pipeline)		857m	1090m	864m
1. Coastal Processes & Effluent Dispersion	10%			
1.1 Effective effluent dispersion from outfall	30%	Effective dispersion expected	Effective dispersion - direct wave exposure	Effective dispersion - direct wave exposure
Scoring (1 - 10)		3.0	1.0	1.0
1.2 Vulnerability of pipeline to major storms (particularly in excess of design event)	30%	Most protected	Direct wave exposure	Very energetic
Scoring (1 - 10)		2.0	5.0	9.0
1.3 Vulnerability of pipeline to coastal erosion	25%	Most protected area	Direct wave exposure - stable beach - seasonal profile changes	Rocky coast
Scoring (1 - 10)		2.0	3.0	0.0
1.4 Impact of presence of pipeline on coastal processes	15%	Sandy beach - pipeline buried. Effect only during construction	Sandy beach - pipeline buried. Effect only during construction	Pipeline on surface
Scoring (1 - 10)		2.0	2.0	5.0
Cumulative Score (Sub category score x sub category weighting x 10)		23.0	28.5	37.5
Ranking (based on score)		1	2	3
2. Pipeline Design and Construction	20%			
2.1 Geotechnical/geophysical/bathymetric Survey Requirements	5%	Available geophysics probably sufficient. Some additional diver probes desirable to confirm nearshore sediment depths Shoreline trial pits required Shoreline trial pit rsults likely to be of value to desalination plant design	Geophysics survey required Diver probes required Shoreline trial pits required. Access more difficult, increased cost	Shoreline rock cores required.
Scoring (1 - 10)		3	5	8
2.2 Pumpstation & pipeline - access routes & services	10%	Currrent access relatively good. Will be improved for desalination plant. May need power supply but could be shared with desalination plant in future	Current access reasonable - connection to onshore pipeline located near sand mine access road. May need power - limited potential to share with desalination plant.	Currrent access relatively good. Will be improved for desalination plant. May need power supply but could be shared with desalination plant in future
Scoring (1 - 10)		3	7	4
2.3 Pipeline maintenance - accessibility	5%	Currrent access relatively good. Will be improved for desalination plant.	Access poor - dunes	Currrent access relatively good. Will be improved for desalination plant.
Scoring (1 - 10)		3	7	3
2.4 Pipeline construction method: connection to onshore pipeline to back of dunes	15%	Likely buried in sand (depth of sand to be confirmed) Relatively good access for construction. Improvements in access will benefit desalination plant construction.	Buried in sand. Poor access for construction - may need substantial works to improve.	Buried - probably need to excavate in rock. Access for construction would need improvement (soft soil & surface lying boulders).
Scoring (1 - 10)		3	6	8
2.5 Pipeline construction method: through dunes to high water mark	15%	Likely buried in sand (depth of sand to be confirmed). Relatively good access for construction. Improvements in access will benefit desalination plant construction.	Significant change in height. Excavation through dunes would be difficult.	No dunes - rocky shore, many boulders. Buried - need to excavate in rock. Excavation through rock would be difficult. May need to consider directional drilling.
Scoring (1 - 10)		2	5	8
2.6 Pipeline construction method: through surf zone	25%	Likely buried - propose post lowering of pipeline to avoid expensive termporary works. Some removal of rock high points may to be necessary. Pipeline on beach/seabed surface may be feasible (relatively sheltered crossing point) but required rock sizes or concrete quantities may be uneconomical. Relatively sheltered crossing location. Easiest location for working in surf zone of the 3 locations.	Likely buried - propose post lowering of pipeline to avoid expensive termporary works. Some removal of rock high points may to be necessary. Pipeline on beach/seabed surface may be feasible (although crossing point fairly exposed) but required rock sizes or concrete quantities likely to be uneconomical. Fairly exposed crossing location. Working in surf zone likely to be more challenging than option 1 locations.	Would need to be buried, difficult and expensive excavation in rock. Would need to construct access jetty. Exposed location, will be very challenging working conditions to construct pipeline.
Scoring (1 - 10)		4	5	9
2.7 Pipeline construction method: seabed beyond surf zone to pipeline end	25%	Likely placed on surface of seabed (some localised excavation of rocky outcrops may be neeed). Armour rock may be required for protection/pipeline stability. Preliminary calculations suggest median armour rock diameter 630mm (grading 300-1000kg) Relatively sheltered location, easiest location for offshore working.	Likely placed on surface of seabed (some localised excavation of rocky outcrops may be neeed). Armour rock may be required for protection/pipeline stability. Preliminary calculations suggest median armour rock diameter 630mm (grading 300-1000kg) Relatively sheltered location, easiest location for offshore working.	Likely placed on seabed as rocky nature of seabed would make excavation of trench difficult. However significant preparation of surface include blasting of rock outcrops/placing of bedding may be required. May require steel pipe - more expensive. Highly dynamic environment, may require may require large rock/substantial concrete volumes to protect/stabilise pipe. Exposed location, construction could be very challenging with significant downtime.
Scoring (1 - 10)		3	4	10
Cumulative Score (Sub category score x sub category weighting x 10)		31.0	52.0	81.0
Ranking (based on score)		1	2	3

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Saldanha Regional Marine Outfall (SRMO) Concept Options Trade Off Assessment

Ranking: Each subcategory to be scored out 10. 1 = least impact, 10 = most impact) Categories and subcategories weighted proportionally out of 100%		Weighting	Route Option 1	Route Option 2	Route Option 3
3. Potential Impact on and of Future Desalination Plant Construction		5%			
	3.1 Potential for recirculation of effluent discharge to affect desalination plant intake	40%	SSP pipeline to be decommisioned once WCDM desalination plant is operational with SSP effluent diverted through WCDM outfall. Therefore no concurrent operation of pipelines so no risk of recirculation	SSP pipeline to be decommisioned once WCDM desalination plant is operational with SSP effluent diverted through WCDM outfall. Therefore no concurrent operation of pipelines so no risk of recirculation	SSP pipeline to be decommisioned once WCDM desalination plant is operational with SSP effluent diverted through WCDM outfall. Therefore no concurrent operation of pipelines so no risk of recirculation
	Scoring (1 - 10)		0	0	0
	3.2 Potential for desalination plant/intake/outfall pipeline construction to damage or disrupt operation of SSP outfall	20%	SSP pipeline to be designed to minimise risk of disruption. However pipeline runs through desalination plant footprint so some potential for disruption	SSP outfall located far from desalination plant site, disruption unlikely	SSP pipeline to be designed to minimise risk of disruption. However connection to onshore pipeline is within desalination plant footprint so some potential for disruption
	Scoring (1 - 10)		5	2	3
	3.3 Potential for SSP outfall location to cause difficulties for WCDM desalination plant or pipelines construction	20%	SSP pipeline to be designed to minimise risk of disruption. However pipeline runs through desalination plant footprint so some potential for disruption May be temporary risk of recirculation of effluent during commisioning of WCDM desalination plant while SSP outfall remains operational. Numerical modelling required to confirm SSP outfall location to minimise this risk.	SSP outfall located far from desalination plant site, disruption unlikely	SSP pipeline to be designed to minimise risk of disruption. However connection to onshore pipeline is within desalination plant footprint so some potential for disruption
	Scoring (1 - 10)		5	2	3
	3.4 Ease of future connection into desalination plant outfall pipeline	20%	Connection point to be at desalination plant site, straightforward connection	New onshore section of pipeline would need to be constructed in future to allow connection	Connection point to be at desalination plant site, straightforward connection
	Scoring (1 - 10)		3	8	3
	Cumulative Score (Sub category score x sub category weighting x 10)		32.0	40.0	24.0
	Ranking (based on score)		2	3	1
4.Financial		15%			
Capital Expenditure (CAPEX)	4.1 Estimated Construction Cost (+/- 50%) (Refer to report for cost estimate assumptions)	90%	R 33 866 859	R 34 023 692	R 78 620 124
	Scoring (1 - 10)		3	4	9
Operational Expenditure (OPEX)	4.2 OPEX considerations (subjective only, comparison with lowest cost option, no costing)	10%	No particular OPEX concerns identified at this stage, lowest OPEX option	Potentially increased OPEX due to additional services requirements, more difficult access to pipeline for maintenance, higher risk of pipeline damage due to excessive wave conditions	Potential increased maintenance costs due to higher risk of pipeline damage due to excessive wave conditions and higher risk of damage to surface mounted sections of pipe (if any)
	Scoring (1 - 10)		3	5	4
	Cumulative Score (Sub category score x sub category weighting x 10)		30.0	41.0	85.0
	Ranking (based on score)		1	2	3
5. Marine Ecological Impact(Note: Inputs provided by CSIR.)		25%			
	5.1 Disturbance of Intertidal Sandy beach systems	15%	Intertidal sandy beach system will be disturbed. The pipeline will cross the same distance compared to option 2.	Intertidal sandy beach system will be disturbed. The pipeline will cross the same distance compared to option 2.	No crossing of Intertidal sandy beach system. Rocky area with many boulders
	Scoring (1 - 10)		5	5	2
	5.2 Disturbance of Subtidal macrofaunal communities	15%	Subtidal macrofaunal communities will be disturbed during pipeline crossing.	Subtidal macrofaunal communities will be disturbed during pipeline crossing.	No subtidal macrofaunal communties as it is a rocky coast with direct wave exposure and no protection.
	Scoring (1 - 10)		5	5	2
	5.3 Disturbance of Rocky intertidal and subtidal biota (including blasting)	20%	Sandy beach-no real presence of rocks	Sandy beach-no real presence of rocks	Rocky intertidal and subtidal biota will be heavily disturbed as it is prevalent on the rocky coast
	Scoring (1 - 10)		4	4	8
	5.4 Effects of discharge in low-oxygen benthic zones	15%	Low rate of dispersion due to protection from waves and currents in Danger Bay. Most protected.	Moderate rate of dispersion. Direct wave exposure.	High energy system. Effective dispersion due to direct wave exposure.
	Scoring (1 - 10)		6	5	2
	5.5 Effect of discharges (brine, sewage and REM) on marine biota at discharge point	20%	Will impact on marine biota at discharge point. Low rates of dispersion due to protection from waves and currents in Danger Bay. Most protected.	Will impact on marine biota at discharge point. Moderate rate of dispersion. Direct wave exposure.	Will not impact on marine biota at discharge point. High energy system. Effective dispersion due to direct wave exposure.
	Scoring (1 - 10)		8	7	4
	5.6 Impact on inshore fisheries	15%	No discernible difference in impact on inshore fisheries between the three options.	No discernible difference in impact on inshore fisheries between the three options.	No discernible difference in impact on inshore fisheries between the three options.
	Scoring (1 - 10)		5	5	5
	Cumulative Score (Sub category score x sub category weighting x 10)		55.5	52.0	40.5
	Ranking (based on score)		3	2	1

Saldanha Regional Marine Outfall (SRMO) Concept Options Trade Off Assessment

Ranking: Each subcategory to be scored out 10. 1 = least impact, 10 = most impact) Categories and subcategories weighted proportionally out of 100%	Weighting	Route Option 1	Route Option 2	Route Option 3
6. Terrestrial Ecological Impact Category Weighting (Note: Inputs provided by CSIR.)	25%			
6.1 Rocky outcrops	40%	No exposed rocks. Pipeline will cross sandy beach.	No exposed rocks. Pipeline will cross sandy beach.	Rocky coast. Cobble terrace just above High Water Mark and exposed granite east of this. Very high sensitivity for both fauna and flora, low rehabilitation potential.
Scoring (1 - 10)		2	2	10
6.2 Sensitive Vegetation and associated Species of Conservation Concern - Saldanha Granite Strandveld	40%	No sensitive vegetation, including Saldanha Granite Strandveld, present along route	No sensitive vegetation, including Saldanha Granite Strandveld, present along route. The pipeline will traverse highly disturbed areas from sand mining areas. No remnants from Saldanha Granite Strandveld present.	The pipeline will traverse highly sensitive Saldanha Granite Strandveld.
Scoring (1 - 10)		2	2	10
6.3 Critical Biodiversity Areas and Ecological Support Areas	20%	The area falls within a Critical Biodiversity Area which is a planning tool of CapeNature. If the desalination plant is constructed in line with the West Coast District Municipal planning, this area will be degraded and will impact less on biodiversity compared to the pipeline in Option 2.	The area falls within a Critical Biodiversity Area which is a planning tool of CapeNature.	The area falls within a Critical Biodiversity Area which is a planning tool of CapeNature.
Scoring (1 - 10)		3	5	5
Cumulative Score (Sub category score x sub category weighting x 10)		22.0	26.0	90.0
Ranking (based on score)		1	2	3
Total Score		34	41	67
	100%	1	2	3

APPENDIX 3: COST ESTIMATE BREAKDOWN

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Outfall Pipeline Layout 1A - post lower pipe through surf zone

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	1623	R 80	R 129 830	
Trench backfilling with sand onshore - landbased operation	m^3	1474	R 100	R 147 392	
Remove sand in the trench - post lower pipe	sum	1	R 150 000	R 150 000	3 x local excavators, 2-3 days
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	0	R 1 220	R 0	
Remove rock in high spots	day	2	R 20 000	R 40 000	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	857	R 2 500	R 2 142 500	
Precast weight collars +/- 0.5t	No	105	R 2 500	R 262 500	
Continuous weight collar	m	150	R 1 200	R 180 000	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	150	R 600	R 90 000	
Install HDPE pipes and fittings					
Weld pipes into strings	No	70	R 7 000	R 492 917	12m lengths
Fit weight collars to pipe	No	105	R 2 500	R 262 500	
Install outfall pipelines (offshore & surf zone)	m	465	R 5 000	R 2 325 000	
Install outfall pipelines (onshore)	m	392	R 1 000	R 392 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 16 863 639**	
P & G	25%			R 4 215 910	
Contingency	30%			R 6 323 865	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 27 403 413**	

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Outfall Pipeline Layout 1B - post lower pipe through surf zone, armour protection offshore

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	1623	R 80	R 129 830	
Trench backfilling with sand onshore - landbased operation	m^3	1474	R 100	R 147 392	
Remove sand in the trench - post lower pipe	sum	1	R 150 000	R 150 000	3 x local excavators, 2-3 days
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	0	R 1 220	R 0	
Remove rock in high spots	day	2	R 20 000	R 40 000	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	857	R 2 500	R 2 142 500	
Precast weight collars +/- 0.5t	No	105	R 2 500	R 262 500	
Continuous weight collar	m	150	R 1 200	R 180 000	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	150	R 600	R 90 000	
Install HDPE pipes and fittings					
Weld pipes into strings	No	70	R 7 000	R 492 917	12m lengths
Fit weight collars to pipe	No	105	R 2 500	R 262 500	
Install outfall pipelines (offshore & surf zone)	m	465	R 5 000	R 2 325 000	
Install outfall pipelines (onshore)	m	392	R 1 000	R 392 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	2775	R 1 220	R 3 385 683	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	485	R 1 220	R 591 822	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 20 841 144**	
P & G	25%			R 5 210 286	
Contingency	30%			R 7 815 429	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 33 866 859**	

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Outfall Pipeline Layout 1C - bury in deeper trench through beach/surf zone

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
Construct coffer dam / access jetty	m	150	R 157 345	R 23 601 750	Each option similar price, which option depends on rock level
Dismantle coffer dam / access jetty	m	150	R 11 666	R 1 749 900	
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	1623	R 80	R 129 830	
Trench backfilling with sand onshore - landbased operation	m^3	1474	R 100	R 147 392	
Remove sand in the trench within a cofferdam/from jetty	m^3	289	R 800	R 231 300	
Remove rock in the trench within a cofferdam/from jetty including drilling & blasting	m^3	96	R 9 269	R 893 300	
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	329	R 1 220	R 400 770	
Remove rock in high spots	day	0	R 20 000	R 0	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	857	R 2 500	R 2 142 500	
Precast weight collars +/- 0.5t	No	155	R 2 500	R 387 500	
Continuous weight collar	m	0	R 1 200	R 0	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	0	R 600	R 0	
Install HDPE pipes and fittings					
Weld pipes into strings	No	70	R 7 000	R 492 917	12m lengths
Fit weight collars to pipe	No	105	R 2 500	R 262 500	
Install outfall pipelines (offshore & surf zone)	m	465	R 5 000	R 2 325 000	
Install outfall pipelines (onshore)	m	392	R 1 000	R 392 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 43 405 659**	
P & G	25%			R 10 851 415	
Contingency	30%			R 16 277 122	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 70 534 196**	

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Outfall Pipeline Layout 1D - bury in deeper trench through beach/surf zone, armour protection offshore

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
Construct coffer dam / access jetty	m	150	R 157 345	R 23 601 750	Each option similar price, which option depends on rock level
Dismantle coffer dam / access jetty	m	150	R 11 666	R 1 749 900	
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	1623	R 80	R 129 830	
Trench backfilling with sand onshore - landbased operation	m^3	1474	R 100	R 147 392	
Remove sand in the trench within a cofferdam/from jetty	m^3	289	R 800	R 231 300	
Remove rock in the trench within a cofferdam/from jetty including drilling & blasting	m^3	96	R 9 269	R 893 300	
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	329	R 1 220	R 400 770	
Remove rock in high spots	day	0	R 20 000	R 0	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	857	R 2 500	R 2 142 500	
Precast weight collars +/- 0.5t	No	155	R 2 500	R 387 500	
Continuous weight collar	m	0	R 1 200	R 0	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	0	R 600	R 0	
Install HDPE pipes and fittings					
Weld pipes into strings	No	70	R 7 000	R 492 917	12m lengths
Fit weight collars to pipe	No	105	R 2 500	R 262 500	
Install outfall pipelines (offshore & surf zone)	m	465	R 5 000	R 2 325 000	
Install outfall pipelines (onshore)	m	392	R 1 000	R 392 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	2775	R 1 220	R 3 385 683	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	485	R 1 220	R 591 822	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 47 383 164**	
P & G	25%			R 11 845 791	
Contingency	30%			R 17 768 686	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 76 997 641**	

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Outfall Pipeline Layout 2A - post lower pipe through surf zone

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 300 000	R 300 000	From connection to onshore pipe to shore only
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	5996	R 80	R 479 660	
Trench backfilling with sand onshore - landbased operation	m^3	5720	R 100	R 572 025	
Remove sand in the trench - post lower pipe	sum	1	R 150 000	R 150 000	3 x local excavators, 2-3 days
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	0	R 1 220	R 0	
Remove rock in high spots	day	2	R 20 000	R 40 000	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	1090	R 2 500	R 2 725 000	
Precast weight collars +/- 0.5t	No	72	R 2 500	R 179 167	
Continuous weight collar	m	150	R 1 200	R 180 000	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	150	R 600	R 90 000	
Install HDPE pipes and fittings					
Weld pipes into strings	No	90	R 7 000	R 628 833	12m lengths
Fit weight collars to pipe	No	72	R 2 500	R 179 167	
Install outfall pipelines (offshore & surf zone)	m	365	R 5 000	R 1 825 000	
Install outfall pipelines (onshore)	m	725	R 1 000	R 725 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 18 222 852**	
P & G	25%			R 4 555 713	
Contingency	30%			R 6 833 569	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 29 612 134**	

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Outfall Pipeline Layout 2A - post lower pipe through surf zone, armour protection offshore

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 300 000	R 300 000	From connection to onshore pipe to shore only
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	5996	R 80	R 479 660	
Trench backfilling with sand onshore - landbased operation	m^3	5720	R 100	R 572 025	
Remove sand in the trench - post lower pipe	sum	1	R 150 000	R 150 000	3 x local excavators, 2-3 days
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	0	R 1 220	R 0	
Remove rock in high spots	day	2	R 20 000	R 40 000	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	1090	R 2 500	R 2 725 000	
Precast weight collars +/- 0.5t	No	72	R 2 500	R 179 167	
Continuous weight collar	m	150	R 1 200	R 180 000	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	150	R 600	R 90 000	
Install HDPE pipes and fittings					
Weld pipes into strings	No	90	R 7 000	R 628 833	12m lengths
Fit weight collars to pipe	No	72	R 2 500	R 179 167	
Install outfall pipelines (offshore & surf zone)	m	365	R 5 000	R 1 825 000	
Install outfall pipelines (onshore)	m	725	R 1 000	R 725 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	1894	R 1 220	R 2 310 863	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	331	R 1 220	R 403 942	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 20 937 657**	
P & G	25%			R 5 234 414	
Contingency	30%			R 7 851 621	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 34 023 692**	

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Outfall Pipeline Layout 2B - bury in deeper trench through beach/surf zone

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
Construct coffer dam / access jetty	m	150	R 157 345	R 23 601 750	Each option similar price, which option depends on rock level
Dismantle coffer dam / access jetty	m	150	R 11 666	R 1 749 900	
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	5996	R 80	R 479 660	
Trench backfilling with sand onshore - landbased operation	m^3	5720	R 100	R 572 025	
Remove sand in the trench within a cofferdam/from jetty	m^3	289	R 800	R 231 300	
Remove rock in the trench within a cofferdam/from jetty including drilling & blasting	m^3	96	R 9 269	R 893 300	
Supply and place rock riprap for backfilling of the trench in the surfzone	m^3	329	R 1 220	R 400 770	
Remove rock in high spots	day	0	R 20 000	R 0	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	1090	R 2 500	R 2 725 000	
Precast weight collars +/- 0.5t	No	122	R 2 500	R 304 167	
Continuous weight collar	m	0	R 1 200	R 0	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	0	R 600	R 0	
Install HDPE pipes and fittings					
Weld pipes into strings	No	90	R 7 000	R 628 833	12m lengths
Fit weight collars to pipe	No	72	R 2 500	R 179 167	
Install outfall pipelines (offshore & surf zone)	m	365	R 5 000	R 1 825 000	
Install outfall pipelines (onshore)	m	725	R 1 000	R 725 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	0	R 1 220	R 0	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 44 564 872**	
P & G	25%			R 11 141 218	
Contingency	30%			R 16 711 827	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 72 417 916**	

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Outfall Pipeline Layout 2C - bury in deeper trench through beach/surf zone, armour protection offshore

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 100 000	R 100 000	From connection to onshore pipe to shore only
Construct coffer dam / access jetty	m	150	R 157 345	R 23 601 750	Each option similar price, which option depends on rock level
Dismantle coffer dam / access jetty	m	150	R 11 666	R 1 749 900	
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	5996	R 80	R 479 660	
Trench backfilling with sand onshore - landbased operation	m^3	5720	R 100	R 572 025	
Remove sand in the trench within a cofferdam/from jetty	m^3	289	R 800	R 231 300	
Remove rock in the trench within a cofferdam/from jetty including drilling & blasting	m^3	96	R 9 269	R 893 300	
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	329	R 1 220	R 400 770	
Remove rock in high spots	day	0	R 20 000	R 0	Divers blasting
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	1090	R 2 500	R 2 725 000	
Precast weight collars +/- 0.5t	No	122	R 2 500	R 304 167	
Continuous weight collar	m	0	R 1 200	R 0	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	0	R 600	R 0	
Install HDPE pipes and fittings					
Weld pipes into strings	No	90	R 7 000	R 628 833	12m lengths
Fit weight collars to pipe	No	72	R 2 500	R 179 167	
Install outfall pipelines (offshore & surf zone)	m	365	R 5 000	R 1 825 000	
Install outfall pipelines (onshore)	m	725	R 1 000	R 725 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	3	R 33 000	R 99 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	1894	R 1 220	R 2 310 863	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	331	R 1 220	R 403 942	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 47 279 677**	
P & G	25%			R 11 819 919	
Contingency	30%			R 17 729 879	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 76 829 474**	

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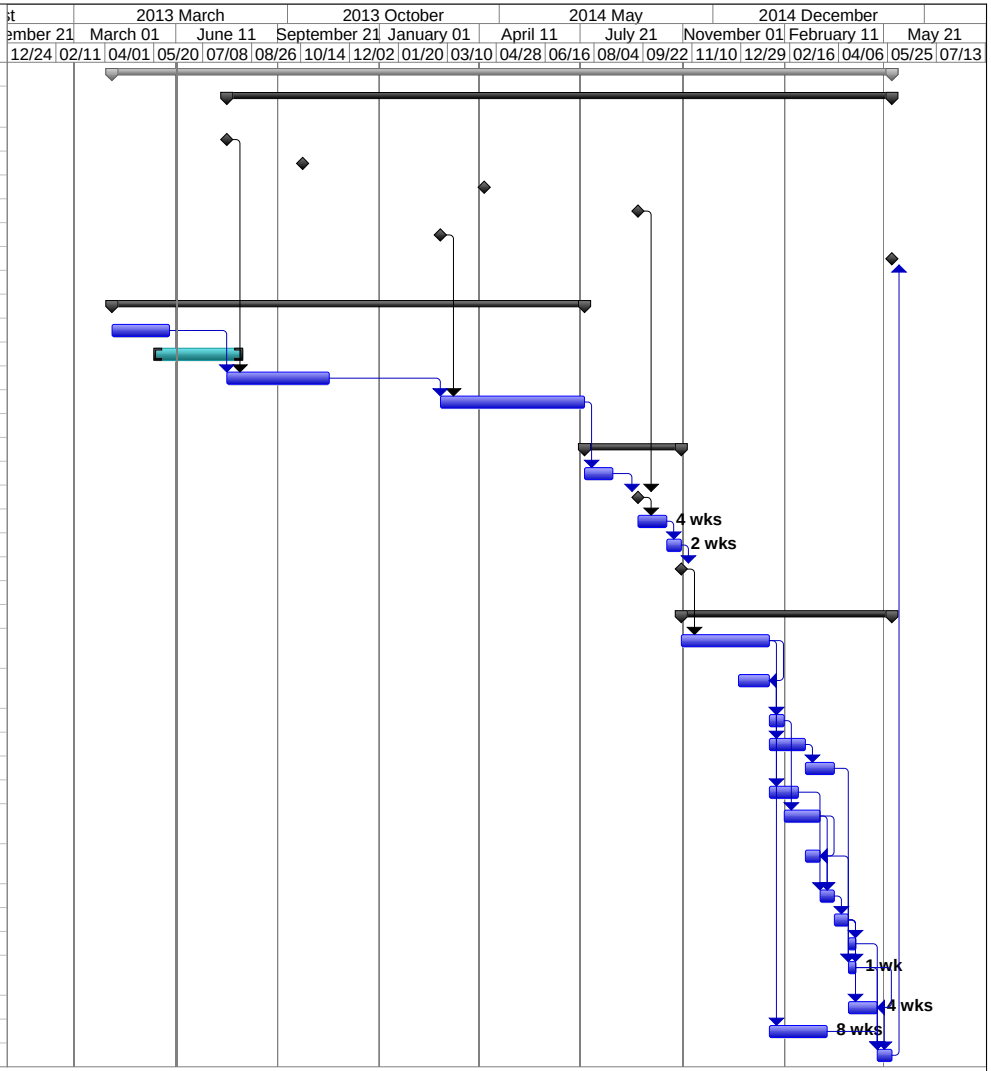
Outfall Pipeline Layout 3 - bury in trench through beach/surf zone, armour protection offshore

Use a conversion factor of 1.00 for $N to Rands

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	COMMENT
TEMPORARY WORKS					
Construct stringing yard	Sum	1	R 3 500 000	R 3 500 000	
Remove stringing yard	Sum	1	R 300 000	R 300 000	
Site access improvements	Sum	1	R 200 000	R 200 000	From connection to onshore pipe to shore only
Construct coffer dam / access jetty	m	150	R 157 345	R 23 601 750	Each option similar price, which option depends on rock level
Dismantle coffer dam / access jetty	m	150	R 11 666	R 1 749 900	
TRENCH EXCAVATION & BACKFILL ONSHORE AND THROUGH SURF ZONE					
Trench excavation onshore - landbased operation	m^3	2360	R 600	R 1 415 880	
Trench backfilling onshore - landbased operation	m^3	2143	R 160	R 342 912	
Remove sand in the trench within a cofferdam/from jetty	m^3	0	R 800	R 0	
Remove rock in the trench within a cofferdam/from jetty including drilling & blasting	m^3	251	R 9 269	R 2 321 885	
Supply and place rock riprap for backfilling of the trench in the surfzone - marine based operation	m^3	0	R 1 220	R 0	
Tremie concrete for pipeline protection in the surfzone	m^3	207	R 3 000	R 621 000	
PIPELINE					
Supply HDPE pipes and fittings					
Supply pipes - 350mm HDPE	m	864	R 2 500	R 2 160 000	
Precast weight collars +/- 0.5t	No	98	R 2 500	R 245 000	
Continuous weight collar	m	0	R 1 200	R 0	
Diffuser sections - 3 no.	No	3	R 50 000	R 150 000	
Temporary Buoyancy	m	0	R 600	R 0	
Install HDPE pipes and fittings					
Weld pipes into strings	No	90	R 7 000	R 628 833	12m lengths
Fit weight collars to pipe	No	72	R 2 500	R 179 167	
Install outfall pipelines (offshore & surf zone)	m	365	R 7 000	R 2 555 000	
Install outfall pipelines (onshore)	m	294	R 1 000	R 294 000	
Install diffuser heads	No	1	R 100 000	R 100 000	
Install diffuser heads grout ballast	ton	6	R 33 000	R 198 000	
ROCKFILL					
Supply from quarry 50 km from site and place 500 - 1000 kg armour rock using marine equipment for pipeline cover	m^3	1269	R 1 220	R 1 547 741	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
Supply from quarry 50 km from site and place 50 - 100 kg underlayer rock using marine equipment for pipeline cover	m^3	222	R 1 220	R 270 547	Rate build up using plant hire rates, personnel charge out rates and productivity rates. A distance of 50km to the quarry has been assumed
PUMP STATION & SURGE TANK					
Pump station	Sum	1	R 4 000 000	R 4 000 000	Includes pumps and mechanical equipment but excludes electricity supply
Surge Tank (1 ML)	Sum	1	R 2 000 000	R 2 000 000	
SUB-TOTAL:				**R 48 381 615**	
P & G	25%			R 12 095 404	
Contingency	30%			R 18 143 105	
TOTAL CARRIED FORWARD TO SUMMARY:				**R 78 620 124**	

APPENDIX 4: PRELIMINARY ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
0	**EPC Schedule**	**537.93 days**	**Mon 13/04/08**	**Fri 15/05/29**	
1	**Project Approvals (indicative only, outside of WP scope to determine)**	**458.09 days**	**Thu 13/08/01**	**Fri 15/05/29**	
2	Approval to Proceed with Preliminary Design	0 days	Thu 13/08/01	Thu 13/08/01	
3	EIA Scoping Report Approval	0 days	Wed 13/10/16	Wed 13/10/16	
4	EIA Application Submission	0 days	Wed 14/04/16	Wed 14/04/16	
5	EIA Application Approval	0 days	Wed 14/09/17	Wed 14/09/17	
6	Approval to commence detailed design	0 days	Mon 14/03/03	Mon 14/03/03	
7	Commissioning	0 days	Fri 15/05/29	Fri 15/05/29	37
8					
9	**Engineering**	**326.21 days**	**Mon 13/04/08**	**Fri 14/07/25**	
10	Conceptual Engineering	8 wks	Mon 13/04/08	Tue 13/06/04	
11	Dispersion Modelling of 3 Options	62.57 days	Mon 13/05/20	Fri 13/08/16	
12	Preliminary Engineering Design	14 wks	Thu 13/08/01	Mon 13/11/11	10,2
13	Detailed Engineering Design	20 wks	Mon 14/03/03	Fri 14/07/25	12,6
14					
15	**Procurement & Tender Award for Construction**	**66.48 days**	**Fri 14/07/25**	**Thu 14/10/30**	
16	Prepare Construction Tender Package	4 wks	Fri 14/07/25	Fri 14/08/22	13
17	Issue Invitation to Tender to Market	0 days	Wed 14/09/17	Wed 14/09/17	16,5
18	Contractors' Tender Preparation	4 wks	Wed 14/09/17	Wed 14/10/15	17
19	Review of Tenders and Selection of Contractor	2 wks	Wed 14/10/15	Thu 14/10/30	18
20	Construction Contract Tender Award	0 days	Thu 14/10/30	Thu 14/10/30	19
21					
22	**Construction**	**145.23 days**	**Thu 14/10/30**	**Fri 15/05/29**	
23	Procurement and Supply Pipes, Precast Weight Collars and Other Fittings	12 wks	Thu 14/10/30	Mon 15/01/26	20
24	Onshore Site Preparation and Construction of Stringing Yard	4 wks	Fri 14/12/26	Mon 15/01/26	23FF
25	Prefabricate Outfall Strings	2 wks	Mon 15/01/26	Tue 15/02/10	23,24
26	Onshore Trench	5 wks	Mon 15/01/26	Tue 15/03/03	24
27	Construct Onshore Pipeline to the Connection Point	4 wks	Tue 15/03/03	Wed 15/04/01	26
28	Prepare Launching Way	4 wks	Mon 15/01/26	Tue 15/02/24	24
29	Mounting of the Weights Collars for the Pipeline Marine Section	5 wks	Tue 15/02/10	Wed 15/03/18	25
30	Pipeline Installation Through Shore Crossing (Post Lower Method)	2 wks	Tue 15/03/03	Wed 15/03/18	29FF
31	Offshore Pipe String Launching Operation	2 wks	Wed 15/03/18	Wed 15/04/01	30,28,29
32	Submersion of the Offshore Pipeline onto Final Position	2 wks	Wed 15/04/01	Wed 15/04/15	31
33	Install Diffusers	1 wk	Wed 15/04/15	Thu 15/04/23	32
34	Connection of Onshore, Surf Zone and Offshore Pipe Sections	1 wk	Wed 15/04/15	Thu 15/04/23	32,27,30
35	Placement of Offshore Pipeline Armour Rock Protection	4 wks	Wed 15/04/15	Thu 15/05/14	32,34FF+5 days
36	Construction of Pump Station	8 wks	Mon 15/01/26	Wed 15/03/25	24
37	Site Restoration	2 wks	Thu 15/05/14	Fri 15/05/29	33,34,36,35



Project: EPC Schedule
Date: Wed 13/06/12

Task	Rolled Up Progress	Inactive Task	Manual Summary Rollup	Deadline
Milestone	Split	Inactive Milestone	Manual Summary	Slippage
Summary	External Tasks	Inactive Summary	Start-only
Rolled Up Task	Project Summary	Manual Task	Finish-only
Rolled Up Milestone	Group By Summary	Duration-only	Progress