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1st March 2024

Ensync Engineers
1st Floor, The Boulevard
19 Park Lane
UMHLANGA RIDGE
4319

Attention: Ms. Nandiswa Mnguni Email: nandiswam@ensync.africa

Dear Madam,

PRELIMINARY REPORT ON DESKTOP GEOTECHNICAL INVESTIGATION FOR THE PROPOSED UMDONI SOUTH BULK WATER AUGMENTATION PIPELINE DEVELOPMENT – KWA-ZULU NATAL SOUTH COAST

1. INTRODUCTION AND TERMS OF REFERENCE

Drennan Maud (Pty) Ltd was appointed by Ensync Consulting Engineers to undertake a geotechnical desktop assessment coupled with localized field testing for the proposed Umdoni South Bulk water augmentation pipeline development.

Drennan Maud (Pty) Ltd have commenced with the desktop assessment, with site drive-over surveys and localized field testing currently underway at the time of publishing this preliminary desktop assessment report.

The findings of the desktop and limited field-testing report will be provided in a final desktop report once all relevant information has been assessed and the entire pipeline route has been appraised.

In the interim, set down below in this preliminary report is our initial preliminary assessment of the proposed pipeline development based on a desktop appraisal of available and supplied information and our previous experience in the nearby/surroundings areas.

2. SUPPLIED / REVIEWED INFORMATION

For the purpose of the geotechnical investigation Ensync Engineers supplied Drennan Maud with a suite of aerial photographs of the entire study area, indicating the alignment of proposed new augmentation pipeline as well as existing pipeline alignments therein. Furthermore, a Google Earth digital file indicating the scope of the pipeline augmentation was also supplied (Figure 1 below).

In addition to the above, the relevant 1:50 000 topographical sheets (3030 BC and BD Scottburgh) and 1:250 000 geological series (3030 Port Shepstone) were consulted and the information used to compile the locality plan (Drawing 34163-01) and geological plan (Drawing 34163-02) accompanying this preliminary report.

From information supplied it is understood that the proposed development comprises the upgrade and construction of a secondary bulk water supply pipeline as well as storage across the study area. The purpose of the development is to align the infrastructure with the increased demand at the Umdoni command reservoir, which supplies settlements on the KZN south coast including Sezela, Pennington, Umdoni, Kelso, Malangeni, Bazely, Ifafa, Elysium and Hilltop.

The total length of proposed pipeline amounts to approximately 29km. It is evident from the proposed pipeline alignment that several major road routes, including the N2 freeway and main district R102 road will be crossed as well as railway lines at selected positions, thus require pipe-jacking. Several river/estuary areas along the coastal region will also be crossed, these typically coinciding with existing railway bridge crossings.

3. LOCATION

The proposed pipeline augmentations alignment study area spans from Pennington in the north to Elysium in the south and inland as far as Ifafa Glebe/Amangamazi area on the Kwa-Zulu Natal south Coast.

The majority of the proposed pipeline augmentation alignment is located with a coastal corridor bounded in the west by the existing N2 freeway and in the north and south by the major Mzinto and Mtwalume Rivers respectively.

The approximate extent of the study area is depicted in Drawing 1 and Drawing 2 of this preliminary desktop report, whilst the supplied Google Earth alignment data is illustrated in Figure 1 overleaf.

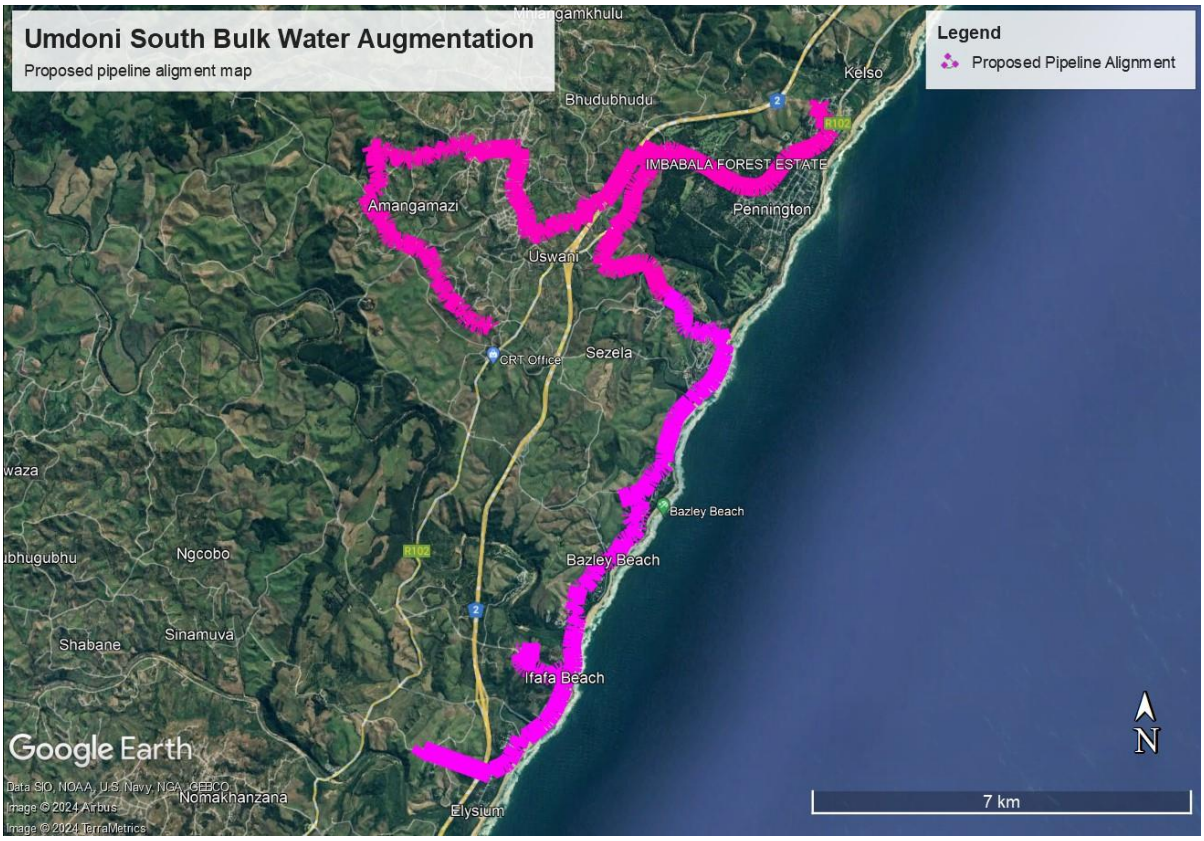

Figure 1: Proposed bulk water aygmentation pipeline alignment within study area between Pennington (north), Elysium (south) and Amangamazi (west).

4. CLIMATE

4.1 Temperature

Mean annual average temperature in the area is about 22°C, the warmest months being January and February when it is about 25°C, the coolest months being June and July when it is about 17°C.

4.2 Rainfall

Rainfall over the area is markedly seasonal, most rainfall occurring in the summer months of October to March. A rainfall gradient from the coastline inland prevails over the area, at the coast average annual rainfall being some 1150mm, this declining to about 900mm along the inland boundary of the area.

4.3 Evaporation

Average annual evaporation (USWB Class A Pan) over the area is some 1750mm, this varying from about 220mm in the month of January to about 80mm in the month of June.

5. TOPOGRAPHY AND DRAINAGE

The study area is characterized by undulating topography comprising well elevated hilltops and deep incised perennial and non-perennial drainage/stream valleys etched into the landscape, separated by moderately steep to steep sideslopes (>1:3) in places.

With the exception of relatively small towns located along the coastal cordon, including Pennington, Umdoni, Sezela, Bazely Beach, Ifafa Beach and Elysium, the area is largely under sugar cane cultivation. The portion of the study area in the Ifafa Glebe area is currently occupied by rural housing located along ridge tops and valley sideslopes.

Across the study area coastal cordon (i.e. east of the N2), elevation in the Sezela/Pennington area varies between approximately 80m to 130m above mean sea level along, reducing towards the coastline and ranging between ~50 and 100m along the central to southern portions of coastal cordon from Sezela to Elysium, it approaching sea level (i.e. <10m) in places. West of the N2, the elevation ranges between approximately 100m to 250m, increasing away from the coastline.

The study area is drained by several main rivers and associated tributaries; the Mzinto River along the north eastern boundary, the Mkumbane, Ifafa and Sezela Rivers through the central portion of the study area and the Mtwalume River in the south west, all flowing in a general south easterly direction towards the coast. A dendritic pattern characterizes the study area with many of the streams/rivers originating out of the relatively more elevated topography to the west.

The minor river valley bottoms are generally poorly drained with characteristic alluvial wetland conditions for much of the year until the onset of the seasonal rains when the streams flow strongly again in response to the precipitation. The main rivers mentioned above have an all-year base flow. There are areas of marsh/wetland within the broad valley bottoms of the minor streams feeding the prominent rivers mentioned above.

6. GEOLOGY, SOILS AND STRUCTURES

6.1 Geology

The geological formations occurring across the bulk pipeline augmentation study area are as follows (Figure 2);

Tillite (C-Pd)	Dwyka Tillite Formation	Karoo Group
Sandstone (O-Sn)		Natal Group
Granite/Gneiss (Nq, Nss, Nsm)	Mapumulo / Sezela Suites	Natal Metamorphic Province

The northern and central portions of the study area are underlain predominantly by rocks of the Natal Structural and Metamorphic Province comprising essentially of the Sezela Suite with localized occurrences of the Quha formation of the Mapamulo Metamorphic Suite.

Faulted outliers of Natal Group sandstone and Dwyka tillite extensively underlie the northern and southern portions of the study areas coastal cordon respectively with localized occurrence of Pietermaritzburg Formation shale in the vicinity of the Sezela river mouth.

Well elevated hilltop areas along the coastal cordon and shoreline areas are capped with Quaternary clayey sand sediment of the Berea Formation and Recent Aeolian dune sand.

The occurrence and distribution of the various geological formations present in the area in question are shown on the geological plan of the area, Figure 2, that accompanies this report.

6.2 Soils

In areas underlain by weathered granite and sandstone bedrock a mantle of colluvial grey/brown sand is expected across the elevated hilltops (<0.5m thick) and sideslopes (>0.5<1.5m thick). Residual soils, typically comprising slightly clayey to clayey sand are generally absent or very thin if present.

In areas underlain by weathered tillite bedrock, brown slightly clayey to clayey colluvial sand is typical, whilst the development of yellow brown clayey soils is more prevalent across sideslopes and valley bases and can host large to very large unweathered very hard rock boulders.

Localised occurrence of Berea Formation sediment comprises red brown clayey sand, typically capped by a variably thick mantle of recent dune sand which thickens and becomes more prevalent close to the shoreline/sea level.

Alluvium overlies the bedrock unconformably in the stream and river valleys and is expected to range between dark brown, sandy clay/clayey sand to clean brown fine to medium grained sand.

6.3 Structure

The “bedrock” geological structure of the area in question is one of tilted fault blocks. The fault blocks are generally tilted in a south-east or seaward direction angles of about 5º to 15º. The faulting giving rise to these blocks was associated with the disruption of Gondwana, about 165 million years ago, the intrusion of the karoo dolerite into the pre-existing Karoo Supergroup sedimentary rocks, mainly in

the form of sub-accordant sheets of varying thickness, having taken place somewhat prior to this at about 190 million years ago.

7. GEOTECHNICAL APPRAISAL AND CONSIDERATIONS

In terms of the proposed pipeline development and the geological conditions prevailing across the study area, geotechnical considerations and preliminary development recommendations that should be taken into account include, but are not limited to, the following;

7.1 Stability

7.1.1 *Overall Slope Stability*

Based on initial appraisal of aerial imagery no clear indication of large scale potentially unstable terrain was observed within the study area along the proposed pipeline alignment.

That being said, given the moderate to occasional steep topography characterizing the area, localized problems may be encountered associated where trench excavations along sideslopes and valley bottoms, in particular, where intersecting hillwash and/or deeply weathered clayey materials.

This will only become evident once more a detailed geotechnical site drive-over and localized testing has been completed.

7.1.2 *Trench / Excavation Stability*

The Standard Engineering Specifications to Earthworks for Pipe Trenches, part DB states that, 'trenches must be excavated in narrow sidewall conditions with vertical sides necessitating the use of adequate shoring methods to prevent erosion and consequent slope instability along any section of the proposed route".

The sandy residual and colluvial subsoils derived from the weathered sandstone and weathered granite as well as the alluvium and any fill material derived therefrom are likely to have relatively low clay content and associated cohesive characteristics. As such, potential instability can be expected in near vertical trench sidewalls in this sandy material if left open for extended periods of time. In the typically more clayey tillite derived soils sidewall collapse is relatively less common, but nevertheless still possible.

Excavations greater than 1.2m depth must be restricted to a maximum temporary slope batter of 1:1.75 (30°) in the all materials or alternatively adequately shored to ensure safe working conditions. Trench / excavation sidewalls in competent, firmly bedded, weathered sandstone/granite/tillite bedrock can be steepened or cut vertically over the short term, at the discretion of design Engineer and provided no adverse ground water seepage is encountered.

7.2 Problem Soils

7.2.1 *Active Soils*

The colluvial soils derived from the weathered granite and sandstone bedrock are unlikely to be active given their sandy nature. Similalrly, residual soils derived from these parent materials are likely to be more clayey (clayey sand to sandy clay) but also likely to only be slightly active at most.

Residual and colluvial soils derived from tillite bedrock as well as lenses/pockets of clayey alluvial may be subject to slight to moderate heave upon fluctuations in the materials in-situ moisture content.

7.2.2 *Collapsible/Compressible Soils*

The clayey residual soils derived from the in-situ weathering of the prevailing soils, if/where intersected, are likely to classify as low compressibility clay and thus only subject to slight consolidation upon loading. Soft alluvial clays, if encountered, may be somewhat more susceptible to consolidation settlement in the mid to long term.

Sandy alluvial material, likely encountered in valley/stream bases may classify as potentially collapsible in the sense that the material will undergo settlement under an implied load, with a critical increase in the materials in-situ moisture content. Similalrly, sandy colluvial soils as well as recent dune sand and Berea Formation sediment may also be somewhat collapsible, especially if very loose to loose and substantially thick.

7.2.3 *Erosive Soils*

The soils associated with sandstone and granite rocks are moderately susceptible to erosion, whilst the recent dune sand and Berea formation sediment are considered highly prone to erosion via concentrated flowing water across sloping areas. Clayey soils are less susceptible to erosion however the onset of erosion gullies/dongas therein is still possible under concentrated flow.

7.3 Seepage

Across elevated hilltops and sideslopes ground water seepage is likely to be encountered at the soil / rock interface, perched on less permeable horizons or along open joints within the weathered bedrock

which act as conduits for seasonal seepage especially in the wetter summer months. Such seepage is likely to occur during or shortly after rainfall events and be relatively short-lived.

Along lower slope and valley bottoms or towards the heads of natural drainage lines / depressions more permanent seepage is likely to be encountered at relatively shallow depths where perched in/on less permeable soils.

Notwithstanding the above seepage is expected to be non-problematic as long as all the necessary precautions are taken and the trench and structure excavations are properly shored and supported where required. Where encountered seepage should be dealt with symptomatically as and when it occurs. Should seepage persist suitable measures should be installed to keep the excavations dry (I.e. sump and pumping and/or dewatering) during pipe installation.

7.4 Material Suitability

According to SABS 1200 LB standards, the bedding requirements for pipes should be based on the following:

- ***Selected Granular Material***: Non-cohesive, singularly graded between 0.6 mm and 19 mm, having a compactibility factor not exceeding 0.4.

- ***Selected Fill Material:*** Material with a plasticity index not exceeding 6 and free of vegetation and lumps or stones exceeding 30mm.

In terms of the above the likely suitability of the various materials encountered on site are as follows;

Depending on the degree of weathering the weathered sandstone, granite and tillite material may fall within the required compactability limits but will likely not meet the minimum grading requirements. As such additional screening of the material would be required to produce a suitable pipe bedding material.

The weathered sandstone and granite/gneiss may also be suitable for selected fill material, as the weathered sandstone/granite is likely to have a relatively low clay content and therefore have a low associated plasticity index, unlike typical highly weathered tillite. However, this will be dependent on the degree of weathering and mineral content of the weathered bedrock.

Sandy alluvium and sandy colluvium as well as Recent dune sand material may potentially have suitable gradings, plasticity indices and compactability factors that would deem the respective materials suitable for selected pipe bedding and selected fill. Additional screening may be required in order to singularly grade the material.

The fill, colluvium, alluvium, residual and weathered sandstone/granite/tillite are generally regarded as suitable for general fill purposes.

With regard to the above, it must be noted that additional laboratory testing will be required during the site investigation to confirm the above preliminary assessment and provide more specific recommendations regarding material suitability.

7.5 Trench Excavatability

The invert level of the proposed bulk water augmentation pipeline is unknown, but inferred to be at an approximate depth of 3.0m below ground level.

Along the coastal cordon, in areas underlain by recent dune sand and Berea Formation sediment, or in deeply weathered valley bottoms underlain by alluvial/residual soil, excavation therein through the entire depth of the material is considered by and large to be easily achievable.

Elevated areas and sideslopes underlain by sandstone, granite or tillite bedrock are anticipated to be generally highly weathered and thus in general;

- On **side slopes**, 'soft' excavation (after SABS 1200D) is expected to depths in the order of 2.0 - 3.0m through all unconsolidated material and completely to highly weathered tillite, granite and sandstone bedrock, below which 'intermediate' excavation may be encountered in the underlying less weathered bedrock.

- Approaching **low lying valley areas**, 'soft' excavation (after SABS 1200D) is anticipated to depths >3m, below which excavation may increase to 'intermediate' in less weathered bedrock if intersected.

The above is supported by an appraisal of aerial imagery which reveals cuts along hilltops and upper sideslopes for local rural housing platforms in the Ifafa Glebe portion of the study area underlain by weathered granite extending to depths of 2-3m.

Notwithstanding the above, weathering in granite, tillite and sandstone bedrock can be somewhat erratic with hard/unweathered quartzite lenses encountered locally in areas underlain by sandstone/granite and hard rock corestones in areas underlain by tillite. If locally encountered, such obstructions would require greater effort to remove efficiently.

7.6 Road and River Crossings

It is evident from the intended alignment that the proposed pipeline will span several existing major river mouth areas as well as pass below several major existing national (N2) and district (R102) roads.

With regard to river crossings, although no details have been provided at this stage, given the size/nature of the river mouths to be crossed along the coastal cordon, relatively large pipe bridges may be required. As an alternative, as the alignment coincides closely with existing road/rail lines, it is considered feasible that pipes span the drainage features on the underside of the existing bridges.

Where crossing small side roads, open trench pipe installation is deemed appropriate, however, where spanning major road routes, pipe-jacking thereunder will be required. The considerations for such crossings will be addressed once localized field testing has been carried out at the respective locations. However, that being said such pipe-jacking is considered feasible as has been carried out in numerous locations in the nearby surrounding areas within the various prevailing bedrock strata.

7.7 Structure Development

No details of any structures required along the pipeline alignment have been have been provided at this preliminary stage. However, if required, earthworks associated therewith in general should adopt the following;

All permanent cut slopes in the sandy colluvial, residual and alluvial soils as well as sandy fill material should be limited to 1:2 (26°). The cut slopes may be increased to 1:1.5 (33°) in the highly to completely weathered bedrock.

Should filling be required for the creation of any platforms, fills should be constructed of suitable granular material (G10 or better) placed in layers not exceeding 300 mm loose thickness compacted to 95% of the materials Mod AASHTO density prior to the placement of the next layer. The maximum particle size of the fill should not exceed two thirds the layer thickness. The maximum slope angle of any engineered fill should be restricted to 1:2 (26°).

Prior to the placing of any fill, all vegetation must be completely removed. On original slopes exceeding 10° (1:6), it is prudent to bench the new fill into competent material to enhance slope stability. Furthermore, fills should not be placed on top of potentially unstable existing fill embankments. All permanent cut and fill batters should be vegetated as soon as possible after construction to reduce the likelihood and severity of potential soil erosion.

In general, for any proposed pump station/reservoir structures, in areas underlain by weathered granite, tillite or sandstone bedrock at relatively shallow depth, founding on conventional shallow footings taken into the bedrock can be considered. In areas, underlain by loose soils to considerable depth, depending on the structural loads and sensitivity to settlement, deep founding on pile foundations may be required. For compact/lightly loaded structures suitably designed reinforced raft foundations can be considered. Ideally the structures should be placed entirely in cut, but where spanning cut to fill platforms, the foundation must be suitably stiffened/articulated to accommodate any differential settlement.

The above general founding recommendations are provided as a guide only. More detailed recommendations will be provided once more details pertaining to potential structures are provided and the site-specific testing has been carried out.

8. CONCLUSION

From the initial desktop assessment of the study area, our preliminary findings are that all aspects of the proposed pipeline augmentation development are considered feasible provided the above general assessment and general recommendations are taken into consideration in the planning phase of the project.

Once the localized testing component of the current assessment has been completed and the results assessed, further comment and recommendations pertaining to the proposed development with regards to material suitability, problem soils, seepage, trenchability and other pertinent geotechnical aspects along the pipeline route will be discussed in our final report.

We trust that the above information meets with your immediate requirements in this regard and will be pleased to furnish you with any additional information you may require.

Yours faithfully,
DRENNAN MAUD (PTY) LTD

A. JOUBERT Pr.Sci.Nat

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Enclosures:	*Drawing No. 34163-01*	-	*Locality Plan*
	Drawing No. 34163-01	-	*Geological Plan*

DRAWING 34163-01
Locality Plan

Preliminary Report: Desktop Geotechnical Investigation for Proposed Umdoni South Bulk Water Augmentation Pipeline – KZN South Coast

LEGEND

Approximate extent of study area

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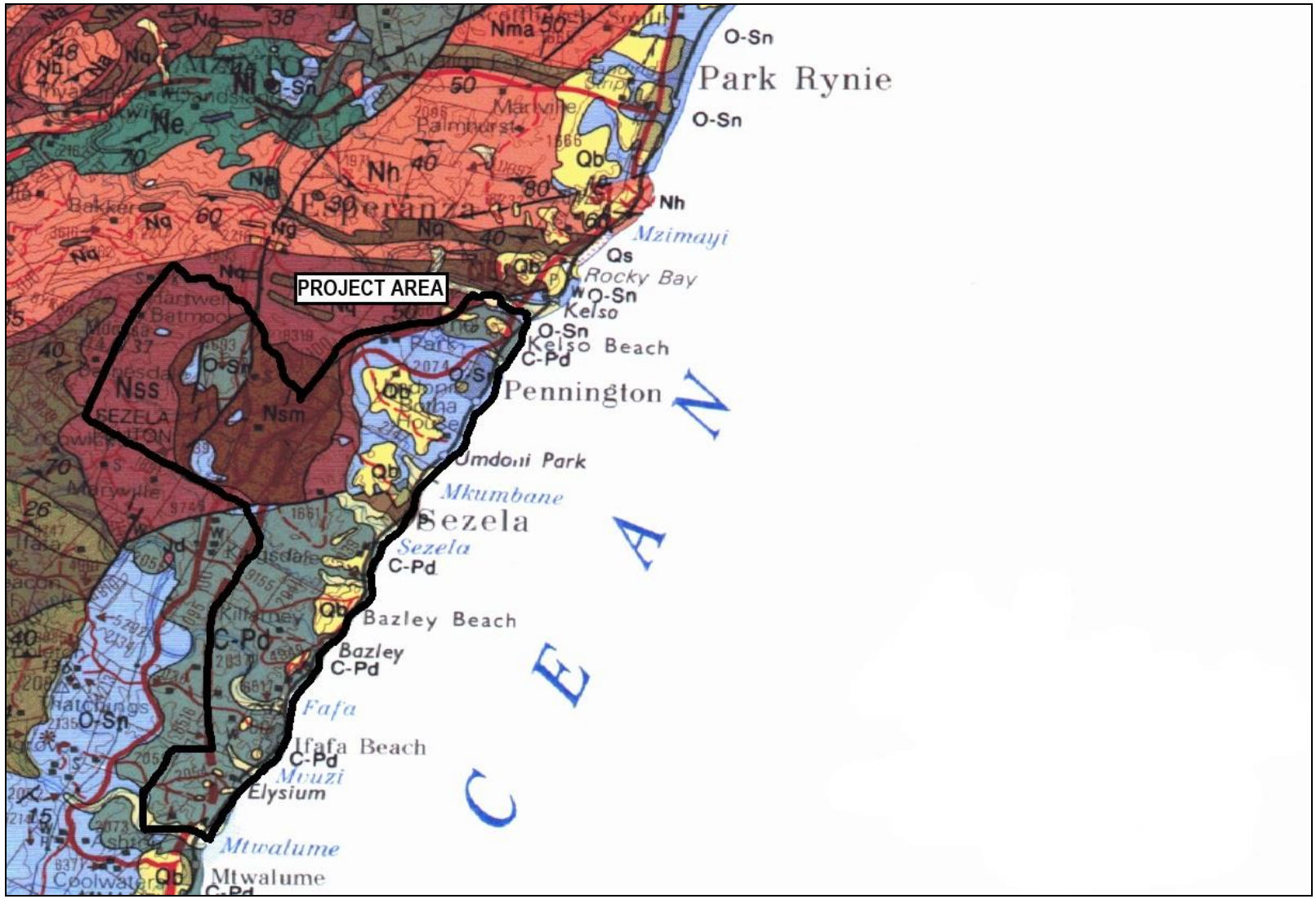
PROJECT
Umdoni South Bulk Water Aug Pipeline

TITLE
Locality Plan – Drawing1

REF. 34163-01

DRAWING 34163-02
Geological Plan



Preliminary Report: Desktop Geotechnical Investigation for Proposed Umdoni South Bulk Water Augmentation Pipeline – KZN South Coast

LEGEND

Approximate extent of study area

N

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PROJECT
Umdoni South Bulk Water Aug Pipeline

TITLE
Geological Plan – Drawing 2

REF. 34163-02