TRANSNET SOC LTD

FEASIBILITY STUDY (FEL 3) FOR THE DEEPENING OF BERTHS 203 TO 205 PORT OF DURBAN

DESIGN REPORT – SEA LEVEL RISE

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1.0 BACKGROUND

1.1 Project

The Port of Durban Container Terminal at Pier No 2, Berths 203 to 205, is being upgraded to improve safety, which provides an opportunity for it to be deepened and refurbished to accommodate Post Panamax container vessels up to 9,200 to 12,000 TEU (fully laden) and 14,000 TEU (partially laden). The modern and more fuel efficient vessels of this size are becoming the norm in international trade and South Africa must be able to accommodate them. As they are far more fuel efficient than their predecessors, the amount of fuel consumed and CO_2 emitted per container movement is also lower.

One of the critical components of the proposed design of the new upgrade is that of the new quay wall and cope height to be selected in the light of current and predicted water levels. This was previously addressed in the Pre-feasibility Study Report by PRDW and their conclusions are supported by ZAA's own research, which has influenced the proposed design already completed.

1.2 Environmental Impact Assessment

Vital components of the planning for this upgrade are the Environmental Impact Assessment (EIA) and application for a Record of Decision (ROD) to authorise the project. Questions have been raised during the Public Participation Process of the EIA relating to the possible impact of Sea Level Rise (SLR) on the Project. The subject is very much in the public mind and thus deserves a comprehensive answer. This report therefore addresses the specific aspect of Sea Level Rise.

1.3 Water Levels

The water level in the harbour is influenced by the following factors:

- Astronomical tides
- Barometric pressure
- Wind and wave set-up
- Resonance (seiche)
- Short period waves
- Long term effects (global warming)

The Astronomical Tide Predictions as defined by the SA Navy Hydrographer and Chart SAN 2006 are as follows

Tide	Abbreviation	Level m, Chart Datum Port *
Highest Astronomical Tide	HAT	2.287
Mean High Water Springs	MHWS	1.997
Mean Level	ML	1.097
Mean Low Water Springs	MLWS	0.197
Lowest Astronomical Tide	LAT	-0.013

* Note that Chart Datum is defined by the SA Navy Hydrographer as 0.913 m below the Land Levelling Datum, but it is defined by TNPA as 0.900 m below this level. The reference level referred to throughout this project will be Chart Datum Port, (CDP).

Tidal records for the period 1972 to 2001 were previously analysed by PRDW and compared with the astronomical predictions in order to determine a residual value due to the impact of barometric pressure and set-up effects, and was found to have a value of 690 mm for a 1:100 year return period. Barometric Pressure is of most critical relevance during passing low pressure systems such as cyclones, which are fortunately not common in the Durban area.

Wind and wave setup and resonance in the Port of Durban are not significant due to the length of the waterway and the convoluted shape of the bay.

Short period waves due to wind or to ship's wake effects will be superimposed on the still water level and a maximum wave height of 600 mm (crest to trough) is a expected for this within the port.

The impacts of climate change and particularly sea level rise will have an impact on the existing quay wall structures in the future and have influenced the new proposals as discussed below.

1.4 Selection of Cope Height

The maximum water level has been calculated as follows:

• HAT	+2.287 m CDP
• 1:100 year residual	0.690 m
• Long term sea level rise	0.580 m
• Waves (600 mm/2)	0.300 m
• Maximum	+3.857 m CDP

A cope level of +4.25 m CDP has been used for the new designs. This allows for a freeboard of just under 0.4m at the cumulative maximum water level. The height difference between the proposed new cope level and the existing terminal area has been taken up in a drainage slope back towards the terminal area.

1.5 Sea Level Rise - Historic

Sea level has changed greatly over history and reached a level of about 120 meters **below** current sea level at the Last Glacial Maximum 19,000-20,000 years ago. This refers to a period in the Earth's climate history when ice sheets were at their maximum extension, between 26,500 and 19,000–20,000 years ago, marking the peak of the last glacial period. During this time, vast ice sheets covered much of North America, northern Europe and Asia.

Melting of the ice sheets during the Holocene Period, (generally accepted to have started approximately 12,000 years BP (before present day), caused sea levels to rise, but climate has been fairly stable over the Holocene and the graph (Figure 1) indicates minimal change over the last 4,000 years.

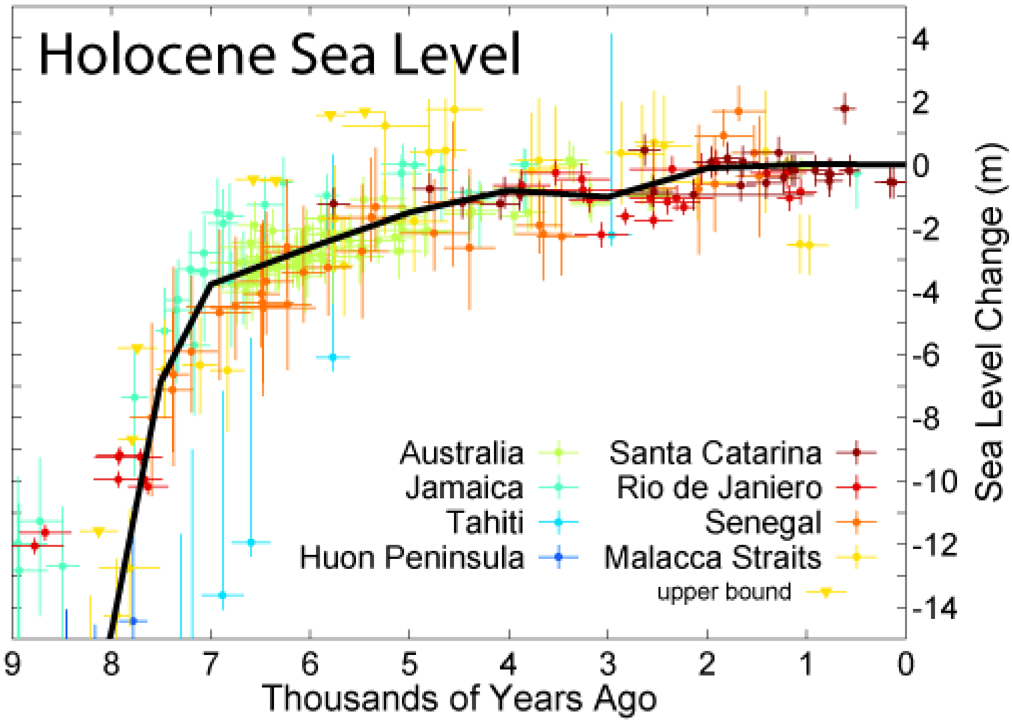

Figure 1 - Changes in sea level during the Holocene[1]

1.6 Sea Level Rise – Shorter Term

Projections of sea level rise published by the CSIR and derived from recent observations from satellites, very carefully calibrated, are that sea level rise from 1993 to 2006 is 3.3 ± 0.4 mm / year (Rahmstorf et al, 2007). The IPCC AR4 Report (2007) concludes that anthropogenic, (man-made) warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised.

Estimates of sea level rise for southern Africa, made by comparisons between approximately 30 years of South African tide gauge records and the longer term records elsewhere, show substantial agreement.

A recent analysis of sea water levels recorded at Durban confirms that the local rate of sea level rise falls within the range of global trends (Mather, 2008).

The probability of sudden large rises in sea level (possibly several metres) due to catastrophic failure of large ice-shelves (e.g. Church and White, 2006) is considered unlikely this century, but events in Greenland (e.g. Gregory, 2004) and Antarctica (e.g., Bentley, 1997; Thomas et al, 2004) may force a re-evaluation of that assessment in the longer term time scale. In 2008, the UN's expert scientific body on climate change projected that the sea level around the world could rise from anywhere between 180 mm and 580 mm by the end of this century as result of rising ocean temperatures and the melting of glaciers, snow and ice in polar regions.

A joint research project by members of the eThekwini Metro council and scientists at the Council for Scientific and Industrial Research in Durban concluded that the predicted climate changes were likely to have significant long-term implications for city planners and these scientific estimates predict that the sea level will rise by an average of 450 mm every 10 years, suggesting that the sea level would rise by almost half a metre in Durban by the year 2100.

1 Source: Figure prepared by Robert A Rohde from published data and is incorporated into the Global Warming Art Project

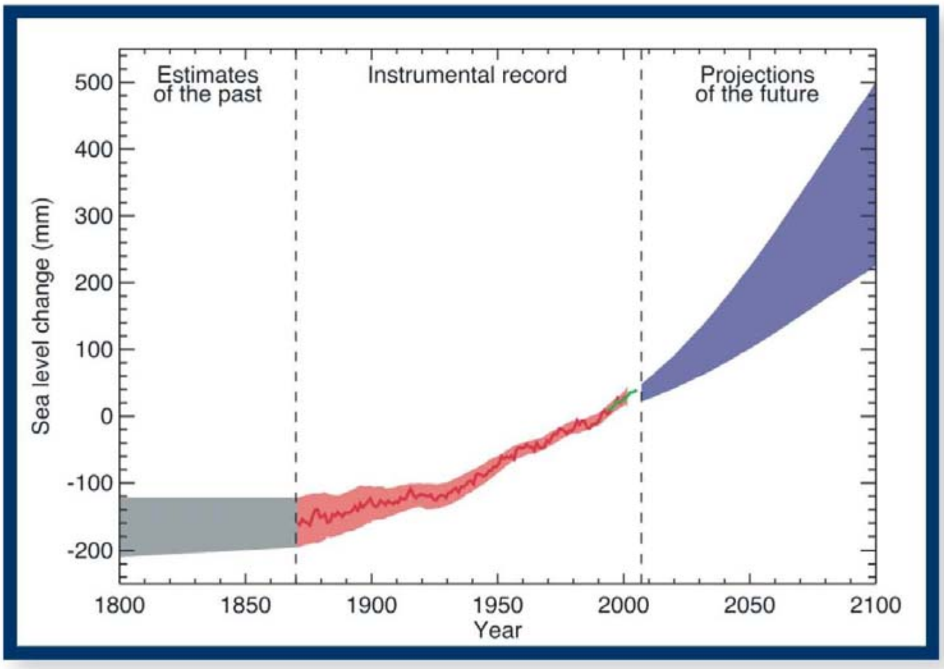

Figure 2: Measured and predicted sea level rise[2]

Linear and nonlinear sea-level changes at Durban, South Africa have been reported on by A.A. Mather, (Coastal and Catchment Policy, Co-ordination and Management, eThekwini Municipality), in which the tide records between 1970 and 2003 for Durban, South Africa, have been analysed to determine the extent of recent linear and nonlinear sea-level trends in the light of predicted global sea-level rise. The linear trends of monthly mean sea level revealed a sea-level rise of 2.7 ± 0.05 mm / y and the yearly mean sea-level trend revealed a rise of 2.4 ± 0.29 mm / y. Nonlinear trends varied between –1 mm and +8 mm / yr. These findings are similar to recently published results of global sea-level rise calculations over the last ten years derived from worldwide tide gauge and TOPEX / Poseidon altimeter measurements, which range between 2.4 and 3.2 mm/y.

[2] Source IPCC (2007)

2.0 CONSEQUENCES OF SLR

2.1 Coastal Cities

Planners and City Officials are quite rightly concerned about SLR and the consequences on their infrastructure. The south-eastern coast of Africa is also subject to cyclonic and other significant weather events that have the potential to create storm surges and large wave events. These may exacerbate the effects of coastal flooding and erosion and may damage the sandy beaches which are backed by flat low coastal plains. Fortunately however, due to the topography of much of the South African coast and the location of existing developments, relatively few developed areas are sensitive to flooding and inundation resulting from the projected sea level rise to 2100.

Property damage, particularly to developments built close to the sea may well occur, principally from erosion mechanisms. The Integrated Coastal Management Act requires that all coastal developments take this into account and development right on the coast will be severely restricted.

2.2 Pier 2 Project

In assessing the possible impact of SLR on the Pier 2 upgrade project, the following facts should be noted:

- The consensus of the reports referred to above, as well as many others, is that a maximum SLR of about 580 mm is possible, (not necessarily likely), by the year 2100.
- The design life of the new project is 50 years, although it is quite likely that this life will be exceeded
- The project proposes to raise the cope level, i.e. the level of the edge of the new quay by 530 mm from its existing level of +3.72 m to 4.25 m CDP (Chart Datum Port - equivalent to Lowest Astronomical Tide).
- Daily maximum tidal rise in Durban is approximately 1,9 m, thus even at the highest spring tide, the new quay will still be some 2.35 m above current water level.
- The new mouth widening project and extension of the breakwater protects the harbour from wave action and extensive studies have shown that large wave events outside the Port are reduced to minimal wave action at the quays.

2.3 Conclusion

In our opinion therefore, it can be stated with confidence that,

- The proposed deepening of Berths 203 to 205 projects results in a higher quay which is less likely to be affected by SLR than the existing quay.
- Even at maximum projections, several centuries are likely to elapse before SLR could seriously affect the new works.

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